Government Gazette
Staatskoerant

REPUBLIC OF SOUTH AFRICA
REPUBLIEK VAN SUID AFRIKA

Vol. 731 29 May Mei 2026 No. 54758

PART 1 OF 7

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ISSN 1682-5845

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NO FUTURE QUERIES WILL BE HANDLED IN CONNECTION WITH THE ABOVE.

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government printing
Department:
Government Printing Works
REPUBLIC OF SOUTH AFRICA

HIGH ALERT: SCAM WARNING!!!

TO ALL SUPPLIERS AND SERVICE PROVIDERS OF THE GOVERNMENT PRINTING WORKS

It has come to the attention of the *GOVERNMENT PRINTING WORKS* that there are certain unscrupulous companies and individuals who are defrauding unsuspecting businesses disguised as representatives of the *Government Printing Works* (*GPW*).

The scam involves the fraudsters using the letterhead of *GPW* to send out fake tender bids to companies and requests to supply equipment and goods.

Although the contact person's name on the letter may be of an existing official, the contact details on the letter are not the same as the *Government Printing Works*'. When searching on the Internet for the address of the company that has sent the fake tender document, the address does not exist.

The banking details are in a private name and not company name. Government will never ask you to deposit any funds for any business transaction. *GPW* has alerted the relevant law enforcement authorities to investigate this scam to protect legitimate businesses as well as the name of the organisation.

Example of e-mails these fraudsters are using:

PROCUREMENT@GPW-GOV.ORG

Should you suspect that you are a victim of a scam, you must urgently contact the police and inform the *GPW*.

GPW has an official email with the domain as **@gpw.gov.za**

Government e-mails DO NOT have org in their e-mail addresses. All of these fraudsters also use the same or very similar telephone numbers. Although such number with an area code 012 looks like a landline, it is not fixed to any property.

GPW will never send you an e-mail asking you to supply equipment and goods without a purchase/order number. *GPW* does not procure goods for another level of Government. The organisation will not be liable for actions that result in companies or individuals being resultant victims of such a scam.

Government Printing Works gives businesses the opportunity to supply goods and services through RFQ / Tendering process. In order to be eligible to bid to provide goods and services, suppliers must be registered on the National Treasury's Central Supplier Database (CSD). To be registered, they must meet all current legislative requirements (e.g. have a valid tax clearance certificate and be in good standing with the South African Revenue Services - SARS).

The tender process is managed through the Supply Chain Management (SCM) system of the department. SCM is highly regulated to minimise the risk of fraud, and to meet objectives which include value for money, open and effective competition, equitability, accountability, fair dealing, transparency and an ethical approach. Relevant legislation, regulations, policies, guidelines and instructions can be found on the tender's website.

Fake Tenders

National Treasury's CSD has launched the Government Order Scam campaign to combat fraudulent requests for quotes (RFQs). Such fraudulent requests have resulted in innocent companies losing money. We work hard at preventing and fighting fraud, but criminal activity is always a risk.

How tender scams work

There are many types of tender scams. Here are some of the more frequent scenarios:

Fraudsters use what appears to be government department stationery with fictitious logos and contact details to send a fake RFQ to a company to invite it to urgently supply goods. Shortly after the company has submitted its quote, it receives notification that it has won the tender. The company delivers the goods to someone who poses as an official or at a fake site. The Department has no idea of this transaction made in its name. The company is then never paid and suffers a loss.

OR

Fraudsters use what appears to be government department stationery with fictitious logos and contact details to send a fake RFQ to Company A to invite it to urgently supply goods. Typically, the tender specification is so unique that only Company B (a fictitious company created by the fraudster) can supply the goods in question.

Shortly after Company A has submitted its quote it receives notification that it has won the tender. Company A orders the goods and pays a deposit to the fictitious Company B. Once Company B receives the money, it disappears. Company A's money is stolen in the process.

Protect yourself from being scammed

- If you are registered on the supplier databases and you receive a request to tender or quote that seems to be from a government department, contact the department to confirm that the request is legitimate. Do not use the contact details on the tender document as these might be fraudulent.
- Compare tender details with those that appear in the Tender Bulletin, available online at **www.gpwonline.co.za**
- Make sure you familiarise yourself with how government procures goods and services. Visit the tender website for more information on how to tender.
- If you are uncomfortable about the request received, consider visiting the government department and/or the place of delivery and/or the service provider from whom you will be sourcing the goods.
- In the unlikely event that you are asked for a deposit to make a bid, contact the SCM unit of the department in question to ask whether this is in fact correct.

Any incidents of corruption, fraud, theft and misuse of government property in the *Government Printing Works* can be reported to:

Supply Chain Management: Ms. Anna Marie Du Toit, Tel. (012) 748 6292.
Email: **Annamarie.DuToit@gpw.gov.za**

Marketing and Stakeholder Relations: Ms Bonakele Mbhele, at Tel. (012) 748 6193.
Email: **Bonakele.Mbhele@gpw.gov.za**

Security Services: Mr Daniel Legoabe, at tel. (012) 748 6176.
Email: **Daniel.Legoabe@gpw.gov.za**

Closing times for **ORDINARY WEEKLY** *GOVERNMENT GAZETTE* 2026

*The closing time is **15:00** sharp on the following days:*

- **23 December,** Tuesday for the issue of Friday **02 January 2026**
- **02 January,** Friday for the issue of Friday **09 January 2026**
- **09 January,** Friday for the issue of Friday **16 January 2026**
- **16 January,** Friday for the issue of Friday **23 January 2026**
- **23 January,** Friday for the issue of Friday **30 January 2026**
- **30 January,** Friday for the issue of Friday **06 February 2026**
- **06 February,** Friday for the issue of Friday **13 February 2026**
- **13 February,** Friday for the issue of Friday **20 February 2026**
- **20 February,** Friday for the issue of Friday **27 February 2026**
- **27 February,** Friday for the issue of Friday **06 March 2026**
- **06 March,** Friday for the issue of Friday **13 March 2026**
- **13 March,** Friday for the issue of Thursday **20 March 2026**
- **20 March,** Friday for the issue of Friday **27 March 2026**
- **26 March,** Thursday for the issue of Thursday **02 April 2026**
- **01 April,** Wednesday for the issue of Friday **10 April 2026**
- **10 April,** Friday for the issue of Friday **17 April 2026**
- **17 April,** Friday for the issue of Friday **24 April 2026**
- **22 April,** Wednesday for the issue of Thursday **30 April 2026**
- **30 April,** Thursday for the issue of Friday **08 May 2026**
- **08 May,** Friday for the issue of Friday **15 May 2026**
- **15 May,** Friday for the issue of Friday **22 May 2026**
- **22 May,** Friday for the issue of Friday **29 May 2026**
- **29 May,** Friday for the issue of Friday **05 June 2026**
- **05 June,** Friday for the issue of Friday **12 June 2026**
- **11 June,** Thursday for the issue of Friday **19 June 2026**
- **19 June,** Friday for the issue of Friday **26 June 2026**
- **26 June,** Friday for the issue of Friday **03 July 2026**
- **03 July,** Friday for the issue of Friday **10 July 2026**
- **10 July,** Friday for the issue of Friday **17 July 2026**
- **17 July,** Friday for the issue of Friday **24 July 2026**
- **24 July,** Friday for the issue of Friday **31 July 2026**
- **31 July,** Friday for the issue of Friday **07 August 2026**
- **06 August,** Thursday for the issue of Friday **14 August 2026**
- **14 August,** Friday for the issue of Friday **21 August 2026**
- **21 August,** Friday for the issue of Friday **28 August 2026**
- **28 August,** Friday for the issue of Friday **04 September 2026**
- **04 September,** Friday for the issue of Friday **11 September 206**
- **11 September,** Friday for the issue of Friday **18 September 2026**
- **17 September,** Thursday for the issue of Friday **25 September 2026**
- **25 September,** Friday for the issue of Friday **02 October 2026**
- **02 October,** Friday for the issue of Friday **09 October 2026**
- **09 October,** Friday for the issue of Friday **16 October 2026**
- **16 October,** Friday for the issue of Friday **23 October 2026**
- **23 October,** Friday for the issue of Friday **30 October 2026**
- **30 October,** Friday for the issue of Friday **06 November 2026**
- **06 November,** Friday for the issue of Friday **13 November 2026**
- **13 November,** Friday for the issue of Friday **20 November 2026**
- **20 November,** Friday for the issue of Friday **27 November 2026**
- **27 November,** Friday for the issue of Friday **04 December 2026**
- **04 December,** Friday for the issue of Friday **11 December 2026**
- **10 December,** Thursday for the issue of Friday **18 December 2026**
- **17 December,** Thursday for the issue of Thursday **24 December 2026**
- **23 December,** Wednesday for the issue of Thursday **31 December 2026**

LIST OF TARIFF RATES

FOR PUBLICATION OF NOTICES

COMMENCEMENT: 1 APRIL 2018

NATIONAL AND PROVINCIAL

Notice sizes for National, Provincial & Tender gazettes 1/4, 2/4, 3/4, 4/4 per page. Notices submitted will be charged at R1008.80 per full page, pro-rated based on the above categories.

Pricing for National, Provincial - Variable Priced Notices		
Notice Type	**Page Space**	**New Price (R)**
Ordinary National, Provincial	1/4 - Quarter Page	252.20
Ordinary National, Provincial	2/4 - Half Page	504.40
Ordinary National, Provincial	3/4 - Three Quarter Page	756.60
Ordinary National, Provincial	4/4 - Full Page	1008.80

EXTRA-ORDINARY

All Extra-ordinary National and Provincial gazette notices are non-standard notices and attract a variable price based on the number of pages submitted.

The pricing structure for National and Provincial notices which are submitted as **Extra ordinary submissions** will be charged at R**3026.32** per page.

GOVERNMENT PRINTING WORKS - BUSINESS RULES

The **Government Printing Works** (**GPW**) has established rules for submitting notices in line with its electronic notice processing system, which requires the use of electronic *Adobe* Forms. Please ensure that you adhere to these guidelines when completing and submitting your notice submission.

Closing Times for Acceptance of Notices

1. The *Government Gazette* and *Government Tender Bulletin* are weekly publications that are published on Fridays and the closing time for the acceptance of notices is strictly applied according to the scheduled time for each gazette.

2. Please refer to the Submission Notice Deadline schedule in the table below. This schedule is also published online on the Government Printing works website www.gpwonline.co.za

   All re-submissions will be subject to the standard cut-off times.
   All notices received after the closing time will be rejected.

Government Gazette Type	Publication Frequency	Publication Date	Submission Deadline	Cancellations Deadline
National Gazette	Weekly	Friday	Friday 15h00 for next Friday	Tuesday, 15h00 - 3 working days prior to publication
Regulation Gazette	Weekly	Friday	Friday 15h00 for next Friday	Tuesday, 15h00 - 3 working days prior to publication
Petrol Price Gazette	Monthly	Tuesday before 1st Wednesday of the month	One day before publication	1 working day prior to publication
Road Carrier Permits	Weekly	Friday	Thursday 15h00 for next Friday	3 working days prior to publication
Unclaimed Monies (Justice, Labour or Lawyers)	January / September 2 per year	Last Friday	One week before publication	3 working days prior to publication
Parliament (Acts, White Paper, Green Paper)	As required	Any day of the week	None	3 working days prior to publication
Manuals	Bi- Monthly	2nd and last Thursday of the month	One week before publication	3 working days prior to publication
State of Budget (National Treasury)	Monthly	30th or last Friday of the month	One week before publication	3 working days prior to publication
Extraordinary Gazettes	As required	Any day of the week	*Before 10h00 on publication date*	*Before 10h00 on publication date*
Legal Gazettes A, B and C	Weekly	Friday	One week before publication	Tuesday, 15h00 - 3 working days prior to publication
Tender Bulletin	Weekly	Friday	Friday 15h00 for next Friday	Tuesday, 15h00 - 3 working days prior to publication
Gauteng	Weekly	Wednesday	Two weeks before publication	3 days **after** submission deadline
Eastern Cape	Weekly	Monday	One week before publication	3 working days prior to publication
Northern Cape	Weekly	Monday	One week before publication	3 working days prior to publication
North West	Weekly	Tuesday	One week before publication	3 working days prior to publication
KwaZulu-Natal	Weekly	Thursday	One week before publication	3 working days prior to publication
Limpopo	Weekly	Friday	One week before publication	3 working days prior to publication
Mpumalanga	Weekly	Friday	One week before publication	3 working days prior to publication

GOVERNMENT PRINTING WORKS - BUSINESS RULES

Government Gazette Type	Publication Frequency	Publication Date	Submission Deadline	Cancellations Deadline
Gauteng Liquor License Gazette	Monthly	Wednesday before the First Friday of the month	Two weeks before publication	3 working days **after** submission deadline
Northern Cape Liquor License Gazette	Monthly	First Friday of the month	Two weeks before publication	3 working days **after** submission deadline
National Liquor License Gazette	Monthly	First Friday of the month	Two weeks before publication	3 working days **after** submission deadline
Mpumalanga Liquor License Gazette	Bi-Monthly	Second & Fourth Friday	One week before publication	3 working days prior to publication

Extraordinary Gazettes

3. *Extraordinary Gazettes* can have only one publication date. If multiple publications of an *Extraordinary Gazette* are required, a separate Z95/Z95Prov *Adobe* Forms for each publication date must be submitted.

Notice Submission Process

4. Download the latest *Adobe* form, for the relevant notice to be placed, from the **Government Printing Works** website www.gpwonline.co.za.

5. The *Adobe* form needs to be completed electronically using *Adobe Acrobat* / *Acrobat Reader*. Only electronically completed *Adobe* forms will be accepted. No printed, handwritten and/or scanned *Adobe* forms will be accepted.

6. The completed electronic *Adobe* form has to be submitted via email to submit.egazette@gpw.gov.za. The form needs to be submitted in its original electronic *Adobe* format to enable the system to extract the completed information from the form for placement in the publication.

7. Every notice submitted **must** be accompanied by an official **GPW** quotation. This must be obtained from the *eGazette* Contact Centre.

8. Each notice submission should be sent as a single email. The email **must** contain **all documentation relating to a particular notice submission**.

   8.1. Each of the following documents must be attached to the email as a separate attachment:

      8.1.1. An electronically completed *Adobe* form, specific to the type of notice that is to be placed.

         8.1.1.1. For National *Government Gazette* or *Provincial Gazette* notices, the notices must be accompanied by an electronic Z95 or Z95Prov *Adobe* form

         8.1.1.2. The notice content (body copy) **MUST** be a separate attachment.

      8.1.2. A copy of the official **Government Printing Works** quotation you received for your notice. *(Please see Quotation section below for further details)*

      8.1.3. A valid and legible Proof of Payment / Purchase Order: **Government Printing Works** account customer must include a copy of their Purchase Order**. Non-Government Printing Works** account customer needs to submit the proof of payment for the notice

      8.1.4. Where separate notice content is applicable (Z95, Z95 Prov and TForm 3, it should **also** be attached as a separate attachment. *(Please see the Copy Section below, for the specifications)*.

      8.1.5. Any additional notice information if applicable.

GOVERNMENT PRINTING WORKS - BUSINESS RULES

9. The electronic *Adobe* form will be taken as the primary source for the notice information to be published. Instructions that are on the email body or covering letter that contradicts the notice form content will not be considered. The information submitted on the electronic *Adobe* form will be published as-is.

10. To avoid duplicated publication of the same notice and double billing, Please submit your notice **ONLY ONCE.**

11. Notices brought to **GPW** by "walk-in" customers on electronic media can only be submitted in *Adobe* electronic form format. All "walk-in" customers with notices that are not on electronic *Adobe* forms will be routed to the Contact Centre where they will be assisted to complete the forms in the required format.

12. Should a customer submit a bulk submission of hard copy notices delivered by a messenger on behalf of any organisation e.g. newspaper publisher, the messenger will be referred back to the sender as the submission does not adhere to the submission rules.

QUOTATIONS

13. Quotations are valid until the next tariff change.

    13.1. ***Take note:*** **GPW**'s annual tariff increase takes place on ***1 April*** therefore any quotations issued, accepted and submitted for publication up to ***31 March*** will keep the old tariff. For notices to be published from 1 April, a quotation must be obtained from **GPW** with the new tariffs. Where a tariff increase is implemented during the year, **GPW** endeavours to provide customers with 30 days' notice of such changes.

14. Each quotation has a unique number.

15. Form Content notices must be emailed to the *eGazette* Contact Centre for a quotation.

    15.1. The *Adobe* form supplied is uploaded by the Contact Centre Agent and the system automatically calculates the cost of your notice based on the layout/format of the content supplied.

    15.2. It is critical that these *Adobe* Forms are completed correctly and adhere to the guidelines as stipulated by **GPW**.

16. **APPLICABLE ONLY TO GPW ACCOUNT HOLDERS**:

    16.1. **GPW** Account Customers must provide a valid **GPW** account number to obtain a quotation.

    16.2. Accounts for **GPW** account customers **must** be active with sufficient credit to transact with **GPW** to submit notices.

        16.2.1. If you are unsure about or need to resolve the status of your account, please contact the **GPW** Finance Department prior to submitting your notices. (If the account status is not resolved prior to submission of your notice, the notice will be failed during the process).

17. **APPLICABLE ONLY TO CASH CUSTOMERS:**

    17.1. Cash customers doing **bulk payments** must use a **single email address** in order to use the **same proof of payment** for submitting multiple notices.

18. The responsibility lies with you, the customer, to ensure that the payment made for your notice(s) to be published is sufficient to cover the cost of the notice(s).

19. Each quotation will be associated with one proof of payment / purchase order / cash receipt.

    19.1. This means that **the quotation number can only be used once to make a payment.**

GOVERNMENT PRINTING WORKS - BUSINESS RULES

COPY (SEPARATE NOTICE CONTENT DOCUMENT)

20. Where the copy is part of a separate attachment document for Z95, Z95Prov and TForm03

20.1. Copy of notices must be supplied in a separate document and may not constitute part of any covering letter, purchase order, proof of payment or other attached documents.

The content document should contain only one notice. (You may include the different translations of the same notice in the same document).

20.2. The notice should be set on an A4 page, with margins and fonts set as follows:

Page size = A4 Portrait with page margins: Top = 40mm, LH/RH = 16mm, Bottom = 40mm; Use font size: Arial or Helvetica 10pt with 11pt line spacing;

Page size = A4 Landscape with page margins: Top = 16mm, LH/RH = 40mm, Bottom = 16mm; Use font size: Arial or Helvetica 10pt with 11pt line spacing;

CANCELLATIONS

21. Cancellation of notice submissions are accepted by **GPW** according to the deadlines stated in the table above in point 2. Non-compliance to these deadlines will result in your request being failed. Please pay special attention to the different deadlines for each gazette. Please note that any notices cancelled after the cancellation deadline will be published and charged at full cost.

22. Requests for cancellation must be sent by the original sender of the notice and must accompanied by the relevant notice reference number (N-) in the email body.

AMENDMENTS TO NOTICES

23. With effect from 01 October 2015, **GPW** will not longer accept amendments to notices. The cancellation process will need to be followed according to the deadline and a new notice submitted thereafter for the next available publication date.

REJECTIONS

24. All notices not meeting the submission rules will be rejected to the customer to be corrected and resubmitted. Assistance will be available through the Contact Centre should help be required when completing the forms. (012-748 6200 or email info.egazette@gpw.gov.za). Reasons for rejections include the following:

24.1. Incorrectly completed forms and notices submitted in the wrong format, will be rejected.

24.2. Any notice submissions not on the correct *Adobe* electronic form, will be rejected.

24.3. Any notice submissions not accompanied by the proof of payment / purchase order will be rejected and the notice will not be processed.

24.4. Any submissions or re-submissions that miss the submission cut-off times will be rejected to the customer. The Notice needs to be re-submitted with a new publication date.

GOVERNMENT PRINTING WORKS - BUSINESS RULES

APPROVAL OF NOTICES

25. Any notices other than legal notices are subject to the approval of the Government Printer, who may refuse acceptance or further publication of any notice.

26. No amendments will be accepted in respect to separate notice content that was sent with a Z95 or Z95Prov notice submissions. The copy of notice in layout format (previously known as proof-out) is only provided where requested, for Advertiser to see the notice in final Gazette layout. Should they find that the information submitted was incorrect, they should request for a notice cancellation and resubmit the corrected notice, subject to standard submission deadlines. The cancellation is also subject to the stages in the publishing process, i.e. If cancellation is received when production (printing process) has commenced, then the notice cannot be cancelled.

GOVERNMENT PRINTER INDEMNIFIED AGAINST LIABILITY

27. The Government Printer will assume no liability in respect of—

27.1. any delay in the publication of a notice or publication of such notice on any date other than that stipulated by the advertiser;

27.2. erroneous classification of a notice, or the placement of such notice in any section or under any heading other than the section or heading stipulated by the advertiser;

27.3. any editing, revision, omission, typographical errors or errors resulting from faint or indistinct copy.

LIABILITY OF ADVERTISER

28. Advertisers will be held liable for any compensation and costs arising from any action which may be instituted against the Government Printer in consequence of the publication of any notice.

CUSTOMER INQUIRIES

Many of our customers request immediate feedback/confirmation of notice placement in the gazette from our Contact Centre once they have submitted their notice – While **GPW** deems it one of their highest priorities and responsibilities to provide customers with this requested feedback and the best service at all times, we are only able to do so once we have started processing your notice submission.
GPW has a 2-working day turnaround time for processing notices received according to the business rules and deadline submissions.
Please keep this in mind when making inquiries about your notice submission at the Contact Centre.

29. Requests for information, quotations and inquiries must be sent to the Contact Centre ONLY.

30. Requests for Quotations (RFQs) should be received by the Contact Centre at least **2 working days** before the submission deadline for that specific publication.

GOVERNMENT PRINTING WORKS - BUSINESS RULES

Payment of cost

31. The Request for Quotation for placement of the notice should be sent to the Gazette Contact Centre as indicated above, prior to submission of notice for advertising.

32. Payment should then be made, or Purchase Order prepared based on the received quotation, prior to the submission of the notice for advertising as these documents i.e. proof of payment or Purchase order will be required as part of the notice submission, as indicated earlier.

33. Every proof of payment must have a valid **GPW** quotation number as a reference on the proof of payment document.

34. Where there is any doubt about the cost of publication of a notice, and in the case of copy, an enquiry, accompanied by the relevant copy, should be addressed to the Gazette Contact Centre, **Government Printing Works**, Private Bag X85, Pretoria, 0001 email: info.egazette@gpw.gov.za before publication.

35. Overpayment resulting from miscalculation on the part of the advertiser of the cost of publication of a notice will not be refunded, unless the advertiser furnishes adequate reasons why such miscalculation occurred. In the event of underpayments, the difference will be recovered from the advertiser, and future notice(s) will not be published until such time as the full cost of such publication has been duly paid in cash or electronic funds transfer into the **Government Printing Works** banking account.

36. In the event of a notice being cancelled, a refund will be made only if no cost regarding the placing of the notice has been incurred by the **Government Printing Works**.

37. The **Government Printing Works** reserves the right to levy an additional charge in cases where notices, the cost of which has been calculated in accordance with the List of Fixed Tariff Rates, are subsequently found to be excessively lengthy or to contain overmuch or complicated tabulation.

Proof of publication

38. Copies of any of the *Government Gazette* or *Provincial Gazette* can be downloaded from the **Government Printing Works** website www.gpwonline.co.za free of charge, should a proof of publication be required.

39. Printed copies may be ordered from the Publications department at the ruling price. The **Government Printing Works** will assume no liability for any failure to post or for any delay in despatching of such *Government Gazette*(s)

GOVERNMENT PRINTING WORKS CONTACT INFORMATION

Physical Address:	**Postal Address:**	**GPW Banking Details:**
Government Printing Works	Private Bag X85	**Bank:** ABSA Bosman Street
149 Bosman Street	Pretoria	**Account No.:** 405 7114 016
Pretoria	0001	**Branch Code:** 632-005

For Gazette and Notice submissions: Gazette Submissions:	**E-mail:** submit.egazette@gpw.gov.za
For queries and quotations, contact: Gazette Contact Centre:	**E-mail:** info.egazette@gpw.gov.za
	Tel: 012-748 6200
Contact person for subscribers: Mrs M. Toka:	**E-mail:** subscriptions@gpw.gov.za
	Tel: 012-748-6066 / 6060 / 6058
	Fax: 012-323-9574

DEPARTMENT OF AGRICULTURE

NO. 7534 **29 May 2026**

AGRICULTURAL PRODUCT STANDARDS ACT, 1990
(ACT No. 119 OF 1990)

REGULATIONS REGARDING THE CLASSIFICATION AND MARKING OF MEAT INTENDED FOR SALE IN THE REPUBLIC OF SOUTH AFRICA

INVITATION FOR PUBLIC COMMENTS:

I, John Henry Steenhuisen, Minister for Agriculture, acting under section 15 of the Agricultural Product Standards Act, 1990 (Act No. 119 of 1990), hereby make known that I intend to publish the amended regulations relating to classification and marking of meat intended for sale in the Republic of South Africa

All interested parties are invited to submit comments and any representations concerning the above-mentioned proposed amended regulations in writing within **30 days** from the date of publication of this Notice to the following address:

Executive Officer: Agricultural Product Standards
Department of Agriculture
Private Bag X343, Pretoria, 0001
30 Hamilton Street, Harvest House Building, Arcadia, Room 156
Tel. no. 012 319 6231; Fax no. 012 319 6265
Email: DibetsoK@nda.gov.za

The proposed amendment regulations are available on the Department's website at the following link: Department of Agriculture - Draft Legislation for Comments, or can be forwarded via electronic mail or posted to any person upon request.

MR JH STEENHUISEN, MP
MINISTER FOR AGRICULTURE

DEPARTMENT OF AGRICULTURE

NO. 7535 **29 May 2026**

NAMC
Promoting market access for South African agriculture

Hillcrest Office Park, 177 Dyer Road, Barbet Place, Ground Floor, Hillcrest, Pretoria, 0083
Private Bag X935, Pretoria, 0001
Tel: 012 341 1115 | **Email:** info@namc.co.za
www.namc.co.za

18 May 2026

THE NATIONAL AGRICULTURAL MARKETING COUNCIL

INVITATION TO DIRECTLY AFFECTED GROUPS IN THE WINTER CEREAL INDUSTRY TO SUBMIT COMMENTS

REQUEST FROM THE SA CULTIVAR AND TECHNOLOGY AGENCY (SACTA), FOR THE CONTINUATION OF STATUTORY LEVIES ON WHEAT, BARLEY AND OATS FOR BREEDING AND TECHNOLOGY PURPOSES

The statutory levy on wheat, barley and oats of R35 per ton (VAT excl), to fund seed breeding and technology, that is administered by the South African Cultivar and Technology Agency (SACTA), will lapse on 30 September 2026.

It is hereby made known that the National Agricultural Marketing Council (NAMC) received a request from SACTA on behalf of specific role players in the winter cereal industry, that the Minister of Agriculture, in terms of Section 15 of the Marketing of Agricultural Products Act, Act No 47 of 1996 (MAP Act), establishes the following statutory levy (VAT excluded) for the different winter cereal commodities, as indicated in the Table below:

Commodity	Period	Amount (VAT excluded)
Wheat	1/10/2026 to 30/9/2027	R 35,00 per metric ton
	1/10/2027 to 30/9/2028	R 35,00 per metric ton
Barley	1/10/2026 to 30/9/2027	R 35,00 per metric ton
	1/10/2027 to 30/9/2028	R 35,00 per metric ton
Oats	1/10/2026 to 30/9/2027	R 35,00 per metric ton
	1/10/2027 to 30/9/2028	R 35,00 per metric ton

The levy will be payable to SACTA by buyers, processors and persons that issue a silo receipt and will be recovered from producers. Persons paying the levy may claim 2,5% commission on the amount of the levies recovered, in accordance with the conditions set by SACTA from time to time.

Statutory levies have been imposed over the past years on winter cereals to, inter alia, provide financial support for seed breeding research projects. The seed breeding and technology levy that is based on the international end point royalty system, was administered by SACTA since 1 October 2016.

Council Members: Prof. A. Jooste (Chairperson), Dr. S.T. Xaba (Vice-Chairperson), Dr. K.M. Hurly, Dr. B.S. Jack-Pama, Dr. M. Kadwa, Ms. H.J. Mahlangu, Ms. R.J. Maisela, Mr. H.T. Mohane, Prof. K. Nephawe and Ms. U. Speirs.

PARTICULARS OF STATUTORY MEASURE REQUIRED UNDER SECTION 10 OF THE MAP ACT

The relevant particulars, as required in terms of Section 10(2) of the MAP Act, to be included in a request for the establishment of a statutory measure of this nature, are as follows:

a) The proposed statutory levy would relate to locally produced wheat, barley and oats; and will apply to the whole of the Republic of South Africa in order to have a uniform system of levies without discrimination, which would exist if levies had to be imposed in certain areas and not in others.

b) The way the objectives referred to in Section 2(2) of the MAP Act will be advanced (namely increased market access for all market participants, promotion of the efficiency of the marketing of agricultural products, optimisation of export earnings from agricultural products and the enhancement of the viability of the agricultural sector) is summarised below.

The purpose and aim of this statutory measure are to compensate breeders of wheat, barley and oats varieties for their proportionate contribution towards obtaining and utilising improved international intellectual property to the benefit of the wheat, barley and oats industries in the Republic of South Africa. SACTA will distribute the levy income in terms of a formal agency agreement concluded with seed breeders.

Sustainable commercial farming, as well as food security, are primarily dependent on the cultivation of high yielding crops from seed varieties most suited to a particular region.

The development of new cultivars with improved quality and yield characteristics constitutes an important part of breeding and technology research undertaken by various organisations. The continuous development of new cultivars is indispensable to the sustained production of winter cereals in South Africa.

Worldwide the levels of Plant Variety Protection (“PVP”) legislation and protection of self-pollinated crops are insufficient to guarantee a return on investment on intellectual property for the holders of such plant breeders’ rights. This is due to PVP exceptions such as "Farmer’s Privilege" and the fact that the offspring or grain produced from self-pollinated crops has the same genetic content as the parent. This means that seed can be harvested and replanted by farmers. This creates a situation where farmers could, for example, only purchase one season’s seed, then lawfully save seed from their harvest for the next and subsequent planting seasons.

The existence of international networks is critical in seed breeding as most agriculture related intellectual property is owned by or falls under foreign control. Without an appropriate mechanism to receive adequate compensation, and to account for the risk of exploitation, South Africa remains an unattractive destination for agriculture related intellectual property associated with self-pollinated crops. This means that access to international nurseries, markers, techniques and technologies is being constrained. The result is that South African farmers do not have access to improved agriculture related intellectual property that is available worldwide.

Most industry role players have realised the need for a sustainable industry research funding strategy for self-pollinated crops. These role players have agreed to a breeding and technology levy on such crops to encourage and stimulate the breeding of self-pollinated crops for the benefit of the production, processing and other value-adding industries in the Republic of South Africa.

c) The Administration of SACTA will take responsibility for the collection of the levy and for the administration functions associated with the proposed levy. The Board of Directors of SACTA appointed specific persons to carry out these functions. These persons were designated and authorised as inspectors by the Minister to perform the functions referred to in Section 21 of the MAP Act.

d) Annual audits will be executed by the Auditor-General.

BUSINESS PLAN

Based on the SACTA business plan submission, the NAMC noted that the expected income by means of the statutory levy is based on an expected success rate of 92% in the collection of the levy. The levy income for the proposed two years is estimated to be between R250 to R284 million per year.

These statutory funds will be used to support breeding research functions, based on the following:

- The levy funds are earmarked for commercial breeding activities by seed companies based on their performance and utilisation in the seed market;

- These funds will be distributed according to the calculated market share of each seed company;

- At least 20% of the levy income will be used for transformation and development projects, of which the business plan will be considered by the NAMC;

- The budget for administration costs represents approximately 5% of the expected income by means of statutory levy on wheat, barley and oats during the next years; and

- The levy is applicable on local production only and not on imported commodities.

As the proposed breeding and technology levy is consistent with the objectives of the MAP Act, the NAMC is investigating the possible implementation of the relevant statutory levy.

Directly affected groups in the winter cereal industry are kindly requested to submit comments or objections regarding the proposed breeding and technology levy to the NAMC in writing Malapane Thamaga via e-mail mthamaga@namc.co.za on or before 12 June 2026, to enable the Council to formulate its recommendation to the Minister in this regard.

DEPARTMENT OF BASIC EDUCATION

NO. 7536 **29 May 2026**

IMPROVEMENT IN CONDITIONS OF SERVICE: ANNUAL COST-OF-LIVING ADJUSTMENT FOR EDUCATORS EMPLOYED IN TERMS OF THE EMPLOYMENT OF EDUCATORS ACT, 1998 WITH EFFECT FROM 1 APRIL 2026

I, Siviwe Gwarube, Minister of Basic Education, has in terms of section 4 of the Employment of Educators Act, 1998 determined that:

In accordance with the Public Sector Co-ordinating Bargaining Council Resolution 1 of 2025 read with applicable directives in Circular No. 20 of 2026 issued by the Director-General of the Department of Public Service and Administration, I hereby determine, for all qualifying employees employed in terms of the Employment of Educators Act (EEA), 1998, an improvement in conditions of service.

Accordingly, in extending the determination made by the Minister of Public Service and Administration, I determine that the salary scales that applied up to 31 March 2025, be adjusted by 4% with effect from 1 April 2026 for all employees employed in terms of the EEA.

The applicable salary adjustment effective from 01 April 2026 for the relevant categories of employees is detailed in the salary scales in **Schedule 1** and **Schedule 2** as attached.

The Personnel Administrative Measures (PAM) will be amended to include these scales as outlined in **Schedule 1 and Schedule 2** respectively.

MS SIVIWE GWARUBE, MP
MINISTER
DATE: 10/04/2026

OSD Educator salary notches with effect from 1 April 2026 for full-time employees

Notch Code	Notch Value 1/4/2024	Notch Value 1/4/2025	Notch Value 1/4/2026	Notch Code	Notch Value 1/4/2024	Notch Value 1/4/2025	Notch Value 1/4/2026	Notch Code	Notch Value 1/4/2024	Notch Value 1/4/2025	Notch Value 1/4/2026	Notch Code	Notch Value 1/4/2024	Notch Value 1/4/2025	Notch Value 1/4/2026
1	154 671	163 179	169 707	76	219 498	231 570	240 834	151	313 500	330 744	343 974	226	445 221	469 707	488 496
2	156 495	165 102	171 705	77	220 539	232 668	241 974	152	315 282	332 622	345 927	227	447 315	471 918	490 794
3	156 762	165 384	171 999	78	221 556	233 742	243 093	153	316 458	333 864	347 220	228	449 475	474 195	493 164
4	157 917	166 602	173 265	79	222 558	234 798	244 191	154	318 246	335 751	349 182	229	451 629	476 469	495 528
5	158 610	167 334	174 027	80	223 617	235 917	245 355	155	319 755	337 341	350 835	230	455 943	481 020	500 262
6	159 318	168 081	174 804	81	224 655	237 012	246 492	156	321 276	338 946	352 503	231	456 153	481 242	500 493
7	160 056	168 858	175 611	82	225 696	238 110	247 635	157	322 767	340 518	354 138	232	460 539	485 868	505 302
8	160 767	169 608	176 391	83	226 743	239 214	248 784	158	324 309	342 147	355 833	233	462 723	488 172	507 699
9	161 475	170 355	177 168	84	227 799	240 327	249 939	159	325 839	343 761	357 510	234	464 985	490 560	510 183
10	162 201	171 123	177 969	85	228 852	241 440	251 097	160	327 390	345 396	359 211	235	467 169	492 864	512 580
11	162 945	171 906	178 782	86	229 932	242 577	252 279	161	328 914	347 004	360 885	236	469 413	495 231	515 040
12	163 683	172 686	179 592	87	230 985	243 690	253 437	162	330 492	348 669	362 616	237	471 687	497 631	517 536
13	164 403	173 445	180 384	88	232 068	244 833	254 625	163	332 046	350 310	364 323	238	473 949	500 016	520 017
14	165 135	174 216	181 185	89	233 148	245 970	255 810	164	333 624	351 972	366 051	239	476 181	502 371	522 465
15	165 909	175 035	182 037	90	234 231	247 113	256 998	165	335 193	353 628	367 773	240	478 488	504 804	524 997
16	166 668	175 836	182 868	91	235 317	248 259	258 189	166	336 777	355 299	369 510	241	480 783	507 225	527 514
17	167 379	176 586	183 648	92	236 439	249 444	259 422	167	338 376	356 988	371 268	242	483 105	509 676	530 064
18	168 180	177 429	184 527	93	237 519	250 584	260 607	168	339 969	358 668	373 014	243	485 391	512 088	532 572
19	168 936	178 227	185 355	94	238 665	251 793	261 864	169	341 574	360 360	374 775	244	487 737	514 563	535 146
20	169 728	179 064	186 228	95	239 757	252 945	263 064	170	343 227	362 103	376 587	245	490 080	517 035	537 717
21	170 472	179 847	187 041	96	240 894	254 142	264 309	171	344 817	363 783	378 333	246	492 429	519 513	540 294
22	171 243	180 660	187 887	97	242 016	255 327	265 539	172	346 476	365 532	380 154	247	494 781	521 994	542 874
23	172 044	181 506	188 766	98	243 147	256 521	266 781	173	348 117	367 263	381 954	248	497 196	524 541	545 523
24	172 803	182 307	189 600	99	244 275	257 709	268 017	174	349 788	369 027	383 787	249	499 542	527 016	548 097
25	173 583	183 129	190 455	100	245 403	258 900	269 256	175	351 417	370 746	385 575	250	501 978	529 587	550 770
26	174 375	183 966	191 325	101	246 570	260 130	270 534	176	353 100	372 522	387 423	251	504 381	532 122	553 407
27	175 164	184 797	192 189	102	247 695	261 318	271 770	177	354 783	374 295	389 268	252	506 829	534 705	556 092
28	175 953	185 631	193 056	103	248 856	262 542	273 045	178	356 472	376 077	391 119	253	509 235	537 243	558 732
29	176 760	186 483	193 941	104	250 020	263 772	274 323	179	358 143	377 841	392 955	254	511 713	539 856	561 450
30	177 558	187 323	194 817	105	252 840	266 745	277 416	180	359 865	379 659	394 845	255	514 161	542 439	564 138
31	178 359	188 169	195 696	106	254 037	268 008	278 727	181	361 566	381 453	396 711	256	516 657	545 073	566 877
32	179 202	189 057	196 620	107	255 198	269 235	280 005	182	363 294	383 274	398 604	257	519 114	547 665	569 571
33	179 991	189 891	197 487	108	256 395	270 498	281 319	183	365 010	385 086	400 488	258	521 631	550 320	572 334
34	180 801	190 746	198 375	109	257 592	271 761	282 630	184	366 756	386 928	402 405	259	524 133	552 960	575 079
35	181 662	191 652	199 317	110	258 792	273 027	283 947	185	368 487	388 755	404 304	260	526 659	555 624	577 848
36	182 511	192 549	200 250	111	259 983	274 281	285 252	186	370 242	390 606	406 230	261	529 182	558 288	580 620
37	183 288	193 368	201 102	112	261 237	275 604	286 629	187	372 003	392 463	408 162	262	531 726	560 970	583 410
38	184 179	194 310	202 083	113	262 419	276 852	287 925	188	373 770	394 326	410 100	263	534 288	563 673	586 221
39	185 016	195 192	203 001	114	263 643	278 142	289 269	189	375 543	396 198	412 047	264	536 862	566 388	589 044
40	185 850	196 071	203 913	115	264 897	279 465	290 643	190	378 045	398 838	414 792	265	539 430	569 100	591 864
41	186 711	196 980	204 858	116	266 118	280 755	291 984	191	378 777	399 609	415 593	266	542 085	571 899	594 774
42	187 548	197 862	205 776	117	267 339	282 042	293 325	192	380 349	401 268	417 318	267	544 644	574 599	597 582
43	188 406	198 768	206 718	118	268 611	283 386	294 720	193	382 380	403 410	419 547	268	547 305	577 407	600 504
44	189 288	199 698	207 687	119	269 856	284 697	296 085	194	383 442	404 532	420 714	269	552 330	582 708	606 015
45	190 131	200 589	208 614	120	271 137	286 050	297 492	195	384 183	405 312	421 524	270	554 985	585 510	608 931
46	191 019	201 525	209 586	121	272 388	287 370	298 866	196	386 013	407 244	423 534	271	557 631	588 300	611 832
47	191 898	202 452	210 549	122	273 663	288 714	300 264	197	387 837	409 167	425 535	272	560 313	591 129	614 775
48	192 780	203 382	211 518	123	274 953	290 076	301 680	198	389 673	411 105	427 548	273	562 998	593 964	617 724
49	193 659	204 309	212 481	124	276 222	291 414	303 072	199	391 530	413 064	429 588	274	565 698	596 811	620 682
50	194 532	205 230	213 438	125	277 515	292 779	304 491	200	393 402	415 038	431 640	275	568 404	599 667	623 655
51	195 438	206 187	214 434	126	278 802	294 135	305 901	201	395 244	416 982	433 662	276	571 173	602 589	626 694
52	196 536	207 345	215 640	127	280 110	295 515	307 335	202	397 152	418 995	435 756	277	573 876	605 439	629 658
53	197 217	208 065	216 387	128	281 436	296 916	308 793	203	399 027	420 972	437 811	278	576 675	608 391	632 727
54	198 339	209 247	217 617	129	282 729	298 278	310 209	204	400 926	422 976	439 896	279	579 429	611 298	635 751
55	199 251	210 210	218 619	130	284 112	299 739	311 730	205	402 837	424 992	441 993	280	582 222	614 244	638 814
56	200 172	211 182	219 630	131	285 402	301 098	313 143	206	404 769	427 032	444 114	281	585 015	617 190	641 877
57	201 081	212 139	220 626	132	286 755	302 526	314 628	207	406 671	429 039	446 202	282	587 835	620 166	644 973
58	202 047	213 159	221 685	133	288 120	303 966	316 125	208	408 648	431 124	448 368	283	590 649	623 136	648 060
59	202 947	214 110	222 675	134	289 461	305 382	317 598	209	410 565	433 146	450 471	284	593 514	626 157	651 204
60	203 901	215 115	223 719	135	290 799	306 792	319 065	210	412 551	435 240	452 649	285	596 343	629 142	654 309
61	204 849	216 117	224 763	136	292 176	308 247	320 577	211	414 498	437 295	454 788	286	599 247	632 205	657 492
62	205 764	217 080	225 762	137	293 553	309 699	322 086	212	416 472	439 377	456 951	287	602 106	635 223	660 633
63	206 727	218 097	226 821	138	294 945	311 166	323 613	213	418 467	441 483	459 141	288	605 049	638 328	663 861
64	207 693	219 117	227 883	139	296 304	312 600	325 104	214	420 474	443 601	461 346	289	607 926	641 361	667 014
65	208 623	220 098	228 903	140	297 711	314 085	326 649	215	422 448	445 683	463 509	290	610 875	644 472	670 251
66	209 586	221 112	229 956	141	299 118	315 570	328 194	216	424 473	447 819	465 732	291	613 815	647 574	673 476
67	210 579	222 162	231 048	142	300 534	317 064	329 748	217	426 507	449 964	467 964	292	616 749	650 670	676 698
68	211 548	223 182	232 110	143	301 923	318 528	331 269	218	428 565	452 136	470 220	293	619 725	653 811	679 962
69	212 499	224 187	233 154	144	303 363	320 049	332 850	219	430 563	454 245	472 416	294	622 758	657 009	683 289
70	213 507	225 249	234 258	145	304 791	321 555	334 416	220	432 636	456 432	474 690	295	625 692	660 105	686 508
71	214 497	226 293	235 344	146	306 231	323 073	335 997	221	434 721	458 631	476 976	296	628 752	663 333	689 865
72	215 451	227 301	236 394	147	307 656	324 576	337 560	222	436 797	460 821	479 253	297	631 791	666 540	693 201
73	216 477	228 384	237 519	148	309 114	326 115	339 159	223	438 852	462 990	481 509	298	634 836	669 753	696 543
74	217 509	229 473	238 653	149	310 569	327 651	340 758	224	440 979	465 234	483 843	299	637 878	672 960	699 879
75	218 454	230 469	239 688	150	312 036	329 199	342 366	225	443 079	467 448	486 147	300	640 992	676 248	703 299

Notch Code	Notch Value 1/4/2024	Notch Value 1/4/2025	Notch Value 1/4/2026
301	644 049	679 473	706 653
302	650 301	686 067	713 511
303	650 598	686 382	713 838
304	656 910	693 039	720 762
305	660 054	696 357	724 212
306	663 240	699 717	727 707
307	665 697	702 309	730 401
308	666 453	703 107	731 232
309	669 993	706 842	735 117
310	672 879	709 887	738 282
311	675 372	712 518	741 018
312	676 497	713 703	742 251
313	679 737	717 123	745 809
314	683 073	720 642	749 469
315	686 334	724 083	753 045
316	689 661	727 593	756 696
317	693 009	731 124	760 368
318	696 369	734 670	764 058
319	699 696	738 180	767 706
320	703 131	741 804	771 477
321	706 506	745 365	775 179
322	709 962	749 010	778 971
323	713 367	752 601	782 706
324	716 838	756 264	786 516
325	720 303	759 921	790 317
326	723 798	763 608	794 151
327	727 284	767 286	797 976
328	730 851	771 048	801 891
329	734 346	774 735	805 725
330	737 955	778 542	809 685
331	741 501	782 283	813 573
332	745 125	786 108	817 551
333	748 716	789 894	821 490
334	752 361	793 740	825 489
335	755 988	797 568	829 470
336	759 675	801 456	833 514
337	763 335	805 317	837 531
338	767 082	809 271	841 641
339	770 763	813 156	845 682
340	774 531	817 131	849 816
341	778 278	821 082	853 926
342	782 073	825 087	858 090
343	785 838	829 059	862 221
344	789 708	833 142	866 469
345	793 497	837 138	870 624
346	797 376	841 233	874 881
347	801 246	845 316	879 129
348	805 155	849 438	883 416
349	809 028	853 524	887 664
350	813 675	858 426	892 764
351	817 611	862 581	897 084
352	821 601	866 790	901 461
353	825 561	870 966	905 805
354	829 629	875 259	910 269
355	833 607	879 456	914 634
356	837 693	883 767	919 119
357	841 758	888 054	923 577
358	845 871	892 395	928 092
359	849 936	896 682	932 550
360	854 112	901 089	937 134
361	858 240	905 442	941 661
362	862 434	909 867	946 263
363	866 604	914 268	950 838
364	870 840	918 735	955 485
365	875 049	923 178	960 105
366	879 321	927 684	964 791
367	883 581	932 178	969 465
368	887 919	936 756	974 226
369	892 188	941 259	978 909
370	896 568	945 879	983 715
371	900 921	950 472	988 491
372	905 334	955 128	993 333
373	909 699	959 733	998 121
374	914 175	964 455	1 003 032
375	918 594	969 117	1 007 883
376	923 112	973 884	1 012 839
377	927 570	978 585	1 017 729
378	932 100	983 367	1 022 703
379	936 642	988 158	1 027 683
380	941 214	992 982	1 032 702
381	945 765	997 782	1 037 694
382	950 406	1 002 678	1 042 785
383	955 011	1 007 538	1 047 840
384	959 718	1 012 503	1 053 003
385	964 341	1 017 381	1 058 076
386	969 117	1 022 418	1 063 314
387	973 791	1 027 350	1 068 444
388	978 588	1 032 411	1 073 706
389	983 337	1 037 421	1 078 917
390	988 143	1 042 491	1 084 191
391	992 949	1 047 561	1 089 462
392	997 836	1 052 718	1 094 826
393	1 002 648	1 057 794	1 100 106
394	1 007 598	1 063 017	1 105 539
395	1 012 485	1 068 171	1 110 897
396	1 017 432	1 073 391	1 116 327
397	1 022 397	1 078 629	1 121 775
398	1 027 422	1 083 930	1 127 286
399	1 032 375	1 089 156	1 132 722
400	1 037 484	1 094 547	1 138 329
401	1 042 509	1 099 848	1 143 843
402	1 047 627	1 105 245	1 149 456
403	1 052 727	1 110 627	1 155 051
404	1 057 875	1 116 057	1 160 700
405	1 063 023	1 121 490	1 166 349
406	1 068 252	1 127 007	1 172 088
407	1 073 427	1 132 464	1 177 764
408	1 078 725	1 138 056	1 183 578
409	1 083 957	1 143 576	1 189 320
410	1 089 279	1 149 189	1 195 158
411	1 094 589	1 154 790	1 200 981
412	1 099 974	1 160 472	1 206 891
413	1 105 299	1 166 091	1 212 735
414	1 110 774	1 171 866	1 218 741
415	1 116 150	1 177 539	1 224 642
416	1 121 655	1 183 347	1 230 681
417	1 127 115	1 189 107	1 236 672
418	1 132 647	1 194 942	1 242 741
419	1 138 161	1 200 759	1 248 789
420	1 143 771	1 206 678	1 254 945
421	1 149 321	1 212 534	1 261 035
422	1 155 000	1 218 525	1 267 266
423	1 160 607	1 224 441	1 273 419
424	1 166 349	1 230 498	1 279 719
425	1 172 004	1 236 465	1 285 923
426	1 177 764	1 242 540	1 292 241
427	1 183 524	1 248 618	1 298 562
428	1 189 353	1 254 768	1 304 958
429	1 195 113	1 260 843	1 311 276
430	1 201 035	1 267 092	1 317 777
431	1 206 876	1 273 254	1 324 185
432	1 209 279	1 275 789	1 326 822

Notch Code	Notch Value 1/4/2024	Notch Value 1/4/2025	Notch Value 1/4/2026
INCLUSIVE PACKAGE			
1	897 198	946 545	984 408
2	901 584	951 171	989 217
3	905 946	955 773	994 005
4	910 374	960 444	998 862
5	914 805	965 118	1 003 722
6	919 272	969 831	1 008 624
7	923 760	974 568	1 013 550
8	928 275	979 329	1 018 503
9	932 784	984 087	1 023 450
10	937 347	988 902	1 028 457
11	941 880	993 684	1 033 431
12	946 485	998 541	1 038 483
13	951 114	1 003 425	1 043 562
14	955 764	1 008 330	1 048 662
15	960 411	1 013 235	1 053 765
16	965 112	1 018 194	1 058 922
17	969 804	1 023 144	1 064 070
18	974 547	1 028 148	1 069 275
19	979 284	1 033 146	1 074 471
20	984 078	1 038 201	1 079 730
21	988 881	1 043 268	1 084 998
22	993 717	1 048 371	1 090 305
23	998 547	1 053 468	1 095 606
24	1 003 437	1 058 625	1 100 970
25	1 008 333	1 063 791	1 106 343
26	1 013 271	1 069 002	1 111 761
27	1 018 191	1 074 192	1 117 161
28	1 023 177	1 079 451	1 122 630
29	1 028 178	1 084 728	1 128 117
30	1 033 215	1 090 041	1 133 643
31	1 038 261	1 095 366	1 139 181
32	1 043 352	1 100 736	1 144 764
33	1 049 106	1 106 808	1 151 079
34	1 054 248	1 112 232	1 156 722
35	1 059 384	1 117 650	1 162 356
36	1 064 574	1 123 125	1 168 050
37	1 069 755	1 128 591	1 173 735
38	1 074 999	1 134 123	1 179 489
39	1 080 237	1 139 649	1 185 234
40	1 085 529	1 145 232	1 191 042
41	1 090 824	1 150 818	1 196 850
42	1 096 170	1 156 458	1 202 715
43	1 101 516	1 162 098	1 208 583
44	1 106 916	1 167 795	1 214 508
45	1 112 307	1 173 483	1 220 421
46	1 117 767	1 179 243	1 226 412
47	1 123 227	1 185 003	1 232 403
48	1 128 735	1 190 814	1 238 448
49	1 134 243	1 196 625	1 244 490
50	1 139 808	1 202 496	1 250 595
51	1 145 379	1 208 376	1 256 712
52	1 150 998	1 214 304	1 262 877
53	1 156 608	1 220 220	1 269 030
54	1 162 281	1 226 205	1 275 252
55	1 167 969	1 232 208	1 281 495
56	1 173 705	1 238 259	1 287 789
57	1 179 423	1 244 292	1 294 065
58	1 185 216	1 250 403	1 300 419
59	1 190 997	1 256 502	1 306 761
60	1 196 847	1 262 673	1 313 181
61	1 202 691	1 268 838	1 319 592
62	1 208 601	1 275 075	1 326 078
63	1 214 499	1 281 297	1 332 549
64	1 220 466	1 287 591	1 339 095
65	1 226 442	1 293 897	1 345 653
66	1 232 466	1 300 251	1 352 262
67	1 238 490	1 306 608	1 358 871
68	1 244 574	1 313 025	1 365 546
69	1 250 655	1 319 442	1 372 221
70	1 256 802	1 325 925	1 378 962
71	1 262 943	1 332 405	1 385 700
72	1 269 150	1 338 954	1 392 513
73	1 275 342	1 345 485	1 399 305
74	1 281 612	1 352 100	1 406 184

Notch Code	Notch Value 1/4/2024	Notch Value 1/4/2025	Notch Value 1/4/2026
INCLUSIVE PACKAGE			
75	1 287 897	1 358 730	1 413 078
76	1 294 230	1 365 414	1 420 032
77	1 300 566	1 372 098	1 426 983
78	1 306 962	1 378 845	1 434 000
79	1 313 343	1 385 577	1 440 999
80	1 319 805	1 392 393	1 448 088
81	1 326 276	1 399 221	1 455 189
82	1 332 801	1 406 106	1 462 350
83	1 339 320	1 412 982	1 469 502
84	1 345 911	1 419 936	1 476 732
85	1 352 499	1 426 887	1 483 962
86	1 359 156	1 433 910	1 491 267
87	1 365 786	1 440 903	1 498 539
88	1 372 509	1 447 998	1 505 919
89	1 379 223	1 455 081	1 513 284
90	1 386 012	1 462 242	1 520 733
91	1 392 816	1 469 421	1 528 197
92	1 399 674	1 476 657	1 535 724
93	1 406 529	1 483 887	1 543 242
94	1 413 453	1 491 192	1 550 841
95	1 420 362	1 498 482	1 558 422
96	1 427 358	1 505 862	1 566 096
97	1 434 366	1 513 257	1 573 788
98	1 441 431	1 520 709	1 581 537
99	1 448 496	1 528 164	1 589 292
100	1 455 636	1 535 697	1 597 125
101	1 462 776	1 543 230	1 604 958
102	1 469 982	1 550 832	1 612 866
103	1 477 176	1 558 422	1 620 759
104	1 484 451	1 566 096	1 628 739
105	1 491 714	1 573 758	1 636 707
106	1 499 067	1 581 516	1 644 777
107	1 506 438	1 589 292	1 652 865
108	1 513 860	1 597 122	1 661 007
109	1 521 270	1 604 940	1 669 137
110	1 528 770	1 612 851	1 677 366
111	1 536 258	1 620 753	1 685 583
112	1 543 833	1 628 745	1 693 896
113	1 551 417	1 636 746	1 702 215
114	1 559 070	1 644 819	1 710 612
115	1 566 726	1 652 895	1 719 012
116	1 574 448	1 661 043	1 727 484
117	1 582 179	1 669 200	1 735 968
118	1 589 985	1 677 435	1 744 533
119	1 597 767	1 685 643	1 753 068
120	1 605 651	1 693 962	1 761 720
121	1 608 762	1 697 244	1 765 134

OSD SALARY NOTCHES WITH EFFECT FROM 1 APRIL 2026 FOR FULL-TIME EMPLOYEES: THERAPISTS, COUNSELLORS AND PSYCHOLOGISTS

Job title	Code	01/04/2024	01/04/2025	01/04/2026
Education Therapist Grade 1	1	376 524	397 233	413 121
	2	382 173	403 194	419 322
	3	387 903	409 239	425 610
	4	393 720	415 374	431 988
	5	399 627	421 605	438 468
	6	405 618	427 926	445 044
	7	411 702	434 346	451 719
	8	417 879	440 862	458 496
	9	424 149	447 477	465 375
	10	430 512	454 191	472 359
Education Therapist Grade 2	1	439 755	463 941	482 499
	2	446 352	470 901	489 738
	3	453 048	477 966	497 085
	4	459 846	485 139	504 546
	5	465 645	491 256	510 906
	6	472 629	498 624	518 568
	7	479 718	506 103	526 347
	8	486 915	513 696	534 243
	9	494 217	521 400	542 256
	10	501 630	529 221	550 389
Education Therapist Grade 3	1	514 785	543 099	564 822
	2	522 504	551 241	573 291
	3	530 343	559 512	581 892
	4	538 299	567 906	590 622
	5	545 262	575 250	598 260
	6	555 555	586 110	609 555
	7	563 889	594 903	618 699
	8	572 346	603 825	627 978
	9	580 932	612 882	637 398
	10	589 644	622 074	646 956
	11	598 488	631 404	656 661
	12	605 550	638 856	664 410
	13	614 634	648 438	674 376
	14	623 229	657 507	683 808
Chief Education Therapist Grade 1	1	545 262	575 250	598 260
	2	555 555	586 110	609 555
	3	563 889	594 903	618 699
	4	572 346	603 825	627 978
	5	580 932	612 882	637 398
	6	589 644	622 074	646 956
	7	598 488	631 404	656 661
	8	605 550	638 856	664 410
Chief Education Therapist Grade 2	1	623 229	657 507	683 808
	2	632 574	667 365	694 059
	3	641 436	676 716	703 785
	4	651 057	686 865	714 339
	5	660 822	697 167	725 055
	6	670 734	707 625	735 930
	7	680 796	718 239	746 970
	8	689 430	727 350	756 444

INCLUSIVE PACKAGE

Job title	Code	01/04/2024	01/04/2025	01/04/2026
Education Counsellor/ Psychometrist Grade 3	1	868 662	916 437	953 094
	2	881 691	930 183	967 389
	3	894 918	944 139	981 906
	4	907 392	957 300	995 592
	5	921 000	971 655	1 010 520
	6	934 815	986 229	1 025 679
	7	948 837	1 001 022	1 041 063
	8	961 806	1 014 705	1 055 292
Chief Education Counsellor/ Psychometrist Grade 1	1	868 662	916 437	953 094
	2	881 691	930 183	967 389
	3	894 918	944 139	981 906
	4	907 392	957 300	995 592
	5	921 000	971 655	1 010 520
	6	934 815	986 229	1 025 679
	7	948 837	1 001 022	1 041 063
	8	961 806	1 014 705	1 055 292
Chief Education Counsellor/ Psychometrist Grade 2	1	990 945	1 045 446	1 087 263
	2	1 005 807	1 061 127	1 103 571
	3	1 020 894	1 077 042	1 120 125
	4	1 036 206	1 093 197	1 136 925
	5	1 051 749	1 109 595	1 153 980
	6	1 065 894	1 124 517	1 169 499
	7	1 081 884	1 141 389	1 187 046
	8	1 098 111	1 158 507	1 204 848
	9	1 113 600	1 174 848	1 221 843
Senior Education Counsellor/ Psychometrist Specialist Grade 1	1	1 065 894	1 124 517	1 169 499
	2	1 081 884	1 141 389	1 187 046
	3	1 098 111	1 158 507	1 204 848
	4	1 113 600	1 174 848	1 221 843
	5	1 129 983	1 192 131	1 239 816
	6	1 146 933	1 210 014	1 258 416
	7	1 164 135	1 228 161	1 277 286
	8	1 180 629	1 245 564	1 295 388
Senior Education Counsellor/ Psychometrist Specialist Grade 2	1	1 215 663	1 282 524	1 333 824
	2	1 233 897	1 301 760	1 353 831
	3	1 252 407	1 321 290	1 374 141
	4	1 271 193	1 341 108	1 394 751
	5	1 290 264	1 361 229	1 415 679
	6	1 309 617	1 381 647	1 436 913
	7	1 329 261	1 402 371	1 458 465
Education Psychologist Grade 1	1	827 211	872 709	907 617
	2	839 619	885 798	921 231
	3	852 213	899 085	935 049
	4	864 996	912 570	949 074
	5	868 662	916 437	953 094
	6	881 691	930 183	967 389
	7	894 918	944 139	981 906
	8	907 392	957 300	995 592

Job title	Code	01/04/2024	01/04/2025	01/04/2026
Education Therapist Specialist Grade 1	1	605 550	638 856	664 410
	2	614 634	648 438	674 376
	3	623 229	657 507	683 808
	4	632 574	667 365	694 059
	5	641 436	676 716	703 785
	6	651 057	686 865	714 339
	7	660 822	697 167	725 055
	8	670 734	707 625	735 930
Education Therapist Specialist Grade 2	1	689 430	727 350	756 444
	2	699 771	738 258	767 787
	3	710 268	749 334	779 307
	4	720 921	760 572	790 995
	5	731 736	771 981	802 860
	6	742 710	783 558	814 899
	7	753 852	795 315	827 127
	8	765 159	807 243	839 532

INCLUSIVE PACKAGE				
Job title	Code	01/04/2024	01/04/2025	01/04/2026
Senior Education Therapist Specialist Grade 1	1	990 945	1 045 446	1 087 263
	2	1 005 807	1 061 127	1 103 571
	3	1 020 894	1 077 042	1 120 125
	4	1 036 206	1 093 197	1 136 925
	5	1 051 749	1 109 595	1 153 980
	6	1 065 894	1 124 517	1 169 499
	7	1 081 884	1 141 389	1 187 046
	8	1 098 111	1 158 507	1 204 848
Senior Education Therapist Specialist Grade 2	1	1 129 983	1 192 131	1 239 816
	2	1 146 933	1 210 014	1 258 416
	3	1 164 135	1 228 161	1 277 286
	4	1 180 629	1 245 564	1 295 388
	5	1 198 338	1 264 248	1 314 819
	6	1 215 663	1 282 524	1 333 824
	7	1 233 897	1 301 760	1 353 831
	8	1 252 407	1 321 290	1 374 141
	9	1 271 193	1 341 108	1 394 751
	10	1 290 264	1 361 229	1 415 679
Education Counsellor/ Psychometrist Grade 1	1	675 450	712 599	741 102
	2	685 584	723 291	752 223
	3	695 868	734 142	763 509
	4	706 305	745 152	774 957
	5	715 638	754 998	785 199
	6	726 375	766 326	796 980
	7	737 271	777 822	808 935
	8	748 332	789 489	821 070
Education Counsellor/ Psychometrist Grade 2	1	769 347	811 662	844 128
	2	780 888	823 836	856 788
	3	792 600	836 193	869 640
	4	803 544	847 740	881 649
	5	815 595	860 454	894 873
	6	827 211	872 709	907 617
	7	839 619	885 798	921 231
	8	852 213	899 085	935 049

INCLUSIVE PACKAGE				
Job title	Code	01/04/2024	01/04/2025	01/04/2026
Education Psychologist Grade 2	1	961 806	1 014 705	1 055 292
	2	976 233	1 029 927	1 071 123
	3	990 945	1 045 446	1 087 263
	4	1 005 807	1 061 127	1 103 571
	5	1 020 894	1 077 042	1 120 125
	6	1 036 206	1 093 197	1 136 925
	7	1 051 749	1 109 595	1 153 980
	8	1 065 894	1 124 517	1 169 499
Education Psychologist Grade 3	1	1 113 600	1 174 848	1 221 843
	2	1 129 983	1 192 131	1 239 816
	3	1 146 933	1 210 014	1 258 416
	4	1 164 135	1 228 161	1 277 286
	5	1 180 629	1 245 564	1 295 388
	6	1 198 338	1 264 248	1 314 819
	7	1 215 663	1 282 524	1 333 824
	8	1 233 897	1 301 760	1 353 831
	9	1 252 407	1 321 290	1 374 141
	10	1 271 193	1 341 108	1 394 751
	11	1 290 264	1 361 229	1 415 679
	12	1 309 617	1 381 647	1 436 913
Senior Education Psychologist Grade 1	1	1 180 629	1 245 564	1 295 388
	2	1 198 338	1 264 248	1 314 819
	3	1 215 663	1 282 524	1 333 824
	4	1 233 897	1 301 760	1 353 831
	5	1 252 407	1 321 290	1 374 141
	6	1 271 193	1 341 108	1 394 751
	7	1 290 264	1 361 229	1 415 679
	8	1 309 617	1 381 647	1 436 913
Senior Education Psychologist Grade 2	1	1 346 862	1 420 938	1 477 776
	2	1 367 064	1 442 253	1 499 943
	3	1 387 569	1 463 886	1 522 440
	4	1 408 380	1 485 840	1 545 273
	5	1 429 506	1 508 130	1 568 454
	6	1 450 950	1 530 753	1 591 983
	7	1 472 715	1 553 715	1 615 863
	8	1 494 804	1 577 019	1 640 100
	9	1 517 229	1 600 677	1 664 703
	10	1 539 987	1 624 686	1 689 672

DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT

NO. 7537 **29 May 2026**

I, Willem Abraham Stephanus Aucamp, Minister of Forestry, Fisheries and the Environment, hereby publish the draft 10th National Greenhouse Gas Inventory Report, which will form part of the Second Biennial Transparency Report to the United Nations Framework Convention on Climate Change (UNFCCC), for public comment as set out in the Schedule hereto.

Members of the public are invited to submit to the Minister, within 30 days from the date of publication of this Notice in the Government *Gazette* or in the newspaper, whichever date is the last date, written inputs or comments to the following addresses:

By post to: The Director-General: Department of Forestry, Fisheries and the Environment
Attention: Mr Jongikhaya Witi
Department of Forestry, Fisheries and the Environment
Private Bag X447
Pretoria
0001

By e-mail to: GHGreporting@dffe.gov.za

Hand delivered at: Environment House, 473 Steve Biko Road, Arcadia, Pretoria, 0083.

Any inquiries in connection with the notice can be directed to Mr Jongikhaya Witi at Tel: +2712 399 9048.

For Communication and media enquiries kindly contact Dr. Nomxolisi Mashiyi at Tel: (012) 399 9484 / Email: NMashiyi@dffe.gov.za, Call Centre: 086 111 2468

Comments received after the closing date may be disregarded.

MR WILLEM ABRAHAM STEPHANUS AUCAMP
MINISTER OF FORESTRY, FISHERIES AND THE ENVIRONMENT

SCHEDULE

DRAFT 10th NATIONAL GHG INVENTORY

1990 – 2024 REPORT FOR THE REPUBLIC OF SOUTH AFRICA FOR PUBLIC COMMENT

NATIONAL GHG INVENTORY DOCUMENT

SOUTH AFRICA

1990 - 2024

February 2026

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REPUBLIC OF SOUTH AFRICA

Acknowledgements

The Department of Forestry, Fisheries and the Environment (DFFE) acknowledges with appreciation the numerous individuals, institutes, and organisations that directly and indirectly contributed to the preparation of this National Inventory Document (NID) for 2024.

The information used in the preparation of the NID was obtained from a wide range of data providers and contributing organisations. The DFFE is grateful for the cooperation, technical inputs, and support provided by all organisations and individuals involved in the compilation of this NID.

The DFFE further extends its sincere appreciation to the sector experts and independent reviewers who reviewed the individual sector submissions.

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Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

Report compilation details

Internal report reviewer: Sindisiwe Mashele' Jongikhaya Witi
External Reviewer: Luanne Stevens

Compilers and technical contributors

Executive Summary

Lead Author: Lungile Moyo (DFFE)

Other Contributors: Sewela Malaka (DFFE), Tshamaano Khalushi (DFFE), Sindisiwe Mashele (DFFE)

Chapter 1: National circumstances, institutional arrangements and cross-cutting information

Lead Author: Malebo Rebecca Seeletse (DFFE)

Chapter 2: Trends in GHG emissions and removals

Lead Author: Sindisiwe Mashele (DFFE)

Other Contributors: Luanne Stevens (Gondwana Environmental Solutions), Sewela Malaka (DFFE), Tshamaano Khalushi (DFFE), Malebo Rebecca Seeletse (DFFE), Lungile Moyo

Chapter 3: Energy (CRF Sector 1)

Lead Author: Malebo Rebecca Seeletse (DFFE)

Other Contributors: Sewela Malaka (DFFE), Tshamaano Khalushi (DFFE), Thapedi Phadu

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Chapter 4: Industrial Processes and Product Use (CRF Sector 2)

Lead Author: Tshamaano Khalushi (DFFE)

Other Contributors: Tidimalo Makobe (DFFE)

Chapter 5: Agriculture (CRF Sector 3)

Lead Author: Sewela Malaka (DFFE)

Chapter 6: Land use, Forestry and Land Use Change (LULUCF) (CRT sector 4)

Lead Author: Luanne Stevens (Gondwana Environmental Solutions)

Other contributors: Lungile Moyo (DFFE)

Chapter 7: Waste (CRF Sector 5)

Lead Author: Tshamaano Khalushi (DFFE)

Other Contributors: Thapedi Phadu (DFFE)

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List of abbreviations

AFOLU	Agriculture, Forestry and Other Land Use
AGB	Above-ground biomass
ARC	Agricultural Research Council
Bbl/d	Barrels per day
BCEF	Biomass conversion and expansion factor
BEF	Biomass expansion factor
BNF	Biological nitrogen fixing
BOD	Biological oxygen demand
C	Carbon
C_2F_4	Tetrafluoroethylene
C_2F_6	Carbon hexafluoroethane
CF_4	Carbon tetrafluoromethane
CALC	Computer Automated Land Cover
CFC	Chlorofluorocarbons
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CRT	Common reporting tables
DAFF	Department of Agriculture Affairs, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and Environment
DFID	Department for International Development
DM	Dry matter
DMD	Dry matter digestibility
DMR	Department of Mineral Resources
DMRE	Department of Mineral Resources and Energy
DEE	Department of Electricity and Energy
DoE	Department of Energy
DOM	Dead organic matter
DTI	Department of Trade and Industry
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry

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EF	Emission factor
FAO	Food and Agriculture Organisation
FertASA	Fertiliser Association of South Africa
F-gases	Flourinated gases: e.g., HFC, PFC, SF_6 and NF_3
FOD	First order decay
FRA	Forest resource assessment
FSA	Forestry South Africa
GDP	Gross domestic product
GEI	Gross energy intake
GFRSA	Global Forest Resource Assessment for South Africa
Gg	Gigagram
GHG	Greenhouse gas
GHGI	Greenhouse Gas Inventory
GIS	Geographical Information Systems
GPG	Good Practice Guidance
GWH	Gigawatt hour
GWP	Global warming potential
HFC	Hydrofluorocarbons
HWP	Harvested wood products
IEF	Implied emission factor
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
ISO	International Organization for Standardization
ISRIC	International Soil Reference and Information Centre
ISWC	Institute of Soil, Water and Climate
KCA	Key category analysis
LC	Land cover
LPG	Liquefied petroleum gas
LTO	Landing/take off
LULUCF	Land Use, Land Use Change and Forestry
MCF	Methane conversion factor
MEF	Manure emission factor
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MW	Megawatt
MWH	Megawatt hours

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REPUBLIC OF SOUTH AFRICA

MWTP	Municipal wastewater treatment plant
NAEIS	National Atmospheric Emissions Inventory System
N_2O	Nitrous oxide
NCCC	National Climate Change Committee
NCV	Net calorific value
NID	National Inventory Document
NE	Not estimated
NERSA	National Energy Regulator of South Africa
NGER	National Greenhouse gas Emissions Regulation
NGHGIS	National Greenhouse Gas Inventory System
NIU	National Inventory Unit
NMVOC	Non-methane volatile organic compound
NO	Not occurring
NO_x	Oxides of nitrogen
NTCSA	National Terrestrial Carbon Sinks Assessment
NWBIR	National Waste Baseline Information Report
PFC	Perfluorocarbons
PPM	Parts per million
PRP	Pastures, rangelands and paddocks
QA/QC	Quality assurance/quality control
RSA	Republic of South Africa
SAAQIS	South African Air Quality Information System
SADC	Southern African Development Community
SAEON	South African Environmental Observation Network
SAGERS	South African GHG Emissions Reporting System
SAISA	South African Iron and Steel Institute
SAMI	South African Minerals Industry
SANLC	South African National Land Cover
SAPIA	South African Petroleum Industry Association
SAR	Second Assessment Report
SARS	South African Revenue Service
SASQF	South African Statistical Quality Assurance Framework
SF_6	Sulphur hexafluoride
SNE	Single National Entity
SOC	Soil organic carbon
SOM	Soil organic matter
Stats SA	Statistics South Africa

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TAM	Typical animal mass
TAR	Third Assessment Report (IPCC)
TJ	Terajoule
TM	Tier method
TMR	Total mixed ratio
TOW	Total organics in wastewater
UN	United Nations
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute
WWTP	Wastewater treatment plant-derived
VS	Volatile solids

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Executive summary

E.S.1. Background

E.S.1.1. Background information on greenhouse gas inventories

This report documents South Africa's submission of its national greenhouse gas (GHG) inventory for the year 2024. It also reports on the GHG trends for the period 1990 to 2024. It is compiled in accordance with the guidelines provided by the United Nations Framework Convention on Climate Change (UNFCCC) and follows the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (IPCC, 2006), IPCC Good Practice Guidance (GPG) (IPCC, 2000; IPCC, 2003; IPCC, 2014), the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019) and sections of the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC, 2014a). This report provides an explanation of the methods (Tier 1, 2 and 3 approaches), activity data and emission factors used to develop the inventory. In addition, it assesses the uncertainty and describes the quality assurance and quality control (QA/QC) activities.

In August 1997, the Republic of South Africa joined the majority of countries in the international community in ratifying the UNFCCC. The first national GHG inventory for South Africa was prepared in 1998, using 1990 data (Van der Merwe & Scholes, 1998). It was updated to include 1994 data and published in 2004. It was developed using the 1996 IPCC Guidelines for National Greenhouse Gas Inventories. For the 2000 national inventory (DEAT, 2009), a decision was made to use the recently published IPCC 2006 Guidelines (IPCC, 2006) to enhance accuracy and transparency, and to familiarise researchers with the latest inventory preparation guidelines. South Africa has continued to use these guidelines and has produced six updated inventories since then ((DEA, 2014; DEA, 2017; DEA, 2019; DFFE, 2021; DFFE, 2023) with the latest submission being for the period 2000 to 2022 (DFFE, 2025). This current inventory includes the historic period from 1990 to 2024.

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E.S.1.2. Institutional arrangements for inventory preparation

The Department of Forestry, Fisheries and Environment (DFFE) is responsible for the co-ordination and management of all climate change-related information, including mitigation, adaption, monitoring and evaluation, and GHG inventories. Although the DFFE takes a lead role in the compilation, implementation and reporting of the national GHG inventories, other relevant agencies and ministries play supportive roles in terms of data provision across relevant sectors. Figure ES 1 gives an overview of the institutional arrangements for the compilation of the 1990 – 2024 GHG emissions inventory.

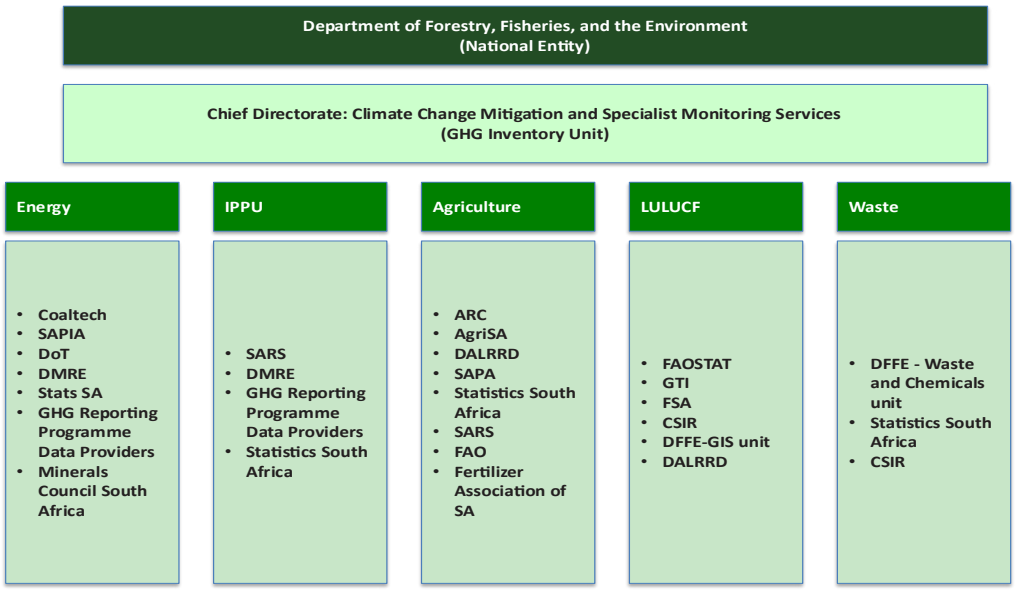


Figure ES 1: Institutional arrangements for the compilation of the 1990 – 2024 inventory for South Africa

The Minister of DFFE promulgated the National Greenhouse Gas Emission Reporting Regulations (NGER), 2016 under Notice No. 275 in the Gazette No. 40762 of 03 April 2017 (DEA, 2017a). The purpose of the NGER is to enable the DFFE to collate and publish GHG emissions data and information in an effective and efficient manner.

The NGER were promulgated in fulfilment of the implementation of the regulatory framework to support the collection of the requisite activity and GHG emissions data necessary for the compilation of the National GHG Emissions Inventory to improve the quality, sustainability, accuracy, completeness and consistency of the National GHG Inventories. The NGER came into effect on 03 April 2017. In accordance with regulation 7(1) of the regulation the initial reporting cycle commenced on 31 March of 2018 requiring data providers to register and submit activity and GHG emissions data to the competent authority (DFFE).

As required in the 2011 White Paper (DEA, 2011), the DFFE has developed the South African Greenhouse Gas Emissions Reporting System (SAGERS) which is the GHG module of National Atmospheric Emissions Inventory System (NAEIS). The SAGERS module and the manual reporting program helps to facilitate the process of enabling Industry to meet its GHG reporting requirements and facilitates the data collection process for energy related activities and Industrial Processes and Product Use (IPPU).

E.S.1.3. Organisation of report

This report follows a standard National Inventory Document (NID) format in line with the UNFCCC Reporting Guidelines or requirements under the enhanced transparency framework. Chapter 1 is the introductory chapter which contains background information for South Africa, the country's inventory preparation and reporting process, key categories, a description of the methodologies, activity data, emission factors, QA/QC process and uncertainty. A summary of the aggregated GHG trends by gas and emission source is provided in Chapter 2. Chapters 3 to 7 deal with detailed explanations of the emissions in the Energy; IPPU; Agriculture; Land Use, Land Use Change and Forestry (LULUCF) and Waste sectors, respectively. They include an overall trend assessment, methodology, data sources, recalculations, uncertainty and time-series consistency, QA/QC and planned improvements and recommendations. Chapter 8 focuses on indirect CO_2 and N_2O emissions while Chapter 9 details improvements and recalculations, the improvement plan and the impacts of recalculations on the overall emission estimates.

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E.S.2. Overview of source and sink category emission estimates and trends

E.S.2.1. Aggregated emission trends

South Africa's national emissions increased between 1990 and 2024, but there has been a decline since 2000 (Table ES 1). Emissions excluding LULUCF show an increase since the last submission, however with the increasing LULUCF sink the national emission including LULUCF show a 1.7% decline since the last submission in 2022.

Table ES 1: Changes in South Africa's emissions excluding and including LULUCF between 1990, 2000, 2022 and 2024

	Emissions (Gg CO_2e)				% Change in emissions		
	1990	2000	2022	2024	Change between 1990 and 2024	Change between 2000 and 2024	Change between 2022 and 2024
Emissions (excl. LULUCF)	405 260	481 534	472 193	477 576	17.8%	-0.8%	1.1%
Emissions (incl. LULUCF)	402 802	468 891	451 889	444 164	10.3%	-5.3%	-1.7%

E.S.2.2. Gas trends

Carbon dioxide

Carbon dioxide (CO_2) is the largest contributor to South Africa's emissions. CO_2 emissions contribute 82.5% to South Africa's emissions (excl. LULUCF) in 2024, which is an increase of 1.3% since 1990 (Figure ES 2). Majority of these CO_2 emissions are from the Energy sector, which contributed an average of 93.5% between 1990 and 2024.

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Methane

Methane (CH_4) is the second largest contributor to South Africa's emissions. CH_4 contributes 12.7 % to South Africa's emissions (excl. LULUCF) in 2024 (Figure ES 2) and this has decreased from 15.1% in 1990. The Agriculture (specifically *Enteric Fermentation*) and Waste (specifically *Wastewater Treatment and Discharge*) sectors are the major contributors to the total CH_4 emissions in 2024.

Nitrous oxide

Nitrous oxide (N_2O) contributed 3.4 % to South Africa's emissions (excl. LULUCF) in 2024 (Figure ES 2) and this declined from 3.7% in 1990. The main contributor to N_2O emissions is the Agriculture sector followed by the Energy sector, contributing 78.4% and 11.1% respectively.

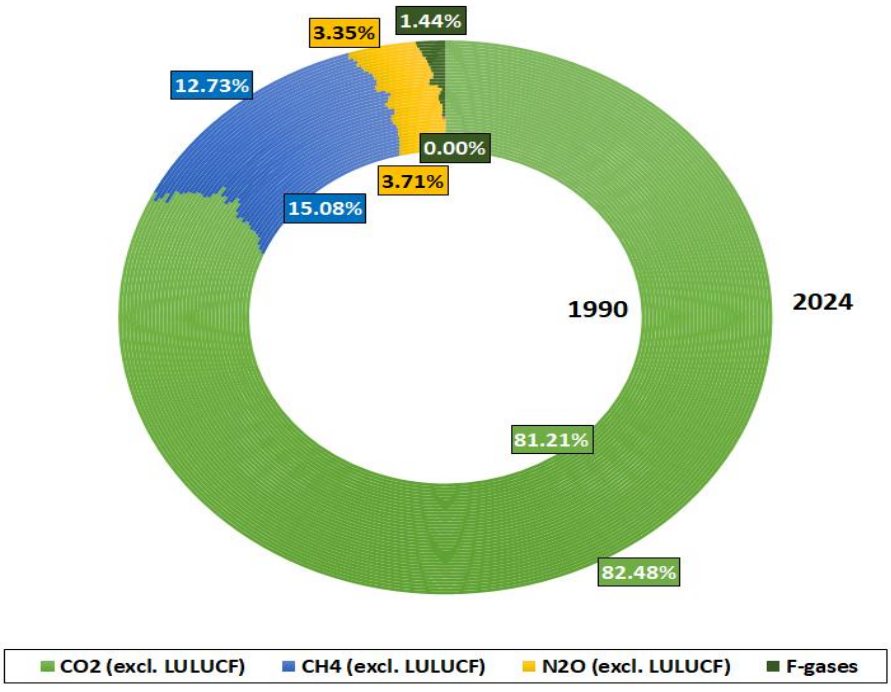


Figure ES 2: Gas contribution to South Africa's emissions (excl. LULUCF), 1990-2024.

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F-gases

Fluorinated gas (F-gas) emissions are only estimated for the IPPU sector in South Africa. F-gas emissions have increased from 0% to 1.4% of the total emissions (excl. LULUCF) since 1990. Emissions increased from 2011 due to the addition of hydrofluorocarbons (HFCs) emissions from *Air conditioning, foam blowing agents, fire protection and aerosols*. There is no data prior to 2005, so this time-series is not consistent. The replacement of ozone depleting substances did contribute to this increase. Perfluorocarbons (PFCs) data is not available prior to 2000, so this time-series is also not consistent.

E.S.2.3. GHG precursors

Carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs) were estimated from biomass burning only. CO emissions varied between 232 Gg CO to 1 190 Gg CO between 1990 and 2024. The NO_x emissions were between 11 Gg NO_x and 62 Gg NO_x, while NMVOCs were between 34 Gg NMVOCs and 167 Gg NMVOCs over the period 1990 to 2024. There is annual variability because the emissions include wildfires.

E.S.3. Overview of emissions estimates and trends by sector

E.S.3.1. Sectoral trends

Energy

Energy sector emissions amount to 375 216 Gg CO_2e in 2024 (Table ES 2). In 2024 Energy emissions account for 78.6% of total emissions (excl. LULUCF) for South Africa (Figure ES 3). The majority of the Energy sector emissions are from *Energy Industries* (61%) and *Transport* (16%), while the *Manufacturing Industries and Construction* emissions contribute (6%). The lowest emissions are from *Solid Fuels* (0.6%) and *Oil and Natural Gas* activities (0.03%).

Since 1990, Energy sector emissions have increased by 19.5%. The highest percentage increase in emissions since 1990 is seen in the *Transport* and the *Manufacturing industries and construction* sub-sectors. This is due to a growing population and to growth in the manufacturing industry resulting in increased energy demand. Fugitive emissions

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from fuels declined by 15% between 1990 and 2024, with substantial reductions in emissions from oil and natural gas systems.

Since 2000, Energy sector emissions decreased by 0.3%. Between 2001 and 2010, emissions became more variable, with sharper increases of up to 5% and occasional declines of between 2% and 5%, indicating sensitivity to economic and operational factors. From 2011 onward, annual changes stabilised, although small fluctuations persisted, typically within the –2% to +2% range. A significant drop of 6% is observed in 2020, likely linked to reduced activity during the COVID-19 pandemic, followed by a strong rebound of 3% in 2021.

Energy emissions increased by 1.4% since 2022. In 2023 emissions decreased by 2.1% but then increased again in 2024. The *Energy Industries* sub-sector emissions decreased by 5% while fugitive emissions from fuels also decreased by 10%.

Table ES 2: Change in sector emissions since 1990, 2000 and since the last inventory submission (2022)

	Emissions (Gg CO_2e)				Change 1990 to 2024		Change 2000 to 2024		Change 2022 to 2024	
	1990	2000	2022	2024	Gg CO_2e	%	Gg CO_2e	%	Gg CO_2e	%
Energy	312 936	376 305	370 030	375 216	62 280	19.9	-1 089	-0.3	5 186	1.4
IPPU	21 242	32 783	30 984	30 372	9 130	43.0	-2 411	-7.4	-612	-2.0
Agriculture	58 804	57 317	52 073	52 744	-6 060	-10.3	-4 573	-8.0	672	1.3
LULUCF	-2 458	-12 643	-20 305	-33 412	-30 954	1 259	-20 769	164	-13 107	65
Waste	11 346	14 430	19 107	19 245	7 899	69.6	4 814	33.4	138	0.7

 # Calculated with AR5 GWP

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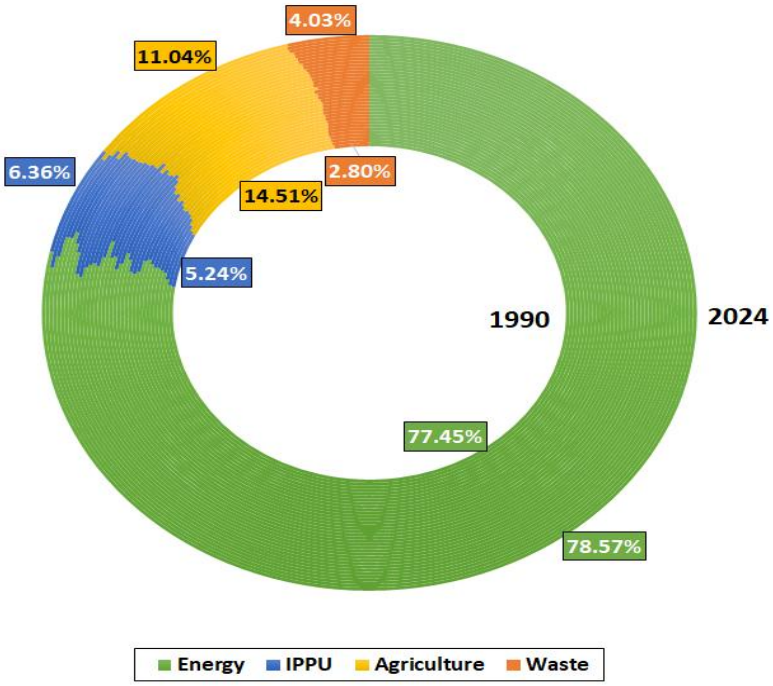


Figure ES 3: Sector contribution to total emissions (excl. LULUCF), 1990-2024

Industrial processes and product use (IPPU)

In 2024 the IPPU sector produced 30 372 Gg CO_2e which is 6.4% of South Africa's emission (excl. LULUCF) (Figure ES 3). The largest source category is the *Ferroalloy production* category which contributes 52.6% to the total IPPU sector emissions. The *Mineral industry* and the *Product used as substitutes for ozone depleting substances* subsectors contribute 16.4% and 22.9%, respectively, to the IPPU sector emissions.

Since 1990, IPPU emissions have increased by 43.0% (Table ES 2). The largest source category is the *Metal industry* category.

Since 2000, IPPU emissions have decreased by 7.4%. The decline can be attributed to the decline in metals production by 39%, specifically Iron and Steel, and Aluminium. This can be ascribed to the deteriorating economy. The chemicals industry also declined by 31.4%.

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The IPPU sector emissions decreased by 2% since 2022. According to the NCPC (2023) report, the decline in cement production can be attributed to cheap import, and this has been compounded by the rapid increase in local prices for fuels. The year 2020 was used by some industries for maintenance during the covid period. Other sector such as the chemical and the metal industry showed a slight decline compared to 2022.

Agriculture

Agriculture emissions in 2024 amounted to 52 744 Gg CO_2e (Table ES 2), accounting for approximately 11% of total emissions excluding LULUCF and 12% including LULUCF for South Africa (Figure ES 3). The majority of Agriculture sector emissions originate from *Enteric fermentation* (68%), followed by *Agricultural soils* (18%) and *Manure management* (8%).

Agricultural emissions have remained relatively stable between 1990 and 2024, fluctuating between approximately 55 000 and 60 000 Gg CO_2e, with a modest long-term decline. Total Agriculture sector emissions decreased from 58 804 Gg CO_2e in 1990 to 52 744 Gg CO_2e in 2024, representing an overall decrease of 10.3% (Table ES 2).

LULUCF

LULUCF sector is a sink of 33 412 Gg CO_2e in 2024 (Table ES 2). *Forest lands* are the largest contributors to this sink, while all other land sectors are estimated to be an overall source of emissions. The dominant *Forest land* sinks are thickets and woodlands. *Harvested wood products* (*HWP)* are a sink in 2024 (1 718 Gg CO_2e).

The LULUCF sector increased its sink by 30 954 Gg CO_2e since 1990. The largest percentage changes are seen in the *Wetland* and *Forest land* categories. *Wetland* category showed a 4-fold increase (503 Gg CO_2e to 2 105 Gg CO_2e) in emissions, while the *Forest land* increased it sink by 39 776 Gg CO_2e between 1990 and 2024. The increasing sink is due to the increasing *Forest land* area. *Croplands* show the least variation and have the lowest overall change (27.2%) over this period.

The LULUCF sector increased its sink by 20 769 Gg CO_2e since 2000. The largest changes are seen in the *Grassland* followed by the *Wetland* category, mainly due to conversions of *Forest Land* to *Grasslands* and *Other Land* to *Wetlands* respectively. The increasing *Forest Land* sink between 2018 and 2024 is attributed to an increasing conversion of *Grasslands*

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to *Forest land*. In terms of emission sources, *Other lands* contribute the most and the emissions increased between 2014 and 2024.

The LULUCF sink grew by 65% between 2022 and 2024, with *Grassland* and *Wetland* categories showing the largest changes, and *Harvested wood products (HWP)* contributing the least.

Waste

Waste sector emissions for 2024 accounted for 4% (excl. LULUCF) and 4.4% (incl. LULUCF) of the national emissions (Figure ES 3). The majority of Waste sector emissions are from *Wastewater treatment and discharge* which is contributing 46.8% to the total Waste sector emissions. This is, followed by *Solid waste disposal* which contributes 38.3%. *Biological treatment of solid waste* and *Incineration and Open Burning of Waste* contributed 13.6% and 0.01% of the total Waste emissions respectively.

Waste sector emissions have increased by 69.6% since 1990 *Solid waste disposal* emissions have increased by 161% since 1990. *Incineration and open burning of waste* emissions increased by 155% since 1990, while emissions from *Wastewater treatment and discharge* increased by 128% throughout the time series.

Waste sector emissions have increased by 44.1% since 2000 (Table ES 2). *Solid waste disposal* emissions have increased by 47.6% since 2000. *Incineration and open burning of waste* emissions increased by 53.1% since 2000, while emissions from *Wastewater treatment and discharge* increased slightly throughout the time series. This is largely driven by increases of 35.6% in *Domestic wastewater treatment and discharge* emissions, whilst there was a 9.4% decline in *Industrial wastewater treatment and discharge* emissions.

E.S.4. Other information

Planned improvements

Table ES 3 summarizes the planned actions to improve various sectors of inventory. Further details on current efforts, barriers, and future goals are provided in Chapter 9.

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Table ES 3: Improvements that are currently in progress and improvements planned or proposed

Sector	Improvement
Tasks in progress	
Energy	Improve uncertainty data for all sectors by incorporating more country specific uncertainty values
	Incorporate NOx, CO, NMVOC, and SOx emissions
	Update of the VKT study, including segregation of on-road/off-road
	Comparison of next VKT approach with fuel statistics
Agriculture	Incorporate all background data and equations for the Tier 2 calculations of enteric fermentation
LULUCF	Improve the uncertainty analysis for the Land sector to incorporate more detail.
	Improvement of land change data through detailed assessment of maps and tracking of land parcels
	Improve the biomass burning emissions
	Incorporate organic soils study to include emissions from organic soils
	Move to a higher tier level for DOM in forest lands
Waste	Data collection on quantities of waste disposed of into managed and unmanaged landfills
Tasks outstanding	
Cross cutting	Implement the IPCC Software
Energy	Further disaggregation of 1A2
	Collect more activity data for estimating emissions associated with non-energy fuel use
	Inclusion of methodology documentation/summary/approval process for tier 3 methods
	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams
	CH_4 emissions from abandoned mines
	Investigate pipeline transport
	Investigate ground activities at airports and harbours
	Comparison of next VKT approach with fuel statistics
	Segregation of military energy use.
	Incorporate emissions from biogas
	CO_2 transport and storage
	CO_2, CH_4 and N_2O emissions from combined heat and power (CHP) combustion systems
IPPU	Update the fluorinated gasses with higher accuracy figures from SARS
	Include emissions from electronics industry
	Incorporate emissions SF_6 emissions

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Agriculture	Improve manure management data, including biogas digesters as a management system
LULUCF	Update SOC reference data
	Initiate data collection on controlled fires
	Perform a more detailed assessment of HWP to include a wider range of products
	Collect data on other disturbances besides fire in forest lands
Waste	Include economic data for different population groups
	Include information on population distribution in rural and urban areas as a function of income
	Include HWP in solid waste
	Obtain data on waste streams and the bucket system
	CH_4, N_2O emissions from biological treatment of waste
	CO_2, CH_4 and N_2O from waste incineration

Key category analysis

A Tier 1 level and trend assessment were conducted, following Approach 1 (IPCC, 2006), on both the emissions including and excluding LULUCF to determine the key categories for South Africa. In the previous inventory there were 53 key categories, while in this inventory there are 43. Table ES 4 shows the top 10 key categories with full details being provided in section 1.4 of this report.

Other sectors – solid fuels, *Forest land converted to grassland*, other sectors – liquid fuels, and Other– solid fuels are new to the top 10 key categories in the 2024 inventory. In the previous inventory, these categories were ranked 16th (Other sectors – solid fuels), 26th (*Land converted to grassland*), 35th (Other sectors – liquid fuels), and 10th (Other – solid fuels), respectively.

Table ES 4: Top 10 key categories for South Africa for 2024 (incl. LULUCF)

Rank	IPCC code	IPCC Category	GHG#	Criteria
1	1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO_2	L,T
2	1.A.4	Other Sectors - Solid Fuels	CO_2	L,T
3	4.A.2.b	Grassland converted to forest land – all pools	CO_2	L,T
4	4.C.2.a	Forest land converted to Grassland – all pools	CO_2	L,T
5	1.A.3.b	Road Transportation	CO_2	L,T
6	4.A.1.a	Forest land remaining forest land – biomass (above and below)	CO_2	L,T

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7	4.C.2.e	Other land converted to Grassland – all pools	CO_2	L,T
8	1.A.4	Other Sectors - Liquid Fuels	CO_2	L,T
9	4.C.1.a	Grassland remaining Grassland – biomass (above and below)	CO_2	L,T
10	1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO_2	L,T

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E.S.5. Improvements introduced

Energy

Energy sector emission estimates were improved through the application of country-specific CO_2 emission factors for solid fuels. These factors are based on a study completed in 2022, which developed temporary Tier 2 CO_2 emission factors for solid fuels. In addition, the time series was extended back to 1990, compared to the previous series which covered the period from 2000 onward.

IPPU

The IPPU sector emission estimates were extended from 2000 back to 1990 to complete the timeseries. Tier 2 and Tier 3 estimates were introduced into the SAGERS data from 2022 onwards in the IPPU sector. Calculations with increased accuracy were achieved for *Other Chemicals and Product Use*, specifically ceramics, soda ash and dolomite usage. Verification of some selected production plants identified areas previously not included and increased accuracy.

Agriculture

The Agriculture sector inventory is subject to continuous improvement, resulting in periodic recalculations. Key updates include the inclusion of organic soils for cropland and grassland within the Agriculture sector and the application of 2019 IPCC Refinement emission factors for soil management, which are disaggregated by wet and dry climate conditions. For the agriculture sector, historical data for the early years (1990–1999) have been included, extending the dataset to cover the full period from 1990 to 2024 and ensuring time-series completeness.

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LULUCF

Several improvements were made in the LULUCF sector including the addition of burnt-area data for early years (1990-1999), enhanced historical information for harvested wood products and fuelwood use, updated biomass and carbon stock datasets, refined wetland methodologies, and improved soil carbon estimates through soil-specific land-change matrices. Recent years also incorporated the updated 2020–2022 land-change data, revised land-use change assumptions, and the removal of a previous land conversion error, resulting in more consistent and accurate land-use information.

Waste

A change in the source of the waste composition data to a more country-specific source led to changes in emission estimates in this sector. An additional improvement was the use of the waste composition and the update of the Methane Correction Factor (MCF) that is on the State of the waste report (DFFE, 2019).

E.S.6. Indicator trends

The carbon intensity indicators show that overall South Africa's carbon intensity is decreasing overtime. Carbon intensity of the population, carbon intensity of the economy and the carbon intensity of the energy supply have declined by 29%, 58% and 35% respectively since 1990.

E.S.7. Conclusions

This report incorporates significant improvements, including the completion of the 1990–1999 time series across all sectors. It provides a comprehensive analysis of South Africa's emissions profile from 1990 -2024. The 2024 emissions profile indicates that the Energy sector remains the dominant contributor to national emissions. In 2024, energy-related emissions accounted for 78.6% South Africa's total emissions (excl. LULUCF). This is followed by the Agriculture sector (11.0%), IPPU sector (6.4%), and the Waste sector (4.0%). With the inclusion of LULUCF these contributions increase to 84.5%, 6.8%, 11.9% and 4.3% respectively. The LULUCF sector contributes a sink of 33 412 Gg CO_2e.

An assessment of historical trends from 1990 to 2024 shows that the share of emissions (excl. LULUCF) has declined in the Agriculture sector, while other sectors show an

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increase. The long-term trends for total emissions excluding LULUCF demonstrate a pattern of initial growth followed by stabilisation and a gradual decline in more recent years. Emissions including the LULUCF sector, which shows a slow increasing sink, has a similar trend but with slightly reduced emissions.

The Energy sector has consistently been the largest contributor to national GHG emissions, in line with findings from previous inventory submissions. Total emissions from the Energy sector increased steadily from 1990 until approximately 2009, after which emissions fluctuated and then gradually declined towards 2024. Fuel combustion activities remain the dominant source of emissions throughout the time series, accounting for the largest share in all years. Emissions from fuel combustion rose steadily during the 1990s and early 2000s, peaked around 2008-2009, and subsequently stabilised before declining gradually over the following decade.

Emissions from the Agriculture sector remained relatively stable over the period 1990-2024, with a slight overall decline. In 2024, the LULUCF sector continued to function as a net sink of 33 412 Gg CO_2e, with forest land contributing the largest share of removals, while other land-use categories were estimated to be net sources of emissions.

Waste sector emissions have increased by 69.6% since 1990. The total emissions from the Waste sector in 2024 is 19 245 Gg CO_2e. Majority of Waste sector emissions are from *Wastewater treatment and discharge* accounting for 47% of the emissions, followed by S*olid waste disposal* accounting for 38%.

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Chapter 1: National circumstances, institutional arrangements and cross-cutting information

1.1 Background information on GHG inventories and climate change

1.1.1 Background information on climate change

South Africa became a Party to the UNFCCC after signing the Convention in 1993 and ratifying it in 1997. As a Party, South Africa is obligated to address climate change by systematically monitoring, compiling, and reporting trends in anthropogenic greenhouse-gas emissions and removals. These obligations have been strengthened by the Paris Agreement, adopted in 2015 and entered into force in 2016, which requires Parties to prepare, communicate, and maintain successive Nationally Determined Contributions (NDCs). The Paris Agreement further mandates regular updates to these NDCs to reflect increasing ambition over time, as well as participation in the global stocktake process to assess collective progress toward the long-term temperature goal. These international commitments form the foundation for South Africa's national GHG inventory system and guide ongoing improvements in transparency, accuracy, completeness, consistency, and comparability in reporting.

1.1.2 Background information on GHG inventories

The first national GHG inventory for South Africa was prepared in 1998, using 1990 data (Van der Merwe & Scholes, 1998). It was updated to include 1994 data and published in 2004. It was developed using the 1996 IPCC Guidelines for National Greenhouse Gas Inventories. For the 2000 national inventory (DEAT, 2009), a decision was made to use the recently published IPCC 2006 Guidelines (IPCC, 2006) to enhance accuracy and transparency, and to familiarise researchers with the latest inventory preparation guidelines. South Africa has maintained a consistent schedule of compiling and publishing its national greenhouse-gas (GHG) inventories in line with UNFCCC and Paris Agreement transparency requirements. The first comprehensive inventory covering 2000 to 2010 was published in 2014, followed by updates released in 2017 for 2011–2012, in 2019 for

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2013–2015, and in 2021 for the 2016-2017 inventory year. Further updates were published in 2023 for the 2018–2020 inventory and in 2024 for the 2021–2022 series. This regular publication cycle demonstrates South Africa's ongoing commitment to producing transparent, accurate, and up-to-date national GHG inventory information.

1.2 National circumstances and institutional arrangements

1.2.1 National Entity

In South Africa the DFFE is the central co-ordinating and policy-making authority with respect to environmental conservation. The DFFE is mandated by the Air Quality Act (Act 39 of 2004) (RSA, 2004) to formulate, co-ordinate and monitor national environmental information, policies, programmes and legislation. The work of the DFFE is underpinned by the Constitution of the Republic of South Africa (RSA) and all other relevant legislation and policies applicable to government to address environmental management, including climate change.

In its capacity as a lead climate institution, the DFFE is responsible for co-ordination and management of all climate change-related information, such as mitigation, adaption, monitoring and evaluation programmes, including the compilation and update of National GHG Inventories. The branch responsible for the management and co-ordination of GHG inventories at the DFFE is the Climate Change and Air Quality branch (Figure 1.1), whose purpose is to monitor and ensure compliance on air and atmospheric quality, as well as support, monitor and report international, national, provincial and local responses to climate change.

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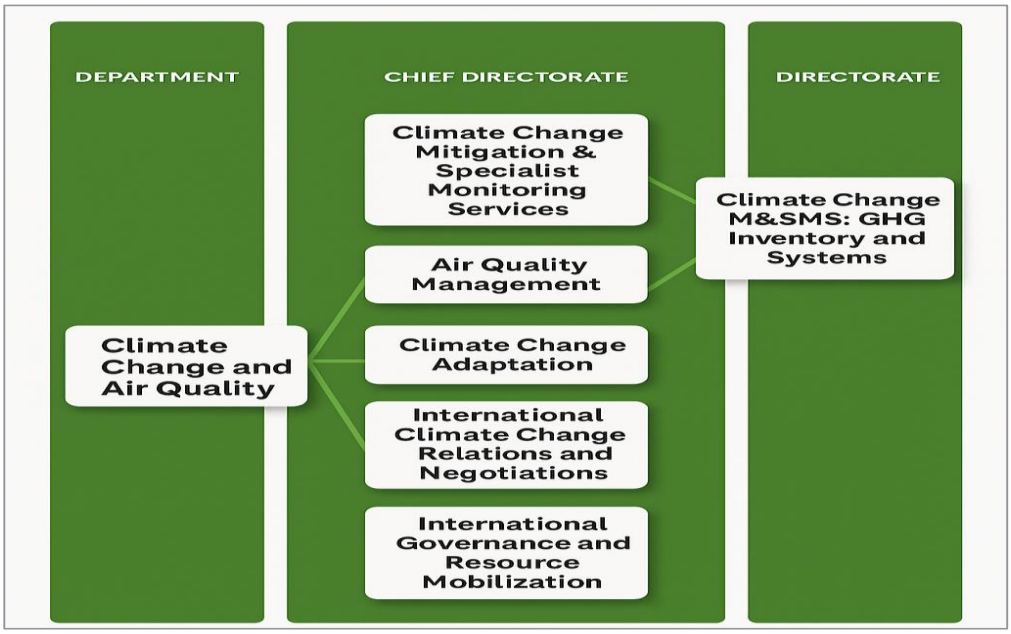


Figure 1.1: Organogram showing where the GHG Inventory compilation occurs within DFFE

DFFE is currently responsible for managing all aspects of the National GHG Inventory development. The Director of the Climate Change Monitoring and Evaluation (M&E): GHG Inventory and Systems directorate is the National Inventory Co-ordinator (NIC) and the tasks of the coordinator include:

- Managing and supporting the National GHG Inventory staff, schedule, and budget to develop the inventory in a timely and efficient manner:
  - Prepare work plans;
  - Establish internal processes;
  - Ensure funding is in place;
  - Appoint consultants where necessary; and
  - Oversee consultants and internal DFFE technical staff handling the report compilation.
- Identifying, assigning, and overseeing national inventory sector leads.
- Assigning cross-cutting roles and responsibilities, including those for QA/QC, archiving, key category analysis (KCA), uncertainty analysis, and compilation of the inventory section of the National Communications (NC) and/or Biennial

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Update Report (BUR)/Biennial Transparency Report (BTR). Managing the QA (external review and public comment) process:

- Appoint external reviewers;
- Liaise between the reviewers and the NID authors;
- Obtain approval from the minister of the DFFE for the NID to go for public comment; and
- Manage the incoming public comments and liaise with NID authors and experts to address any issues

- Maintaining and implementing a national GHG inventory improvement plan:
  - Manage the GHG Improvement programme (including sourcing of funds and appointing service providers for required projects).
- Obtaining official approval (from Cabinet) of the GHG inventory and the NID and submit reports (NID, BUR, NC) to the UNFCCC.

Fostering and establishing links with related national projects, and other regional, international programmes as appropriate.

1.2.2 Inventory preparation process

1.2.2.1 Legal arrangements

Data is sourced from many institutes, associations, companies and ministerial branches. There are no formal agreements between the various government departments for the collection of data for the GHG Inventory. To aid in the collection of data from the energy sector and industries (including forestry plantation industries and certain agricultural industries) the government published the NGER (DEA, 2017a), under Section 53(a), (o) and (p) read with section 12 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), in the Government Gazette of the 3rd April 2017. The purpose of the GHG reporting regulation is to introduce a single national reporting system for the transparent reporting of GHG emissions, which will be used (a) to update and maintain a National GHG Inventory; (b) for the Republic of South Africa to meet its reporting obligations under the UNFCCC and instrument treaties to which it is bound; and (c) to inform the formulation and implementation of legislation and policy.

The NGER were promulgated in fulfilment of the implementation of the regulatory framework to support the collection of the requisite activity and GHG emissions data necessary for the compilation of the National GHG emissions Inventory to improve the quality, sustainability, accuracy, completeness and consistency of the National GHG Inventories. In accordance with regulation 7(1) of the NGER the initial reporting cycle

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commenced on 31 March of 2018 requiring data providers to register and submit activity and GHG emissions data to the competent authority, namely DFFE.

The DFFE is in the process of upgrading the former SAGERS through the development of a new reporting platform, the South African Industrial GHG Emission Management System (SAIGE). Once implemented, SAIGE is intended to serve as the national platform for the management and reporting of industrial GHG emissions. The proposed system is envisaged as a comprehensive, web-based platform to support accurate reporting, monitoring, and management of GHG emissions by major emitters in South Africa.

The purpose of SAIGE is to integrate key functionalities, including GHG reporting, Carbon Budgets, and Mitigation Plans. Upon completion, the platform is expected to facilitate the submission, approval, data management, and data analytics of these modules, thereby supporting regulatory compliance by data providers and enabling national strategic decision-making on emission reductions by the DFFE.

The inventory compilation process (Figure 1.2) is co-ordinated through a central web-based inventory management system (National GHG Information Management System (NGHGIS)).

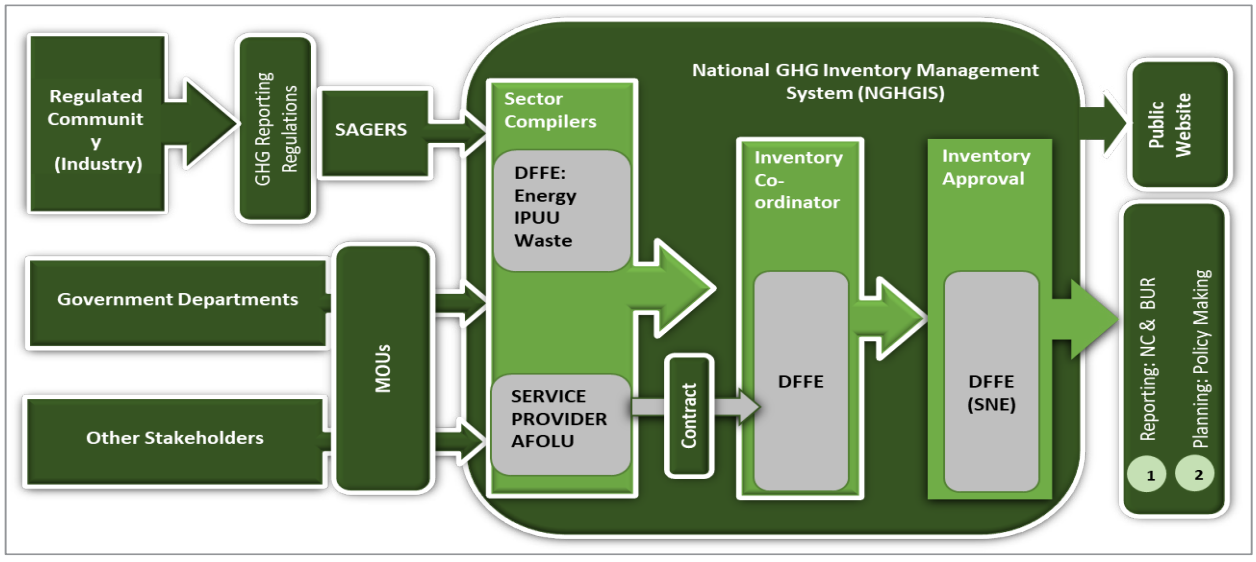


Figure 1.2: The inventory compilation process in South Africa

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1.2.2.2 Inventory management

South Africa uses a hybrid (centralised/distributed) approach to manage the inventory programme. Management and coordination of the inventory programme, as well as compilation, publication and submission of the inventory are carried out by the Single National Entity (being the DFFE) in a centralised manner. Currently DFFE is responsible for collecting data, compiling and QC of the Energy, IPPU, Agriculture and Waste sector inventories, while the LULUCF sector is compiled (in collaboration with DFFE) by external consultants (Gondwana Environmental Solutions (GES)) who are appointed on contract and funded through donor support. DFFE assists with the QC of the LULUCF sector. DFFE were also responsible for combining and compiling the overall inventory and compiling the draft National Inventory Report.

1.2.2.3 Procedural arrangements

1.2.2.3.1 Inventory planning

A planning meeting was held in January 2024 to engage with the whole team and to plan the timelines for the inventory preparation process, from data collection to finalisation of the NID. Since there were several new team members various training sessions (on inventory preparation, calculation files, QC procedures, time-series consistency, splicing techniques, and uncertainty analysis) were included in the inventory compilation plan. The planning phase also involved the preparation of files and templates for the inventory compilation.

1.2.2.3.2 Inventory preparation

After planning there are five main steps in the preparation of a National GHG Inventory:

- Collect;
- Compile;
- Write;
- Improve; and
- Finalise

The stages and activities undertaken in the inventory update and improvement process are shown in Figure 1.3.

The collection phase is dedicated to data collection and preliminary processing, such as data cleansing, data checks and preliminary formatting for further use. The compilation phase involves the preparation and QC of initial estimates, as well as the uncertainty and

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key category analysis. This phase may also include analysis of potential recalculations involved in the inventory.

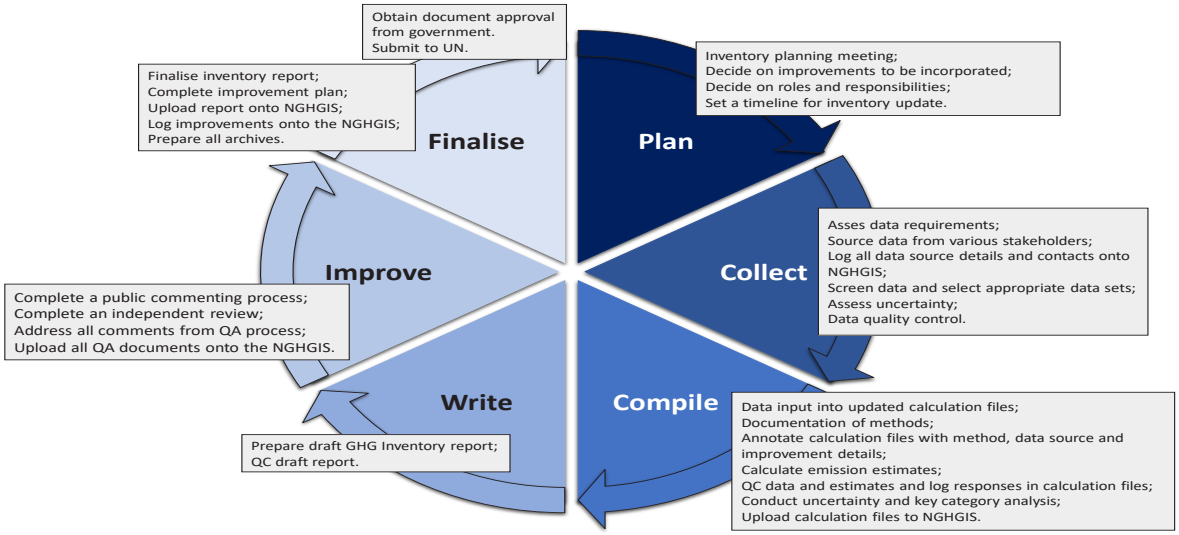


Figure 1.3 : Overview of the phases of the GHG inventory compilation and improvement process undertaken for South Africa's 2024 GHG inventory

The writing phase is where the draft inventory report is prepared, including all crosscutting components (KCA, trends by gas and sector, etc.) and QC of the draft is completed. At the end of this component the draft document is subjected to a QA, or review process. The review is done by independent consultants and/or public commenting process. For the 2024 inventory only the public commenting process was utilised. Comments from the review process are used to improve the Report, after which it is finalized. During the finalization phase the archives are prepared and final Report approvals are obtained before being submitted to UNFCCC.

1.2.2.3.3 Data collection

Data collection and documentation take place under the responsibility of the relevant experts. Three different processes are used to collect data for South Africa's inventory. The first is by obtaining data from South Africa's GHG Reporting Programme, as per the legal arrangements and from government departments, institutes, and organisations

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through an informal process, i.e. where data is obtained without any formal data collection agreements. The third is through the evaluation of publicly available data, official statistics, association statistics, studies, periodicals and third-party research projects. DFFE administers the GHG Reporting Programme, which facilitates the mandatory reporting of GHG emissions by companies in accordance with the NGER. Under this programme, regulated entities submit activity data and emissions information directly through the designated GHG reporting platform, which serves as a primary data source for the national inventory compilation process. The programme strengthens and streamlines data collection, thereby improving the completeness, consistency, accuracy, comparability, and transparency of South Africa's national GHG inventories in line with international reporting principles.

1.2.2.3.4 Data preparation and emission calculation

The process of data preparation and emissions calculation comprises the following steps:

- Data entry;
- Data preparation (model formation, disaggregation, aggregation);
- Calculation of emissions;
- Preparation of report sections (texts); and
- Approval by the relevant experts.

Report texts are prepared along with the time series for activity data, emission factors, uncertainties, and emissions. As a result, the term "data" is understood in a broad sense. In addition to number data, time series, etc., it also includes contextual information such as the sources for time series, and descriptions of calculation methods, and it also refers to preparation of report sections for the NID and documentation of recalculations.

After all checks have been carried out, and the relevant parties have been consulted where necessary, the emissions are calculated in excel by each sector lead based on the following principle:

activity data * emission factor = emission

As much of the data as possible is included in the calculation files, but where larger data sets are referred to these are stored in the NGHGIS.

Following complete preparation of data, report sections and QC/QA checklists by the experts responsible, these materials are transmitted to the Single National Entity where it is

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reviewed by category-specific specialists at the Single National Entity. The results of this review are then provided to the sector lead experts to revise and finalise their contribution.

1.2.2.3.5 Report preparation

Report preparation includes the following steps:

- Aggregation of emissions data for the national trend tables and reporting formats, preparation of data tables for the NID;
- Compilation of submitted report texts to form a report draft, and editing of the complete NID;
- Internal review of the draft (national trend tables and NID) by DFFE;
- Public commenting process;
- External review by 3rd party;
- Finalisation of NID report;
- Approval by DFFE Minister;
- Submission to UNFCCC; and
- Archiving.

1.2.3 Data storage and archiving

The NGHGIS for South Africa assists in managing and storing the inventory related documents and processes. The NGHGIS, amongst other things, keeps records of the following:

- Stakeholder list with full contact details and responsibilities;
- List of input datasets which are linked to the stakeholder list;
- QA/QC plan;
- QA/QC checks;
- QA/QC logs which will provide details of all QA/QC activities;
- All method statements;
- IPCC categories and their links to the relevant method statements together with details of the type of method (Tier 1, 2 or 3) and emission factors (default or country-specific) applied;
- Calculation and supporting files;
- Key references;
- Key categories; and
- All inventory reports.

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The procedures for data storage and archiving are described in detail in the QA/QC plan that has been developed and is discussed in section 1.6 below. The NGHGIS is used to archive inventory data.

1.2.4 Processes for official consideration and approval of inventory

The NIDs are endorsed by the Project Steering Committee (PSC), being chaired by the DFFE and comprising of various stakeholder before they are submitted to the Minister of the DFFE for approval. Once the reports are approved by Minister, they are submitted to the UNFCCC by the Chief Directorate for Climate Change International Relations and Reporting and undergo an international review process.

1.3 Brief description of data sources and methodologies

1.3.1 Data sources

1.3.1.1 Energy sector

The primary source of data for the Energy sector is derived from reports submitted by data providers under South Africa's GHG Reporting Programme. These data providers include, but are not limited to, the main electricity provider, Eskom, as well as petroleum companies such as Engen, PetroSA, and Sasol. Additional data are obtained from annual reports submitted by Transnet and other manufacturing industries reporting emissions from fuel combustion activities.

Data from South Africa's GHG Reporting Programme is supplemented by energy balance data compiled by the Department of Electricity and Energy (DEE), formerly the Department of Mineral Resources and Energy (DMRE). At present, there are no formal processes in place for requesting or obtaining data directly from DEE. The data collection process for the Energy sector is illustrated in Figure 1.4, while the corresponding data sources are presented in Table 1.1. For the historical period 1990–1999, aggregated energy balance data were used, and splicing techniques were applied to address gaps in the time series.

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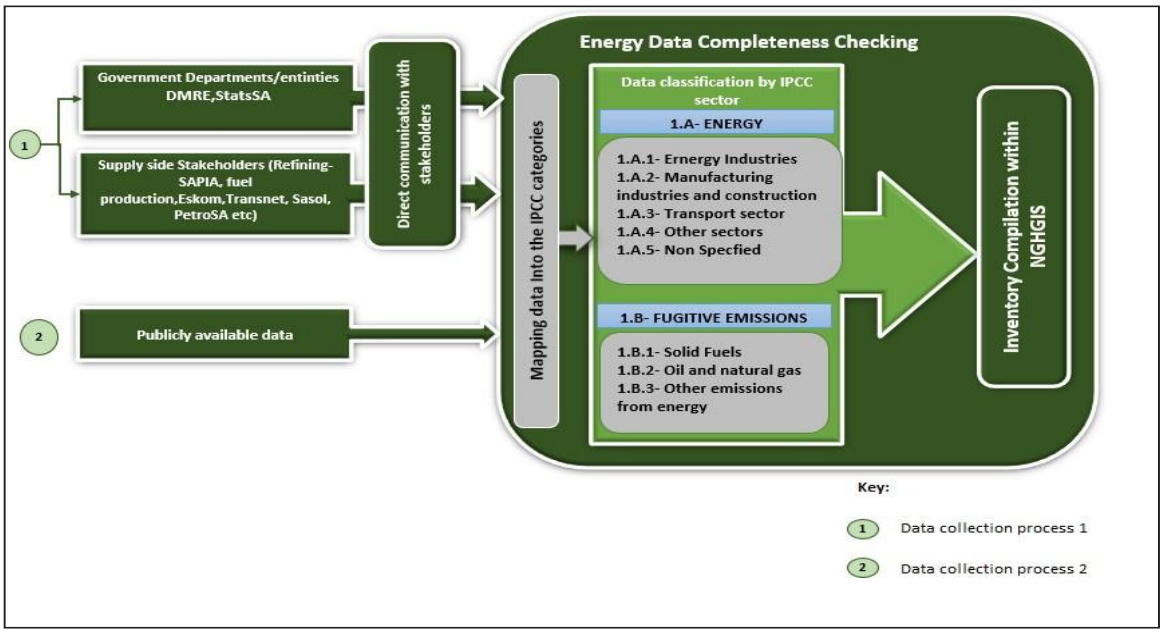


Figure 1.4: Data collection process for the 2024 Energy inventory

Table 1.1: Principal data sources for the Energy sector inventory

Sub-category	Activity data	Activity data sources
Electricity generation	Fuel consumption for public electricity generation	GHG Reporting Programme (Eskom GHG Emissions reports)
	Fuel consumption for auto electricity producers	GHG Reporting Programme (Kelvin Power, Peakers Operations and Ngodwana Energy GHG emissions reports)
	NCVs	GHG Reporting Programme
Petroleum refining	Fuel consumption	GHG Reporting Programme (Refineries)
Manufacture of solid fuels andother energy industries	No activity data, only emission data - based onMass Balance and measurement	GHG Reporting Programme, Food and Agriculture Organisation (FAO) of UN
Manufacturing industries and construction	Other kerosene, bitumen and natural gas consumption	Energy balance (DEE)
	Gas/Diesel consumption	Energy balance (DEE)
	Residual fuel oil consumption	Energy digest

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Sub-category	Activity data	Activity data sources
	LPG consumption	SAMI report (DEE)
Transport	Vehicle kilometres travelled for road transport	Fuel consumption study
	Domestic aviation gasoline consumption	Fuel consumption study
	Domestic aviation jet kerosene consumption	Fuel consumption study
	Road transport fuel consumption	Fuel consumption study
	Road transportation other kerosene consumption	Energy balance (DEE)
	Railway fuel oil consumption	Energy balance (DEE)
	Railway gas/diesel oil consumption	Energy balance (DEE)
	Water-borne navigation fuel consumption	Energy balance (DEE) / Fuel consumption study
	International aviation Jet Kerosene consumption	Energy balance (DEE) / Fuel consumption study
Commercial/ institutional	Other kerosene, gas/diesel oil, gas works gas and natural gas consumption	Energy balance (DEE)
	Sub-bituminous coal consumption	Energy balance (DEE)
	Residual fuel oil consumption	Energy balance (DEE)
Residential	Coal consumption	Energy balance (DEE)
	LPG consumption	Energy balance (DEE)
	Sub-bituminous coal consumption	Energy balance (DEE)
	Other fuel consumption	Energy balance (DEE)
Agriculture/forestry/fishing/fishfarms	Other kerosene consumption	Energy balance (DEE)
	Gas/diesel oil consumption	Energy balance (DEE)
	Other fuel consumption	Energy balance (DEE)
Stationary non-specified	Fuel consumption	Energy balance (DEE)
Fugitive emissions	Solid fuels	Mineral Council Of South Africa Reports GHG Reporting Programme
	Oil and Natural Gas	GHG Reporting Programme and Energy balance
	Other fugitive emissions	GHG Reporting Programme and Energy balance / Fuel consumption study

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1.3.1.2 IPPU sector

Data for the IPPU sector is obtained mostly through South Africa's GHG Reporting Programme (Table 1.2). The HFC and PFC data was supplied by the DFFE Waste and Chemicals branch and supplemented with the 2016 5-year periodic survey conducted by DFFE. There is no formal data collection process in place for this.

Data sources for extending the time-series from 2000 back to 1990 are provided in Table 1.3.

Table 1.2: Principal data sources for the IPPU sector inventory

Sub-category	Activity data	Data source
Cement production	Cement produced	GHG reporting Programme
	Clinker fraction	GHG reporting Programme
Lime production	Mass of lime produced	GHG reporting Programme
Glass production	Glass production	GHG reporting Programme
Other product uses of carbonates (OPUC)	Emissions from OPUC	GHG reporting Programme
Ammonia production	Emissions from ammonia production	GHG reporting Programme
Nitric acid production	Emissions from nitric acid production	GHG reporting Programme
Carbide production	Raw material (petroleum coke) consumption	GHG reporting Programme
Titanium dioxide production	Emissions from titanium dioxide production	GHG reporting Programme
Soda Ash production	Emissions from soda ash production	GHG reporting Programme
Carbon black production	Amount of carbon black produced	GHG reporting Programme
Hydrogen production	Emissions from hydrogen production	GHG reporting Programme
Other chemical processes	Emissions from other chemical processes	GHG reporting Programme
Iron and steel production	Production data	GHG reporting Programme
Ferroalloys production	Production data	GHG reporting Programme
Aluminium production	Production data	GHG reporting Programme
Lead production	Production data	GHG reporting Programme
Zinc Production	Production data	GHG reporting Programme
Lubricant use	Lubricant consumption	Extrapolated
Paraffin wax use	Paraffin wax consumption	Extrapolated

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Sub-category	Activity data	Data source
Refrigeration and air conditioning	Existing, new and retired refrigerators	HFC Survey, Stats SA
	Annual data on stationary air conditioning units	HFC Survey, DEA 2016;BSRIA
	Existing, new and retired refrigeration trucks	HFC study;South African Refrigerated Distribution Association (SARDA)
	Existing. New and retired vehicles	eNaTIS; National Association of Automobile Manufacturers of South Africa (NAAMSA)
Foam blowing agents	Total HFC used in foam manufacturing in a year	HFC Survey (DEA, 2016)
Fire protection	Bank of agent in fire protection equipment in a year	HFC Survey (DEA, 2016)

Table 1.3: Data sources for estimating emissions between 1990 and 1999 in the IPPU sector

Category	Data source description
Mineral Industry	The GDP data (World Bank) was used to estimate the production data for 1994 to 1990.
	The Energy balance data used for 1999 to 1995.
	Statistics South Africa Publications: Manufacturing statistics Indices of the physical volume of manufacturing production Base: 2000=100 January 1990 to November 2002 was used to estimate production data.
Chemical Industry	The year 2000 was used as a baseline, and GDP data (World Bank) was used to estimate the production data for 1999 to 1990.
Metal Industry	The GDP data (World Bank) was used to estimate the production data for 1994 to 1990.
	The Energy balance data used for 1999 to 1995.
	DMRE production statistics was used for subsectors such as ferroalloys for 1999 going backwards.
Non-Energy Products from Fuels and Solvent Use	No improvement in the 1990 to 1999. Emissions estimation was built from the previous inventory.
Product Uses as Substitutes for Ozone Depleting Substances	No emissions data from 1990 to 2007. Emissions data was only estimated from 2008 to 2024 by means of extrapolation.

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1.3.1.3 Agriculture sector

Agricultural data are sourced from multiple institutions, as outlined in Table 1.4, as there is no single, formalised data collection system covering all agriculture-related data. Data is obtained from available government reports, statistical databases, and published literature. Cropland data are provided by the Department of Agriculture, Land Reform and Rural Development (DALRRD). Data on fertiliser use and liming are obtained from the South African Revenue Service (SARS), the Department of Mineral Resources and Energy (DMRE), and the Fertilizer Association of South Africa (FertASA). Some crop statistics are sourced from Statistics South Africa (Stats SA).

Livestock data are primarily obtained from DALRRD and the Agricultural Research Council (ARC). ARC data are generated on a project-specific basis and are therefore often once-off. More recently, the SAGERS is collecting limited agricultural data, including manure management data from poultry farms. Although reporting only commenced in 2022, the system is expected to play an increasing role in agricultural data collection going forward. The same data sources were used for the historical dataset covering the early years (1990–1999).

Table 1.4: Principal data sources for the Agriculture sector inventory

Sub-category	Activity data	Data source	Data collection mechanism
Livestock	Livestock population data (Cattle, sheep, Goats and swine)	DALRRD	DFFE is in the process of developing an MOU with DALRRD
	Livestock population data (Horses, mules and asses)	FAO	Statistics available on FAO Stats website (unofficial)
	Poultry data	South African Poultry Association (SAPA)	Information obtained through direct contact. No formal mechanism is in place.
	Livestock and manure management data	ARC, Tshwane University of Technology (TUT) and University of Pretoria	Data is available through scientific publications.
3C Aggregated & non-CO_2 emissions from land	Limestone and dolomite data	South African Mineral Industry Report compiled by DMRE	No formal mechanism is in place, but data is currently publicly available.
	Burned area data	MODIS burnt area data	No formal process for obtaining this data.
	Planted/harvested areas	FAO	Statistics available on FAO Stats website

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Sub-category	Activity data	Data source	Data collection mechanism
	Crop management data	ARC	DFFE is in the process of developing an MOU with ARC.
	Planted/harvested areas	Statistics SA	Agricultural census data are available from Statistics SA. No formal mechanism is in place.
	Fertilizer data	Fertilizer Association of SA	Annual nitrogen application data for crops
	Urea data	SARS	Provides annual import data for urea
	SOC data	ISRIC	SOC ref data

1.3.1.4 LULUCF sector

Data for the LULUCF sector sub-categories is obtained from various sources as indicated in Table 1.5. DFFE developed a Computer Automated Land Cover (CALC) model which can generate land cover maps based on Sentinel 2 data and these maps can be developed from 2016 onwards, however the first map developed was for 2018 and subsequently for 2020 and 2022. The aim is to generate a map everytwo years. All South African National Land Cover (SANLC) data (including the CALC data) can be obtained from https://www.dffe.gov.za/egis. Other spatial land data, such as the carbon density maps, are obtained from https://catalogue.saeon.ac.za/. These products are developed on a project-by- project basis.

There are no formal data collection processes in place for all the other land, such as carbon stock data and fuel wood removals. Data is obtained from available government reports, agricultural association reports, statistical databases and scientific literature. Plantation data is supplied by Forestry SA, and the cropland data is supplied by DALRRD. Burnt area data is obtained from the MODIS burnt area product which is processed by Gondwana Environmental Solutions.

Plantation data is also being reported to DFFE through South Africa's GHG Reporting Programme via the SAGERS system and manual submissions. This data could be utilised in future inventories.

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Table 1.5: Principal data sources for the LULUCF sector inventory

Sub-category	Activity data	Data source	Data collection mechanism
All land types (Forest land, Cropland, Grassland, Wetland, Settlements, Other land)	Land cover and land use change maps	DFFE	Data and land maps are developed by DFFE and are freely available on the EGIS website. SANLC maps to be produced every 2 years. (https://www.dffe.gov.za/egis)
	Soil maps	ISRIC	Available online (https://www.isric.org/)
	Carbon stock data	Scientific literature	Carbon stock data for the various vegetation classes is obtained for literature which is available online. Where data not available information is obtained from the carbon density maps.
	Carbon density maps	SAEON	Carbon density maps were produced through a project name the Terrestrial Carbon Sinks Assessment. This data is available online (https://catalogue.saeon.ac.za/).
	Burnt area data	MODIS	Available online
Forest land	Timber statistics	DFFE	Statistical data is released annually and is freely available. DFFE is in the process of developing an MOU with DALRRD
	Plantation data	Forestry South Africa	Data obtained through direct request, no formal mechanism in place. Data is also freely available on their website.
	Plantation fertilizer data	DFFE GHG Reporting Programme	Plantation data from industry obtained from DFFE Reporting programme
	Household number and wood fuel use	Statistics SA	Available online
	Household fuel consumption data	Scientific literature	Available online
Harvest wood products	Production data	Forestry South Africa	Data obtained through direct request, no formal mechanism in place. Data is also freely available on their website.
	Import/export data	FAOStat	Available online

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1.3.1.5 Waste sector

Waste data is collected from various data reports, statistics and global data sets (Table 1.6). As with the Agriculture and LULUCF sectors there are no formal data collection processes. The main data providers for the Waste sector are Statistics SA, DFFE, Department of Water and Sanitation (DWS) and UN. In time it may be possible to collect someof the Waste data through South Africa's GHG Reporting Programme.

Table 1.6: Principal data sources for the Waste sector inventory

Sub-category	Activity data	Data source
Solid waste disposal	Population data	Statistics SA (2025);
		UN (2012)
	Waste composition	IPCC 2006 Guidelines
	Waste generation rate for each component	State of Waste Report (2018)
	GDP	World bank
Biological treatment of solid waste	Mass of organic waste by biologicaltreatment type	SAWIC, DFFE (wastewater treatmentand biological treatment of solid waste study)
Open burning of waste	Population data	Statistics SA (2025);
		UN (2012)
	Fraction of population burning waste	Assumption based on population without access to waste collection services.
Wastewater treatmentand discharge	Population data	Statistics SA (2025);
		UN (2012)
	Split of population by income group	Statistics SA (2025)
	BOD generation rates per treatment type	IPCC 2006 Guidelines, DWS
	Per capita nitrogen generation rate	IPCC 2006 Guidelines

1.3.2 Methodologies

The inventory is compiled in accordance with the guidelines provided by the UNFCCC and follows the 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006) (hereinafter referred to as IPCC 2006 Guidelines), IPCC Good Practice Guidance (GPG) (IPCC, 2000; IPCC, 2003; IPCC, 2014), the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019) (hereinafter referred to as IPCC 2019 Refinement) and sections of the 2013 Supplement to the 2006 IPCC Guidelines for

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National Greenhouse Gas Inventories: Wetlands (IPCC, 2014a) (hereinafter referred to as IPCC 2013 Wetland Supplement).

The methods used for the individual categories are outlined in the sector overview sections in each of the sector chapters. In addition, detailed descriptions are provided in the relevant category chapters.

A distinction is made between calculations made with country-specific ("CS") methods and calculations made, in the various categories, with IPCC calculation methods of varying degrees of detail ("Tiers"). Similarly for the emission factors. The manner in which a calculation is assigned to the various IPCC methods depends on the pertinent category's share (expressed as equivalent emissions) of total emissions and this determined via the key category analysis (section 1.4).

1.4 Key categories

A key category is one that is prioritised within the national inventory system because its estimate has a significant influence (either as a source or a sink) on a country's total inventory of GHG's in terms of the absolute level, the trend, or the uncertainty in emissions and removals (IPCC, 2006). There are two approaches which can be used to determine the key categories: namely, the level approach and the trend approach. The former is used if only one year of data is available, while the latter can be used if there are two comparable years. The level assessment determines the contribution from the categories to the total national inventory. The trend assessment identifies categories that may not be large enough to be identified by the level assessment, but whose trend is significantly different from the trend of the overall inventory and should therefore receive particular attention. The trend can be an increase or a decrease in emissions. This inventory provides emissions for more than one year; therefore, both the level and trend assessments for key category analysis were performed.

The key categories were assessed using the Approach 1 level (L1) and Approach 1 trend (T1) methodologies from the IPCC 2006 Guidelines (IPCC, 2006). Key categories based on uncertainty have not yet been included due to a lack of country specific data on uncertainties. The level and trend key category analysis identify key categories of emissions and removals as those that sum to 95% of the gross (excl. LULUCF) or net (incl. LULUCF) emissions and those that are within the top 95% of the categories that contribute to the change between 2000 and 2024, or the trend of emissions. This includes both source and sink categories. The level assessment was conducted on the base year

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(1990) and the current year (2024), while the trend assessment utilised the base year 1990 and 2024.

In the previous inventory there were 54 key categories, while in this inventory there are 43 (Table 1.7).

Table 1.7: K**ey categories for South Africa for 2024 (incl. LULUCF) and their ranking**

Rank	IPCC code	IPCC Category	GHG[#]	Criteria
1	1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO_2	L,T
2	1.A.4	Other Sectors - Solid Fuels	CO_2	L,T
3	4.A.2.b	Grassland converted to forest land – all pools	CO_2	L,T
4	4.C.2.a	Forest land converted to Grassland – all pools	CO_2	L,T
5	1.A.3.b	Road Transportation	CO_2	L,T
6	4.A.1.a	Forest land remaining forest land – biomass (above and below)	CO_2	L,T
7	4.C.2.e	Other land converted to Grassland – all pools	CO_2	L,T
8	1.A.4	Other Sectors - Liquid Fuels	CO_2	L,T
9	4.C.1.a	Grassland remaining Grassland – biomass (above and below)	CO_2	L,T
10	1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO_2	L,T
11	2.C.2	Ferroalloys Production	CO_2	L,T
12	2.C.1	Iron and Steel Production	CO_2	L,T
13	1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L,T
14	5.A	Solid Waste Disposal	CH_4	L,T
15	3.A.1.a.ii	Non-dairy Cattle	CH_4	L,T
16	3.A.2	Sheep	CH_4	L,T
17	1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L,T
18	4.F.2.c	Grassland converted to other land – all pools	CO_2	L,T
19	4.B.2.a	Forest land converted to Cropland – all pools	CO_2	L,T
20	1.A.3.a	Domestic Aviation	CO_2	L,T
21	1.B.3	Fugitive emissions from - Other emissions from energy production	CO_2	L,T
22	4.E.1.a	Settlements remaining Settlements – biomass (above and below)	CO_2	L,T
23	1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L,T
24	4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	T
25	5.D	Wastewater Treatment and Discharge - Domestic	CH_4	L,T
26	1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO_2	L,T
27	1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	T
28	4.F.2.a	Forest land converted to other land – all pools	CO_2	T
29	2.C.3	Aluminium Production	CO_2	T
30	5.B	Biological Treatment of Solid Waste	CH_4	T

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Rank	IPCC code	IPCC Category	GHG[#]	Criteria
31	2.B.2	Nitric Acid Production	N_2O	L,T
32	4.C.2.c	Wetland converted to Grassland – all pools	CO_2	T
33	4.C.2.b	Cropland converted to Grassland – all pools	CO_2	L,T
34	4.E.2.b	Cropland converted to settlements – all pools	CO_2	T
35	2.D.2	Non-energy Products from Fuels and Solvent Use - Paraffin wax use	CO_2	T
36	1.B.2	Oil and Natural Gas	CO_2	T
37	3.A.4	Goats	CH_4	L,T
38	4.G	Harvested Wood Products	CO_2	T
39	3.A.1.a.i	Dairy Cattle	CH_4	L,T
40	3.B.4	Poultry	N_2O	T
41	3.G	Liming	CO_2	L,T
42	3.H	Urea Application	CO_2	T
43	1.A.4	Other Sectors - Gaseous Fuels	CO_2	T

[#]L=Level assessment; T=Trend assessment; C=Confidential

In the 2024 inventory, fuel combustion – energy industries – solid fuels, other sectors – solid fuels, *Grassland converted to forest land*, *Forest land converted to grassland*, and *Road transportation* have emerged among the top 10 key categories. In the previous 2022 inventory, these categories were ranked 4th (Energy industries – solid fuels), 16th (Other sectors – solid fuels), 1st (*Grassland converted to forest land*), 26th (*Forest land converted to grassland*), and 2nd (*Road transportation*), respectively.

Conversely, certain categories previously ranked within the top 10 in 2022 have declined in relative contribution and are no longer classified among the leading contributors. Specifically, *Forest land remaining forest land* – biomass, *Direct N_2O emissions from managed soils*, other – solid fuels, and ferroalloys production, which were ranked 3rd, 5th, 8th, and 9th in 2022, respectively, have exited the top 10 in 2024.

Annex I contains the full key category analysis results for the level assessments (1990 and 2024) and trend assessment, including and excluding LULUCF.

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1.5 General description quality assurance, quality control and verification plans and implementation

1.5.1 Guiding principles

This report is guided by the inventory quality principles as defined in IPCC 2006 Guidelines (IPCC, 2006) (Table 1.8).

Table 1.8: Guiding principles applied during the preparation of the 2024 inventory

Principle	Application of principle
Transparency	Sufficient and clear documentation is provided such that individuals or groups other than the inventory compilers can understand how the inventory was compiled and can assure themselves it meets the good practice requirements for national GHG emissions inventories.
Completeness	Estimates are reported for all relevant categories of sources and sinks, and gases. The entire geographic area of South Africa is included. Where elements are missing their absence is clearly documented together with a justification for exclusion.
Consistency	Estimates for different inventory years, gases and categories are made in such a way that differences in the results between years and categories reflect real differences in emissions. Inventory annual trends, as far as possible, are calculated using the same method and data sources in all years and aim to reflect the real annual fluctuations in emissions or removals and not be subject to changes resulting from methodological differences.
Comparability	The national GHG inventory is reported in a way that allows it to be compared with national GHG inventories for other countries. This comparability is reflected in the appropriate choice of key categories and in the use of the reporting guidance and tables and use of the classification and definition of categories of emissions and removals.
Accuracy	The national GHG inventory contains neither over- nor under-estimates so far as can be judged. All endeavours were made to remove bias from the inventory estimates.

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1.5.2 QA/QC plan and procedures

As part of the NGHGIS, South Africa developed a formal quality assurance/quality control plan (Annex IV). This provides a list of QC procedures that are to be undertaken during the preparation of the inventory. In this inventory the relatively new team was provided with QA/QC training, and each team member was assigned to a sector. Each quality controller went through the sector calculation files and provided comments. A programme, QA Analyst, assisted with the process of tracking the comments by keeping a log in the front of each file.

1.5.3 General QC procedures

The QC procedures are performed by the experts during inventory calculation and compilation. QC measures are aimed at the attainment of the quality objectives. The QC procedures comply with the IPCC good practice guidance and the IPCC 2006 Guidelines. General inventory QC checks include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions.

In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

The general quality checks are used routinely throughout the inventory compilation process. Although general QC procedures are designed to be implemented for all categories and on a routine basis, it is not always necessary or possible to check all aspects of inventory input data, parameters, and calculations every year. Checks are then performed on selected sets of data and processes. A representative sample of data and calculations from every category may be subjected to general QC procedures each year.

The general QC checks carried out on South Africa's 2024 inventory are provided in Table 1.9.

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Table 1.9: Quality control checks carried out on South Africa's 2024 GHG inventory

ID	Type of check	Description	Level
QC001	Activity data source	Is the appropriate data source being used for activity data?	Calculation file
QC002	Correct units	Check that the correct units are being used	Calculation file
QC003	Unit carry through	Are all units correctly carried through calculations to the summary table? This includes activity data and emission factors.	Calculation file
QC004	Method validity	Are the methods used valid and appropriate?	Calculation file
QC005	Uncertainties	Carry out uncertainties analysis	Supporting file
QC006	Double counting – Categories	Check to ensure no double counting is present at category level	Calculation file
QC007	Notation keys	Review the use of notation keys and the associated assumption to ensure they are correct.	Calculation file
QC008	Trend check	Carry out checks on the trend to identify possible errors. Document any stand out data points.	Calculation file
QC009	Emission factor applicability	Where default emission factors are used, are they correct? Is source information provided?	Calculation file
QC010	Emission factor applicability	Where country specific emission factors are used, are they correct? Is source information provided?	Calculation file
QC011	Recalculations	Check values against previous submission. Explain any changes in data due to recalculations.	Calculation file
QC012	Sub-category completeness	Is the reporting of each sub-category complete? If not this should be highlighted.	Calculation file
QC013	Time series consistency	Are activity data and emission factor time series consistent?	Calculation file
QC014	Colour coding	Has colour coding been used in a consistent and accurate manner? Are there any significant data gaps of weaknesses?	Calculation file
QC015	Cross check data	Where possible cross check data against alternative data sources. This includes activity data and EF. If CS EF are used they must be compared to IPCC values as well as any other available data sets.	Supporting file
QC016	Spot checks	Complete random spot checks on a data set.	Calculation file
QC017	Transcription checks	Complete checks to ensure data has been transcribed from models to spreadsheet correctly.	Calculation file
QC018	Transcription to document	Complete checks to ensure data has been transcribed from spreadsheets to documents correctly.	Sector report
QC019	Data source referencing	All source data submitted must be referenced	Calculation file

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ID	Type of check	Description	Level
QC020	Data traceability	Can data be traced back to its original source?	Calculation file
QC021	Links to source data	Where possible, links to the source data must be provided	Calculation file
QC022	Raw primary data	All raw primary data must be present in the workbook	Calculation file
QC023	QA review	Data must be reviewed and checked by a second person	Calculation file
QC024	Verification	Where possible have calculated emissions been checked against other data sets?	Sector report
QC025	Archiving	Are all supporting files and references supplied?	Archive manager
QC026	Data calculations	Can a representative sample of the emission calculations be reproduced?	Calculation file
QC027	Unit conversions	Have the correct conversion factors been used?	Calculation file
QC028	Common factor consistency	Is there consistency in common factor use between sub-categories (such as GWP, Carbon content, Calorific values)?	Calculation file
QC029	Data aggregation	Has the data been correctly aggregated within a sector?	Calculation file
QC030	Trend documentation	Have significant trend changes been adequately explained?	Sector report
QC031	Consistency between sectors	Identify parameters that are common across sectors and check for consistency.	Draft NID
QC032	Data aggregation	Has the data been correctly aggregated across the sectors?	Draft NID
QC033	Documentation - CRF tables	Check CRF tables are included.	Draft NID
QC034	Documentation - KCA	Check that key category analyses have been included.	Draft NID
QC035	Documentation - Uncertainty	Check uncertainty analysis have been included.	Draft NID
QC036	Documentation - Overall trends	Check overall trends are described both by sector and gas species.	Draft NID
QC037	Documentation - NID sections complete	Check all relevant sections are included in the NID.	Draft NID
QC038	Documentation - Improvement plan	Check that the improvement plan has been included.	Draft NID
QC039	Documentation - Completeness	Check for completeness	Draft NID
QC040	Documentation - Tables and figures	Check numbers in tables match spreadsheet; check for consistent table formatting; check the table and figure numbers are correct.	Draft NID

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ID	Type of check	Description	Level
QC041	Documentation - References	Check consistency of references.	Draft NID
QC042	Documentation - General format	Check general NID format - acronyms, spelling, all notes removed; size, style and indenting of bullets are consistent.	Draft NID
QC043	Documentation - Updated	Check that each section is updated with current year information.	Draft NID
QC044	Double counting - Sectors	Check there is no double counting between the sectors.	Draft NID
QC045	National coverage	Check that activity data is representative of the national territory.	Calculation file
QC046	Review comments implemented	Check that review comments have been implemented.	Calculation file
QC047	Methodology documentation	Are the methods described in sufficient detail?	Sector report
QC048	Recalculation documentation	Are changes due to recalculations explained?	Sector report
QC049	Trend documentation	Are any significant changes in the trend explained?	Sector report
QC050	Documentation - QA/QC	Check the QA/QC procedure is adequately described.	Draft NID
QC051	Complete uncertainty check	Check that the uncertainty analysis is complete.	Draft NID
QC052	Consistency in methodology	Check that there is consistency in the methodology across the time series	Calculation file
QC053	Data gaps	Is there sufficient documentation of data gaps?	Sector report
QC054	Steering committee review	Has the draft NID been approved by the steering committee? Was there public consultation?	Draft NID
QC055	Check calorific values	Have the correct net calorific values been used? Are they consistent between sectors? Are they documented?	Calculation file
QC056	Check carbon content	Have the correct carbon content values been used? Are they consistent between sectors? Are they documented?	Calculation file
QC057	Supplied emission check	If emissions are supplied by industry have they been calculated using international standards? Have the methods been adequately described?	Sector report
QC058	Livestock population checks	Have the livestock population data been checked against the FAO database?	Calculation file
QC059	Land area consistency	Do the land areas for the land classes add up to the total land area for South Africa?	Calculation file

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ID	Type of check	Description	Level
QC060	Biomass data checks	Have the biomass factors been compared to IPCC default values or the EFDB?	Calculation file
QC061	Fertilizer data checks	Has the fertilizer consumption data been compared to the FAO database?	Calculation file
QC062	Wastewater flow checks	Do the wastewater flows to the various treatments add up to 100?	Calculation file
QC063	Reference approach	Has the reference approach been completed for the Energy sector? Have the values been compared to the sector approach? Has sufficient explanation of differences been given?	Calculation file
QC064	Coal production checks	Has the industry-specific coal production been checked against the coal production statistics from Department of Mineral Resources?	Calculation file

1.5.4 Workshops

Several workshops and training sessions between the team and the wider group at the DFFE were held during the preparation of this inventory. An initial planning meeting started the process off, followed by several team meetings to share data and queries. This has been useful even with the previous inventories. Everyone had a chance to understand other sectors, and it also improved the cross linkages. This should continue in future inventories.

1.5.5 Review process

General public review (Figure 1.5). The expert and public reviews each present opportunity to uncover technical issues related to the application of methodologies, selection of activity data, or the development and choice of emission factors. The expert and public reviews of the draft document offer a broader range of researchers and practitioners in government, industry and academia, as well as the general public, the opportunity to contribute to the final document. The comments received during these processes are reviewed and, as appropriate, incorporated into the NID or reflected in the inventory estimates.

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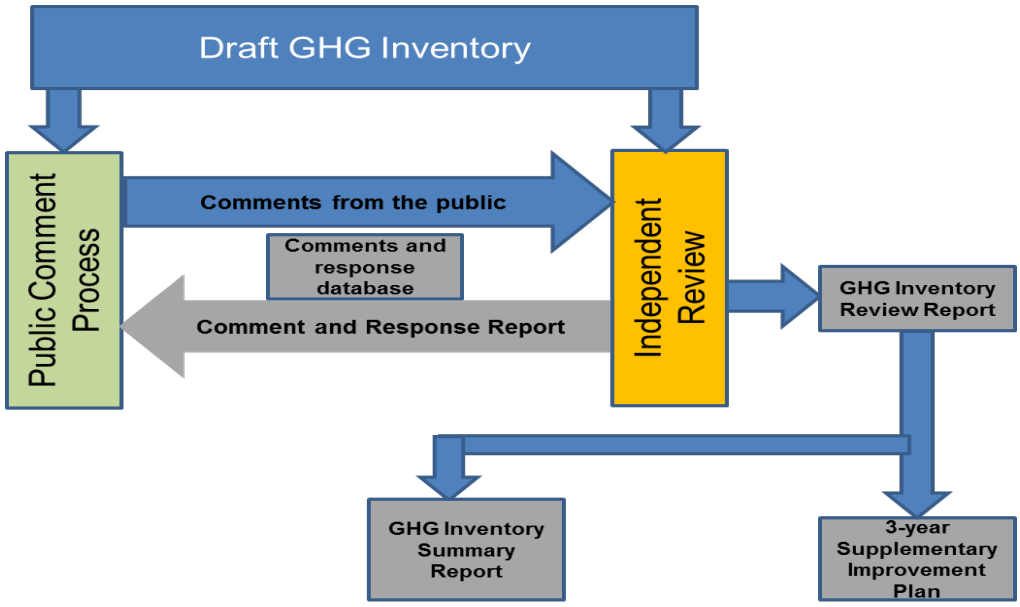


Figure 1.5: The quality assurance review process for the 1990-2024 inventory

1.5.6 Verification activities

Emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system where available. These include national and international statistics, measurement and research projects and programmes initiated to support the inventory system, or for other purposes, but producing information relevant to the inventory preparation. The specific verification activities are described in detail in the relevant category chapters.

1.6 General uncertainty assessment

1.6.1 Procedures for uncertainty determination

Uncertainty is inherent within any kind of estimation and arises from the limitations of the measuring instruments, sampling processes and model complexities and assumptions. Managing these uncertainties, and reducing them over time, is recognised

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by IPCC 2006 Guidelines as an important element of inventory preparation and development. Chapter 3 of the IPCC 2006 Guidelines (IPCC, 2006) describes the methodology for estimating and reporting uncertainties associated with annual estimates of emissions and removals. There are two methods for determining uncertainty:

- Tier 1 methodology which combines the uncertainties in activity rates and emission factors for each source category and GHG in a simple way; and
- Tier 2 methodology which is generally the same as Tier 1; however, it is taken a step further by considering the distribution function for each uncertainty and then carries out an aggregation using the Monte Carlo simulation.

South Africa still lacks data in terms of country specific uncertainty for all sectors. Based on this the uncertainty in this inventory was determined using the simple propagation of error (Approach 1) method. A trend uncertainty between the base year (1990) and 2024 was determined, as well as a combined uncertainty of activity data and emission factor uncertainty. As more uncertainty data becomes available it will be incorporated but there is a general need to build capacity and develop projects to assess the uncertainty in each sector.

1.6.2 Uncertainty assessment results

Emission estimate uncertainties typically are low for CO_2 from energy consumption as well as from some industrial process emissions. Uncertainty surrounding estimates of emissions are higher for LULUCF and synthetic gases. Uncertainty ranges for the various sectors (Annex II) are largely consistent with typical uncertainty ranges expected for each sector (IPCC, 2014).

The total uncertainty for the inventory including LULUCF was determined to be between 14.1% and 14.51%, with a trend uncertainty of 16%[1]. This is an increase on the uncertainty in the last inventory (8.8%), however there were a few new categories in this inventory and a more detailed uncertainty assessment for *Forest lands* have been included. This led to an increase in uncertainty on the activity data, but a reduction in the emission factor uncertainty. Excluding LULUCF reduces the overall uncertainty to 5.7%-6.4%, which is a reduction of the uncertainty from the last inventory.

The Energy sector uncertainty was reduced slightly (by 5% on the upper limit) compared to the previous inventory. The IPPU trend uncertainty increased by 32% compared to the

[1] *The full uncertainty assessment is provided in Annex II.*

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last inventory. The IPPU sector did introduce some new categories in 2022 and 2024 and update some of the uncertainty estimates to be based on country specific data rather than defaults so these changes could contribute to the uncertainty change. The Agriculture sector uncertainty reduced for both the overall uncertainty and trend uncertainty. The uncertainty data did not really change but the emission estimates did, and there was also reallocation of some categories between Agriculture and LULUCF to align with the ETF CRT reporting. LULUCF uncertainty increased by about 30% compared to the previous inventory uncertainty analysis. Part of this change was due to the introduction of new land change maps, however additional changes were made due to a more in-depth analysis of the uncertainty data rather than it being an actual change in uncertainty. The uncertainty data is one aspect of the inventory, which is being improved, so it is likely there will be further changes in the next inventory. Waste sector uncertainty was reduced, but this s likely due to the reduction in the emissions in this sector due to improvements.

1.7 General assessment of completeness

1.7.1 Information on completeness

Table 1.10 provides information on the completeness of the inventory. It shows which activities are not estimated (NE), included elsewhere (IE) or that is not occurring (NO) within the South African jurisdiction.

Table 1.10: Activities in the 2024 inventory which are not estimated (NE), included elsewhere (IE) or not occurring (NO)

NE, IE or NO	IPCC Category	Activity	Comments
NE	1B1b	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams	Research to be initiated in future, depended on availability of funding to initiate a study.
	1B1ai2	CH_4 emissions from abandoned mines	Research to be initiated in future, depended on availability of funding to initiate a study.
	1C1	CO_2 transport	Insufficient data to include
	2D2	CH_4 and N_2O emissions from paraffin wax use	Insufficient data to include,
	2E	Electronics industry	Insufficient data to include, an assessment to assess the significance of this source in South Africa.

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NE, IE or NO	IPCC Category	Activity	Comments
	2F5	PFCs and HFCs from solvents	Insufficient data to include
	2G1	PFCs from electrical equipment	Insufficient data to include
	2G2	PFCs from other product uses	Insufficient data to include
	2G3	N_2O from product uses	Insufficient data to include
	3C7	CH_4 emissions from Rice cultivation	CH_4 emissions from Rice cultivation is assessed to be Insignificant.
	3I	Other carbon containing fertilisers	Research needs to be done to investigate the availability of this category in South Africa.
	4(I)C & 4(I)D	Direct and indirect N_2O emissions from N inputs to managed soils	Not included due to insufficient data.
	4(II)A & 4(II)E	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	Not included due to insufficient data. Organic soils are also only partially included for Croplands and Grasslands.
	4D1a, 4D2a	Emissions from peat extraction	Some data has been identified but time series is not complete and there was insufficient time to verify and include the data. This will be incorporated as part of the proposed land mapping system.
	Energy, IPPU, Waste	NOx, CO, NMVOC emissions	These have only been included for biomass burning in the Agriculture and LULUCF sectors due to a lack of data in other sectors
	Energy, IPPU, Waste	SO_2 emissions	Insufficient data.
IE	1A1aii	CO_2, CH_4 and N_2O emissions from Combined Heat and Power (CHP) combustion systems	Not separated out but is included within 1A1ai
	1A3eii	CO_2, CH_4 and N_2O emissions from off-road vehicles and other machinery	Included under Road transportation.
	1A5b	Non-specified mobile	Included under Non-specified Mobile (1A3b)
	3E	Prescribed burning of savannas	Emissions are included under LULUCF Forest land (4A) as prescribed burning could not be separated from wildfires.
	4A, 4D-4F	Organic soils	Included under mineral soils as insufficient data to separate.
NO	2B3	CO_2, CH_4 and N_2O emissions from Adipic acid production	
	1C2	Injection and storage	
	2B4	CO_2, CH_4 and N_2O Caprolactam, Glyoxal and Glyoxylic acid production	
	3J	Other	

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1.7.2 Description of insignificant categories

Rice cultivation is not included in this Inventory. Rice is not grown in South Africa as it is not considered one of the country's primary crops. In the current inventory, consultations with experts at the ARC continue to indicate that rice cultivation in South Africa is limited to small experimental plots, with the exact cultivated area remaining uncertain but estimated to be less than 50 ha. In the previous inventory, proxy data from an international source (FAOSTAT) was used to assess the negligible impact of rice cultivation. According to FAO data, South Africa had 1 067 hectares of rice cultivation in 2022.

IPCC 2006 Guidelines (Vol. 4, Chapter 5) Equation 5.1 was used to estimate the annual methane emissions from rice cultivation. All other factors affecting CH_4 emissions from rice cultivation were not considered because there is insufficient data on various ecosystems, water management practices, types and quantities of organic amendments, and other conditions related to CH_4 emissions for rice cultivation. Therefore, the equation was adjusted, and the below equation was used:

CH_4 Rice = EF *time *Area * 10^{-6}

Where:

CH_4 Rice = Annual methane emissions from rice cultivation, (Gg CH_4 yr^{-1})

EF = A daily emission factor, (kg CH_4 ha^{-1} day^{-1})

time = cultivation period of rice

Area = Annual harvested area of rice, ha yr^{-1}

The IPCC default emission factor of 1.3 kg CH_4 ha^{-1} d^{-1} was used. The IPCC default of 180 days cultivation period of rice was used.

1.7.3 Total aggregated emissions considered insignificant

The annual methane emissions from rice cultivation were estimated to be 6.99 Gg CO_2e, and this is 0.001% of the national total GHG emissions (excl. LULUCF). Therefore, rice cultivation is considered insignificant since the level of emissions is below the threshold of 0.05% of the national total GHG emissions (excl. LULUCF), as prescribed by the IPCC 2006 Guidelines.

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1.8 Metrics

As GHG's vary in their radiative activity, and in their atmospheric residence time, converting emissions into carbon dioxide equivalents (CO_2e) allows the integrated effect of emissions of the various gases to be compared. To comply with international reporting obligations under the UNFCCC, emissions are presented as CO_2e using the 100- year global warming potentials (GWPs) from the 2014 IPCC Fifth Assessment Report (AR5) in accordance with the Modalities, Procedures, and Guidelines (MPGs) for transparency framework for action and support referred to in Article 13 of the Paris Agreement (Table 1.11).

Table 1.11: AR5 Global warming potentials (GWP) applied in this report (IPCC, 2014b)

GHG	Chemical formula	AR5 GWP
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265
Hydrofluorocarbons (HFCs)		
HFC-23	CHF_3	12 400
HFC-32	CH_2F_2	677
HFC-125	CHF_2CF_3	3170
HFC-134a	CH_2FCF_3	1300
HFC-143a	CF_3CH_3	4 800
HFC-227ea	C_3HF_7	3350
HFC-365mfc	$C_4H_5F_5$	804
HFC-152a	CH_3CHF_2	138
Perfluorocarbons (PFCs)		
PFC-14	CF_4	6 630
PF-116	C_2F_6	11 100

1.9 Summary of flexibilities applied

South Africa's 2024 NID includes one flexibility provision related to completeness for insignificant emissions. The rational to applying this flexibility is as follows:

Completeness Provisions for Insignificant Emissions:

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Flexibility Provision: Emissions sources contributing less than 0.1% of total national GHG emissions (excl. LULUCF) or less than 1,000 kilotons (kt) of CO_2-equivalent may be considered insignificant. South Africa commits to assessing categories that are not estimated in the current NID for significance by 2028.

Covered Sectors and Specific Emissions Categories (Table 1.12):

- IPPU: Subcategories involving N_2O, HFCs, PFCs, and SF_6, specifically in the electronics industry, solvents, and other product uses.
- Agriculture: Emissions from other carbon containing fertilisers (CO_2).
- Waste: Emissions from waste incineration (CH_4).

Improvement Timeline: The significance of these emissions categories will be evaluated and updated by the third Biennial Transparency Report (BTR 3), due December 2028.

Table 1.12: Summary of Flexibility Provision Applied by Sector

Year	Sector	Category	Gas	Explanation for using flexibility provision	Timeframe for improvement
2024	IPPU	2.E Electronics Industry	N_2O HFCs PFCs SF_6	Completeness (32) Flexibility to consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. South Africa will assess the significance of this source and report if significant.	BTR 3 (December 2028)
		2.F.5. Solvents	HFCs PFCs SF6	Completeness (32) Flexibility to consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. South Africa will assess the significance of this source and report if significant.	BTR 3 (December 2028)
		2.G.1 Electrical equipment	HFCs PFCs SF6	Completeness (32) Flexibility to consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. South Africa will assess the significance of this source and report if significant.	BTR 3 (December 2028)

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Year	Sector	Category	Gas	Explanation for using flexibility provision	Timeframe for improvement
		2.G.2. SF6 and PFCs from other product use	PFCs SF_6	Completeness (32) Flexibility to consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. South Africa will assess the significance of this source and report if significant.	BTR 3 (December 2028)
		2.G.3. N_2O from product uses	N_20	Completeness (32) Flexibility to consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. South Africa will assess the significance of this source and report if significant.	BTR 3 (December 2028)
2024	Agriculture	3.I. Other carbon-containing fertilizers	CO_2	Completeness (32) Flexibility to consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. South Africa will assess the significance of this source and report if significant.	BTR 3 (December 2028)
2024	Waste	5.C.1 Waste Incineration	CH_4	Completeness (32) Flexibility to consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. South Africa will assess the significance of this source and report if significant.	BTR 3 (December 2028)

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1.10 Chapter 1 References

IPCC, 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories.* Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). ed. Japan: IGES.

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Chapter 2: Trends in GHG emissions and removals

2.1 Description of trends for aggregated GHG emissions and removals

This chapter provides a description and interpretation of the national aggregated emission trends and a discussion of trends by gas and sector.

2.1.1 National trends

2.1.1.1 Overall emissions (excl. LULUCF)

The overall emissions (excl. LULUCF) include those from Energy, IPPU, Agriculture and Waste. It does not include the sources and removals from land use change and *Harvested wood products*, which together form the LULUCF sector.

2.1.1.1.1 2024

The national emissions (excl. LULUCF) are 477 576 Gg CO_2e in 2024. The profile shows that the Energy sector remains the dominant contributor to national emissions in 2024 (78.7%). This is followed by the Agriculture sector (11.0%), IPPU (6.4%), and the Waste sector (4.0%) contributions.

2.1.1.1.2 1990 – 2024

National emissions have evolved significantly over this period, reflecting changes in the structure of the economy, energy production patterns, industrial activity. South Africa's GHG emissions (excl. LULUCF) increased by 17.8% between 1990 and 2024.

The long-term trends for total emissions excluding LULUCF demonstrate a pattern of initial growth followed by stabilisation and a gradual decline in more recent years. Emissions show an increasing trend between 1990 and 2004, with only 2 years in this period showing a small annual decline (Table 2.1). There is then a plateau period between about 2005 and 2012 where the average annual increase is only 0.36%. After 2012 there

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is a decline in emissions, with most years (except 2018, 2021 and 2024) showing an annual decline in emissions.

2.1.1.1.3 2000- 2024

There has been a reduction of only 0.8% in national emissions (excl. LULUCF) between 2000 and 2024. This is because in 2000 emissions were increasing while by 2024 emissions were on the decline as the national energy and industrial systems evolved.

2.1.1.1.4 2022 - 2024

There has been a modest increase in emissions of 1.1% between 2022 and 2024 which is consistent with post-pandemic economic recovery and fluctuations in electricity generation patterns.

Table 2.1: Trends and annual change in emissions, 1990-2024

	Emissions (excl. LULUCF)		Emissions (incl. LULUCF)	
	Gg CO_2e	Annual change (%)	Gg CO_2e	Annual change (%)
1990	405 260		402 802	
1991	413 144	1.95	409 258	1.60
1992	417 336	1.01	414 292	1.23
1993	424 530	1.72	422 713	2.03
1994	426 798	0.53	426 008	0.78
1995	435 635	2.07	434 393	1.97
1996	451 338	3.60	443 586	2.12
1997	464 566	2.93	456 891	3.00
1998	475 143	2.28	469 056	2.66
1999	466 301	-1.86	458 201	-2.31
2000	481 534	3.27	468 891	2.33
2001	479 530	-0.42	473 159	0.91
2002	489 338	2.05	480 646	1.58
2003	504 898	3.18	481 361	0.15
2004	516 456	2.29	506 317	5.18
2005	514 670	-0.35	517 311	2.17
2006	506 969	-1.50	508 337	-1.73
2007	528 898	4.33	518 580	2.02
2008	524 762	-0.78	527 917	1.80
2009	537 875	2.50	521 845	-1.15

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	Emissions (excl. LULUCF)		Emissions (incl. LULUCF)	
	Gg CO_2e	Annual change (%)	Gg CO_2e	Annual change (%)
2010	520 354	-3.26	511 064	-2.07
2011	520 858	0.10	507 588	-0.68
2012	530 436	1.84	512 050	0.88
2013	520 727	-1.83	493 875	-3.55
2014	519 511	-0.23	497 080	0.65
2015	511 784	-1.49	509 504	2.50
2016	505 938	-1.14	490 682	-3.69
2017	495 816	-2.00	495 756	1.03
2018	497 825	0.41	499 644	0.78
2019	495 645	-0.44	490 990	-1.73
2020	466 822	-5.82	446 350	-9.09
2021	482 104	3.27	472 202	5.79
2022	472 193	-2.06	451 889	-4.30
2023	466 625	-1.18	453 946	0.46
2024	477 576	2.35	444 164	-2.15

2.1.1.2 Net emissions (incl. LULUCF)

Overall emissions including LULUCF represent the sum of emissions from the Energy, IPPU, Agriculture, and Waste sectors, combined with the sources and removals from the LULUCF sector. This integrated total reflects the full national contribution to anthropogenic GHG emissions.

2.1.1.2.1 2024

The overall emissions (incl. LULUCF) are 444 164 Gg CO_2e in 2024. The LULUCF sector continues to play an important mitigation role, significantly lowering the net national emissions. Within the sector, *Forest land* remains the dominant contributor to net removals, reinforcing its critical role in offsetting emissions from other sectors and stabilising the national emissions profile.

2.1.1.2.2 1990 – 2024

South Africa's GHG emissions (incl. LULUCF) were 402 802 Gg CO_2e in 1990 and these have increased by 10.3%. Despite this overall rise, the consistent contribution of LULUCF removals has played an important role in moderating national emission growth, particularly during periods of increasing emissions from energy and industrial activities.

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The emission trend including LULUCF is like that of emissions excluding LULUCF except that the emissions are reduced due to the LULUCF sector being a sink (Figure 2.1). This sink increased slightly between 2018 and 2024 leading to an increased reduction in overall emissions. The long-term trend highlights the sustained importance of land-based mitigation in the national inventory.

2.1.1.2.3 *2000-2024*

Between 2000 to 2024, the emissions including LULUCF fell by 5.3%, consistent with a strengthening land-sector sink.

2.1.1.2.4 *2022-2024*

Since the last submission in 2022, net emissions have decreased by 1.7% as opposed to a 1.1% excluding LULUCF, reinforcing the importance of the land sector.

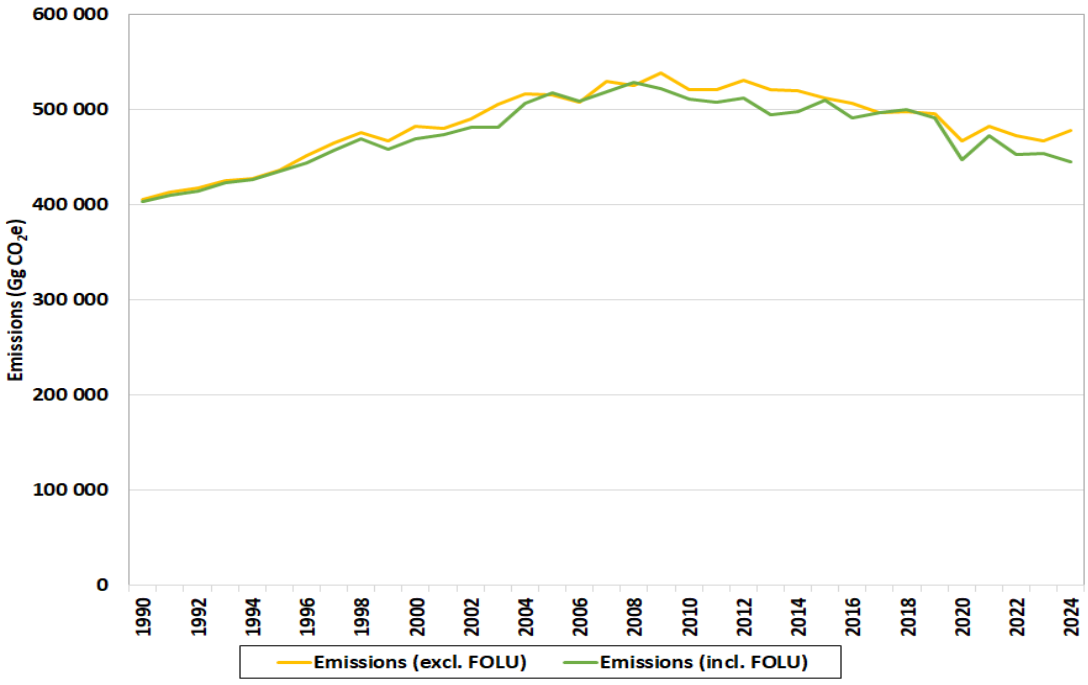


Figure 2.1: National emission trends including LULUCF, 1990-2024

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2.1.2 Indicator trends

South Africa's carbon and energy intensity trends are determined from GHG emissions, GDP data (StatsSA 2023)[2], total primary energy supply data (DRME 2023) and population data (Stats SA 2022).

2.1.2.1 Total emission indicators

The carbon intensity of the population (i.e. total net emissions per capita) has decreased by 29% since 1990 (Figure 2.2) with 2020 experiencing the highest annual decrease of 10% while 2024 had an annual decrease of 4%. Similarly, both the carbon intensity of economy and the carbon intensity of the energy supply have decreased, by 58% and 35% respectively, since 1990. These carbon intensity indicators show that overall South Africa's carbon intensity is decreasing overtime.

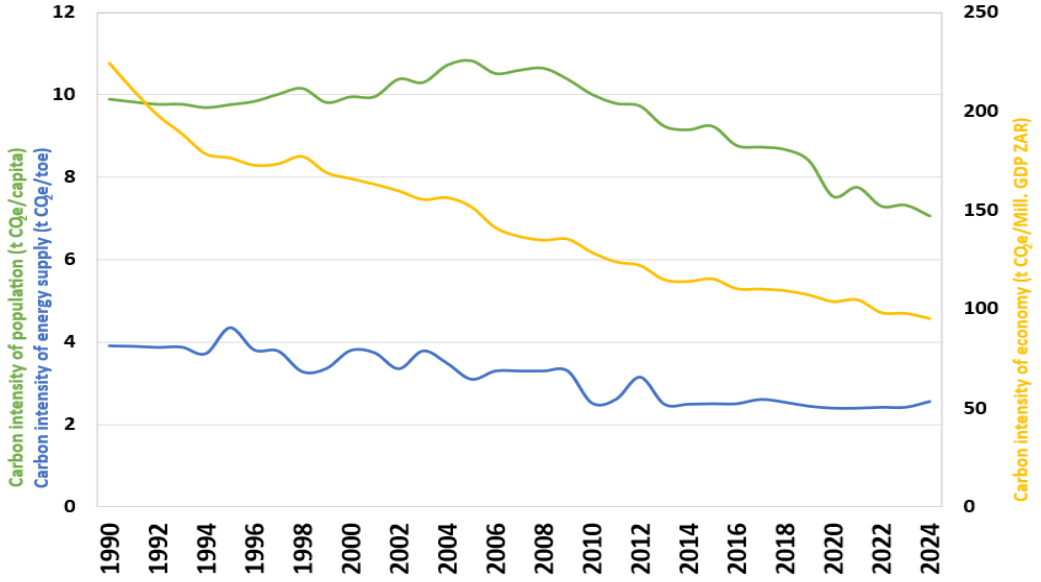


Figure 2.2: Trends in overall carbon intensity of the population and the economy of South Africa, 1990-2024

[2] *In previous inventories the GDP at constant 2010 prices was used. However, in this inventory the GDP at constant 2015 prices was used in line with the changes made by StatsSA in their publication.*

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The carbon intensity of the primary energy supply shows a slower but downward trend. Although progress is evident, the gentler slope relative to the other indicators underscores that the pace of energy-system decarbonisation remains slower than demographic or economic decoupling.

Across all three indicators, Figure 2.2 shows broad and sustained declines in carbon intensity, signalling meaningful progress in reducing emissions relative to population growth, economic activity, and energy use. The most significant gains are seen in the economy wide carbon intensity indicator, confirming that South Africa is experiencing a structural decoupling where emissions grow more slowly than the GDP.

2.2 Description of emission and removal trends by greenhouse gas

Emissions remain CO_2 dominated (Table 2.2), reflecting persistent dependence on carbon-intensive energy systems. Changes in CH_4 and N_2O are comparatively small, while F-gases show rapid growth since 2000.

Table 2.2: Trend in CO_2, CH_4, N_2O and F-gases, 1990-2024

	Emissions						
	CO_2 (excl. LULUCF)	CO_2 (incl. LULUCF)	CH_4 (excl. LULUCF)	CH_4 (incl. LULUCF)	N_2O (excl. LULUCF)	N_2O (incl. LULUCF)	F-gases
	Gg CO_2e						
1990	329 121	323 962	61 122	62 753	15 017	16 087	0
1991	336 495	329 932	61 493	63 094	15 155	16 232	0
1992	341 515	335 799	60 906	62 507	14 915	15 985	0
1993	350 010	345 520	59 735	61 340	14 785	15 853	0
1994	352 699	349 221	59 310	60 935	14 788	15 851	0
1995	360 694	356 751	60 182	61 826	14 758	15 817	0
1996	373 646	363 593	62 220	63 592	15 472	16 401	0
1997	385 773	375 866	63 071	64 410	15 721	16 615	0
1998	395 557	387 018	63 648	65 104	15 938	16 934	0
1999	387 275	376 797	63 198	64 628	15 828	16 776	0
2000	401 244	386 202	63 194	64 635	16 071	17 029	1 025
2001	398 695	389 616	63 486	65 091	16 298	17 402	1 051
2002	408 864	397 548	63 122	64 681	16 418	17 483	935

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	Emissions						
	CO_2 (excl. LULUCF)	CO_2 (incl. LULUCF)	CH_4 (excl. LULUCF)	CH_4 (incl. LULUCF)	N_2O (excl. LULUCF)	N_2O (incl. LULUCF)	F-gases
	Gg CO_2e						
2003	425 093	399 208	63 162	64 601	15 710	16 618	934
2004	436 277	423 941	63 197	64 557	16 055	16 892	927
2005	432 154	431 928	63 934	65 642	16 831	17 990	1 751
2006	424 306	422 901	63 612	65 280	16 935	18 039	2 116
2007	445 137	431 947	65 075	66 896	16 592	17 643	2 094
2008	440 940	441 004	65 847	67 798	16 352	17 494	1 622
2009	455 359	436 834	65 091	66 589	16 313	17 310	1 112
2010	436 959	425 116	65 172	66 686	15 963	17 002	2 260
2011	435 342	419 581	64 628	66 106	16 019	17 033	4 868
2012	442 627	421 977	66 429	67 778	16 689	17 604	4 691
2013	435 139	405 966	65 477	66 877	16 496	17 417	3 615
2014	433 970	409 168	65 501	66 920	16 586	17 537	3 454
2015	426 647	422 384	65 005	66 201	16 215	17 002	3 917
2016	421 574	404 795	64 336	65 285	15 909	16 483	4 119
2017	412 295	410 139	63 114	64 372	15 997	16 835	4 411
2018	413 131	412 689	63 155	64 509	16 789	17 696	4 750
2019	411 646	404 767	62 197	63 581	16 705	17 545	5 097
2020	383 617	360 831	61 675	63 173	16 043	16 858	5 488
2021	398 807	385 341	61 522	63 877	15 939	17 149	5 836
2022	388 527	364 841	61 661	64 072	15 869	16 839	6 136
2023	382 681	365 548	61 205	64 242	16 176	17 592	6 563
2024	393 917	356 334	60 791	63 732	15 986	17 216	6 883

2.2.1 Carbon dioxide (CO_2)

Carbon dioxide (CO_2) is the largest contributor to South Africa's emissions. CO_2 emissions contribute 82.5% (excl. LULUCF) to South Africa's emissions in 2024. The majority of CO_2 emissions are from the Energy sector The Energy, IPPU and Agriculture sectors contribute 93,5%, 5.8% and 0.7% respectively. The average contribution to total CO_2 (excl. LULUCF) between 1990 and 2024 from these sectors is 92.6%, 6.9% and 0.6% respectively (Figure 2.3).

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The LULUCF sector contributes a sink of 37 584 Gg CO_2 in 2024 which is an increase from the 1990 sink (Table 2.2). The sink in 2024 reduced the total CO_2 emissions from 393 917 Gg CO_2 to 356 334 Gg CO_2.

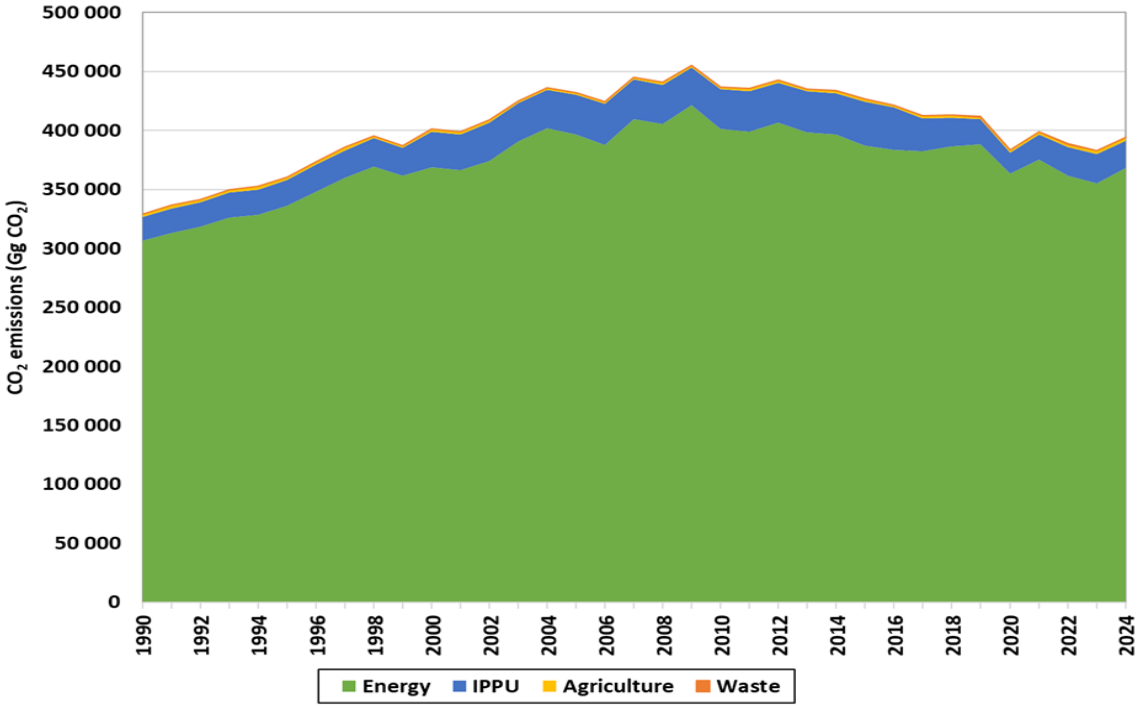


Figure 2.3: Trend and sectoral contribution to CO_2 emissions (excl. LULUCF), 1990-2024

2.2.2 Methane (CH_4)

Methane (CH_4) is the second-largest contributor to South Africa's total GHG emissions (Table 2.2). In 2024, CH_4 accounts for 12.7% and 14.3% of national emissions excluding and including LULUCF respectively. This is a decline from 15.1% (excl. LULUCF) and 15.8% (incl. LULUCF) in 1990. Agriculture and Waste sectors are the dominant sources of CH_4 emissions (Figure 2.4). Within Agriculture, *Enteric Fermentation* is the primary contributor, while in the Waste sector, the largest share originates from *Wastewater Treatment and Discharge*.

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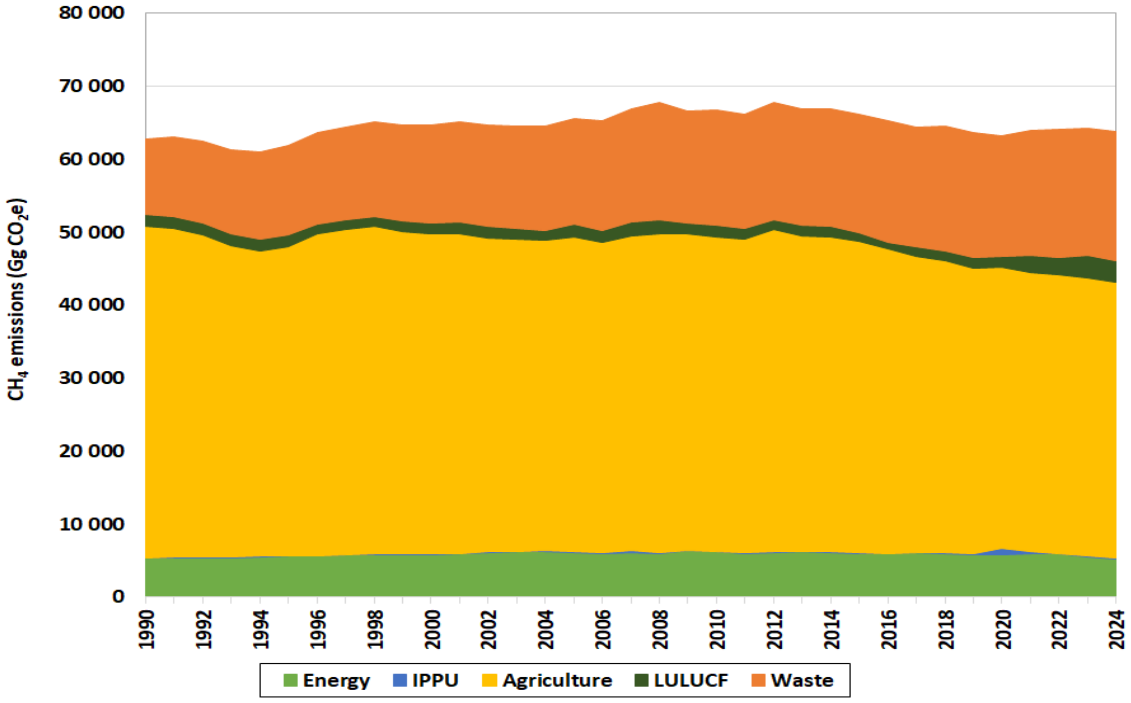


Figure 2.4: Trend and sectoral contribution to CH_4 emissions, 1990-2024

2.2.3 Nitrous oxide (N_2O)

N_2O emissions accounted for 3.9% of South Africa's national GHG emissions (excl. LULUCF) in 1990. By 2024, this share had declined to 3.3%. This gradual decrease shows that, while agriculture and certain industrial activities continue to generate N_2O, their relative contribution to the country's total emissions has slightly reduced over time. With the inclusion of the LULUCF sector the N_2O contribution was 4.3% and 3.9% in 1990 and 2024 respectively, indicating that the LULUCF N_2O emissions increased in 2024 (Figure 2.5).

The Agriculture sector remains the dominant source of N_2O emissions, contributing 71.7% to total emissions (incl. LULUCF) in 2024, followed by Energy (9.9%) and Waste (9.3%) sectors.

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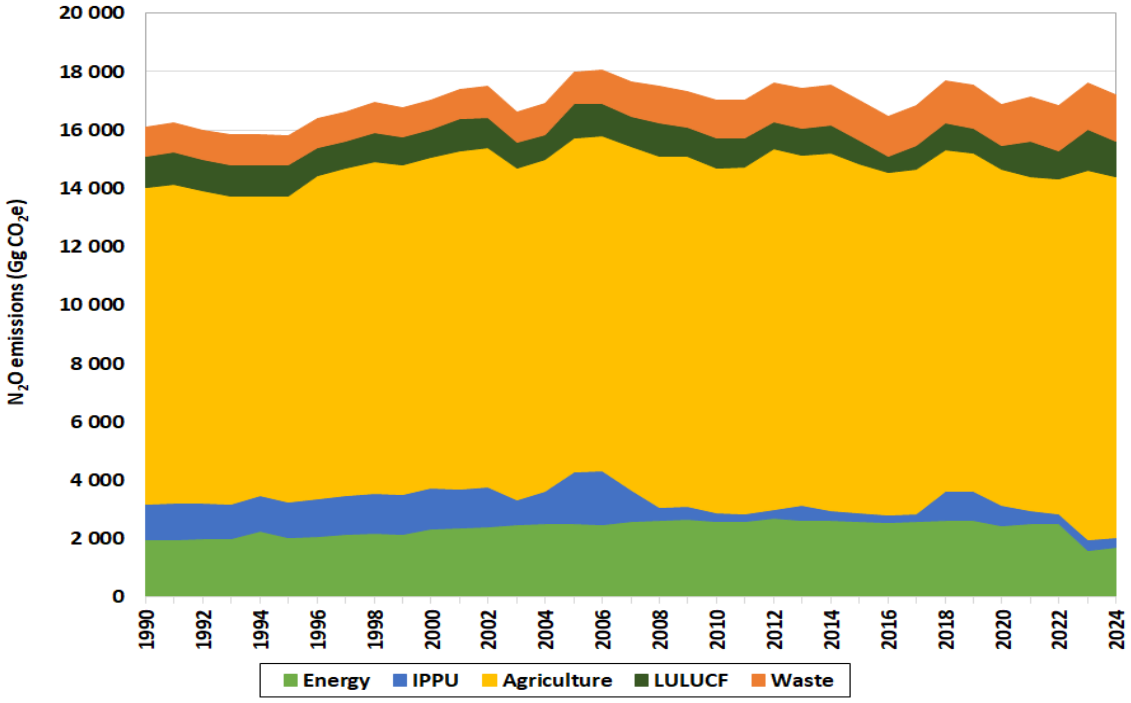


Figure 2.5: Trend and sectoral contribution to N_2O emissions, 1990-2024

2.2.4 F gases

HFC and PFC emissions are only estimated for the IPPU sector in South Africa. F-gas emission estimates varied annually (Figure 2.6) and contribute 1.5% to overall emissions (incl. LULUCF) in 2024. Emissions increase from 2011 due to the addition of HFC emissions from *Air conditioning, foam blowing agents, fire protection and aerosols*. There is no data prior to 2005 so this time-series is not consistent. The elevated F-gas emissions are therefore not necessarily due to an increase in emissions but rather due to the incorporation of new categories.

PFCs are produced during the production of aluminium. The *Aluminium production* data was updated for the years 2014 onwards and the updated data was an order of magnitude lower than the previous years. This is causing the decline in the PFC emissions. There is a sharp decline in emissions from the *Metal industry* between 2007 and 2009 and this is

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attributed to reduced production caused by electricity supply challenges and decreased demand following the economic crisis that occurred during 2008/2009. Increases in 2011 and 2012 were due to increased emissions from aluminium plants due to inefficient operations. The industry was used to assist with the rotational electricity load shedding in the country at the time and which necessitated switching on and off at short notice leading to large emissions of Tetrafluoroethylene (C_2F_6) and Carbon tetrafluoromethane (CF_4).

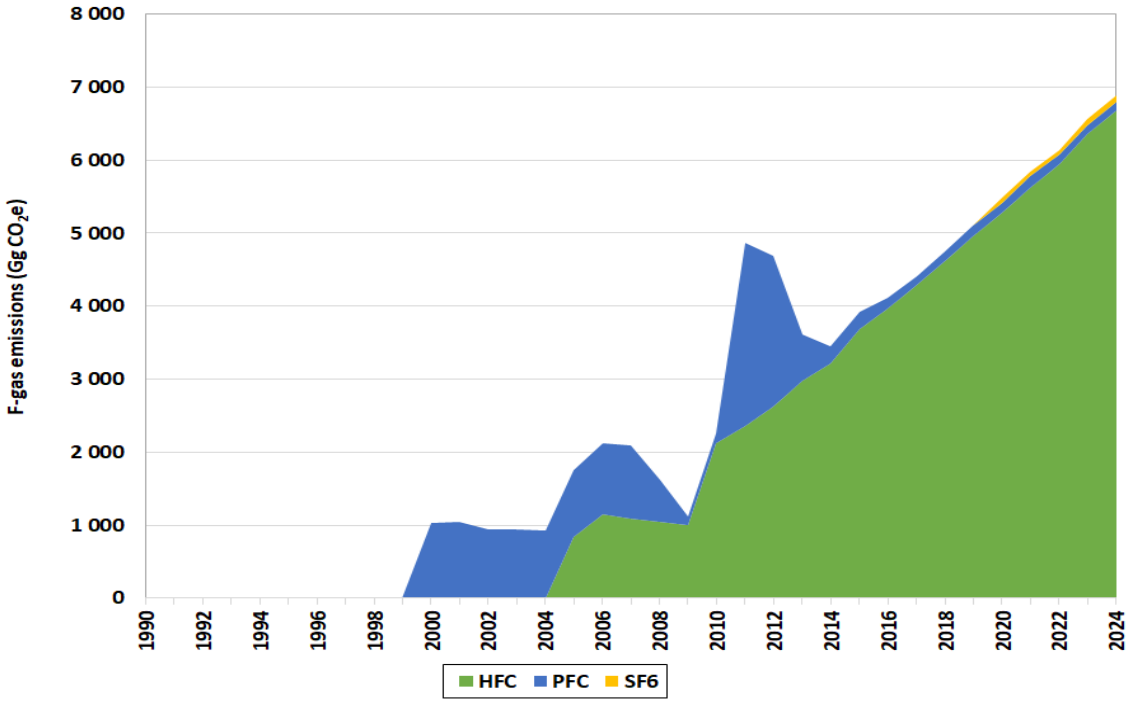


Figure 2.6: Trend in F-gas emissions, 1990-2024

2.2.5 Precursor gases

The trend in emissions of CO, NO_x and NMVOCs is shown in Table 2.3. These emissions were estimated for biomass burning only. There is annual variability because the emissions include wildfires as well as controlled fires.

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Table 2.3: Trends in precursor gas emissions, 1990-2024

	NOx	CO	NMVOC
	(Gg)		
1990	46.3	917.9	111.3
1991	45.6	894.8	105.0
1992	45.6	895.8	105.5
1993	45.7	900.4	107.0
1994	46.1	917.6	112.1
1995	46.6	933.5	116.8
1996	38.0	700.1	65.8
1997	35.6	664.5	66.0
1998	41.7	775.5	76.3
1999	39.5	742.5	76.1
2000	40.8	756.9	72.4
2001	50.9	923.7	80.8
2002	48.1	874.2	78.1
2003	37.6	731.5	83.7
2004	32.9	652.0	79.1
2005	54.8	1 008.5	94.0
2006	51.3	964.1	97.2
2007	49.8	1 063.2	155.3
2008	56.7	1 190.2	167.3
2009	43.1	805.9	79.5
2010	45.9	833.3	73.6
2011	44.3	801.0	69.1
2012	37.0	673.9	60.8
2013	37.9	715.4	73.2
2014	40.0	740.5	70.6
2015	27.1	503.1	48.8
2016	10.9	232.3	33.9
2017	27.1	515.3	55.0
2018	30.0	581.1	66.2
2019	26.8	508.3	52.5
2020	26.7	506.5	52.6
2021	51.4	919.2	75.0
2022	31.9	584.6	54.4
2023	62.2	1 096.6	83.0
2024	48.0	876.7	78.9

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2.3 Description of emission and removal trends by sector

Figure 2.7 presents a comparative view of South Africa's GHG emissions profile for the years 1990 and 2024, illustrating how the relative contribution of key sectors has evolved over three decades. The overall pattern reflects a system dominated by the Energy sector, highlighting the continued reliance on fossil fuel-based energy production and energy intensive economic activity. Despite growth in renewable energy deployment in recent years, the sector's proportional contribution remains largely unchanged. There are smaller but important contributions from the remaining sectors (Figure 2.7, Table 2.4), each following distinct trajectories shaped by structural and policy drivers.

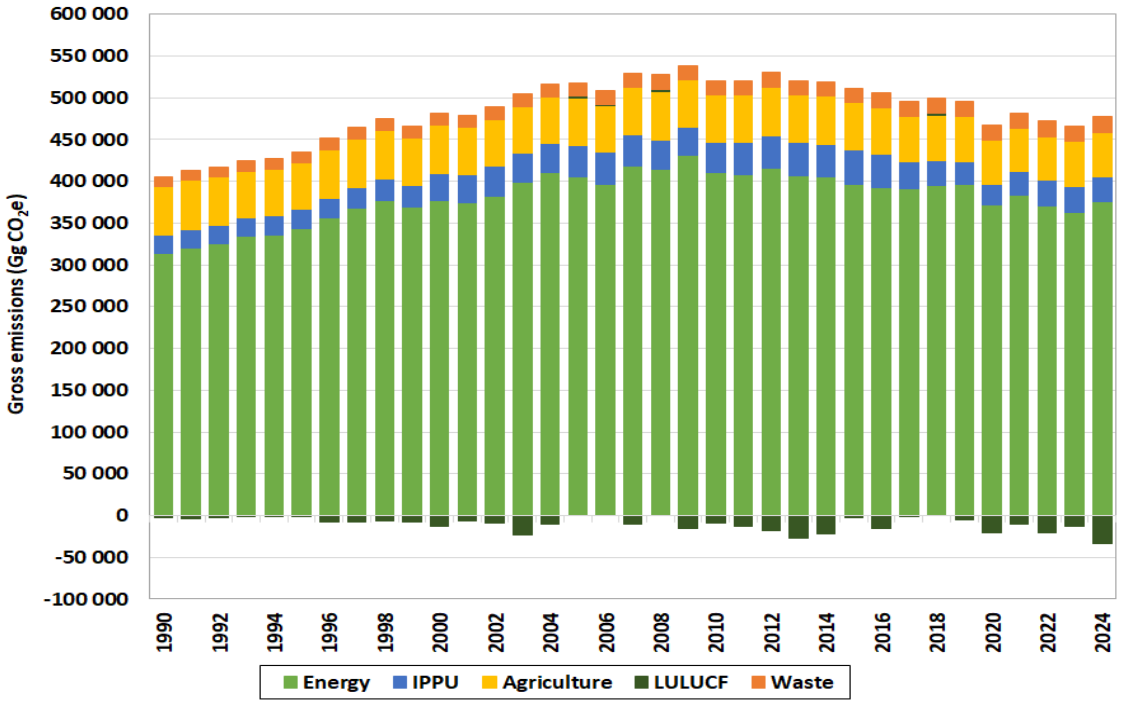


Figure 2.7: National sectoral GHG emissions (incl. LULUCF), 1990-2024

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Table 2.4: Sectoral GHG emissions, 1990-2024

	Energy	IPPU	Agriculture	LULUCF	Waste
	Emissions (Gg CO_2e)				
1990	313 869	21 242	58 804	-2 458	11 346
1991	320 518	22 070	58 537	-3 886	12 018
1992	325 712	22 127	57 161	-3 044	12 336
1993	333 721	22 350	55 777	-1 817	12 682
1994	336 180	22 907	54 737	-790	12 974
1995	343 804	23 407	55 207	-1 241	13 215
1996	355 959	24 095	57 824	-7 752	13 460
1997	367 444	24 972	58 467	-7 675	13 683
1998	377 444	25 432	58 342	-6 088	13 924
1999	369 425	25 113	57 578	-8 100	14 184
2000	377 004	32 783	57 317	-12 643	14 430
2001	374 350	33 057	57 412	-6 370	14 711
2002	382 602	35 035	56 744	-8 692	14 957
2003	399 123	34 425	56 150	-23 537	15 200
2004	410 606	34 495	55 955	-10 139	15 400
2005	404 784	37 594	56 574	2 641	15 718
2006	396 361	38 760	55 705	1 368	16 142
2007	418 120	37 164	56 879	-10 317	16 735
2008	414 215	35 433	57 736	3 155	17 378
2009	430 543	33 563	57 238	-16 031	16 531
2010	410 323	35 956	56 981	-9 289	17 093
2011	407 273	39 675	56 934	-13 270	16 975
2012	415 455	38 810	58 723	-18 387	17 449
2013	407 094	38 913	57 412	-26 852	17 308
2014	405 051	39 234	57 718	-22 431	17 509
2015	395 736	41 597	56 750	-2 279	17 701
2016	392 064	40 337	55 487	-15 256	18 050
2017	390 857	32 508	54 690	-60	17 761
2018	394 993	30 269	53 952	1 819	18 611
2019	396 575	27 469	52 988	-4 655	18 614
2020	371 513	25 098	52 351	-20 472	17 861
2021	383 643	27 841	52 041	-9 902	18 578
2022	370 030	30 984	52 073	-20 305	19 107
2023	362 459	31 788	53 321	-12 679	19 057
2024	375 216	30 372	52 744	-33 412	19 245

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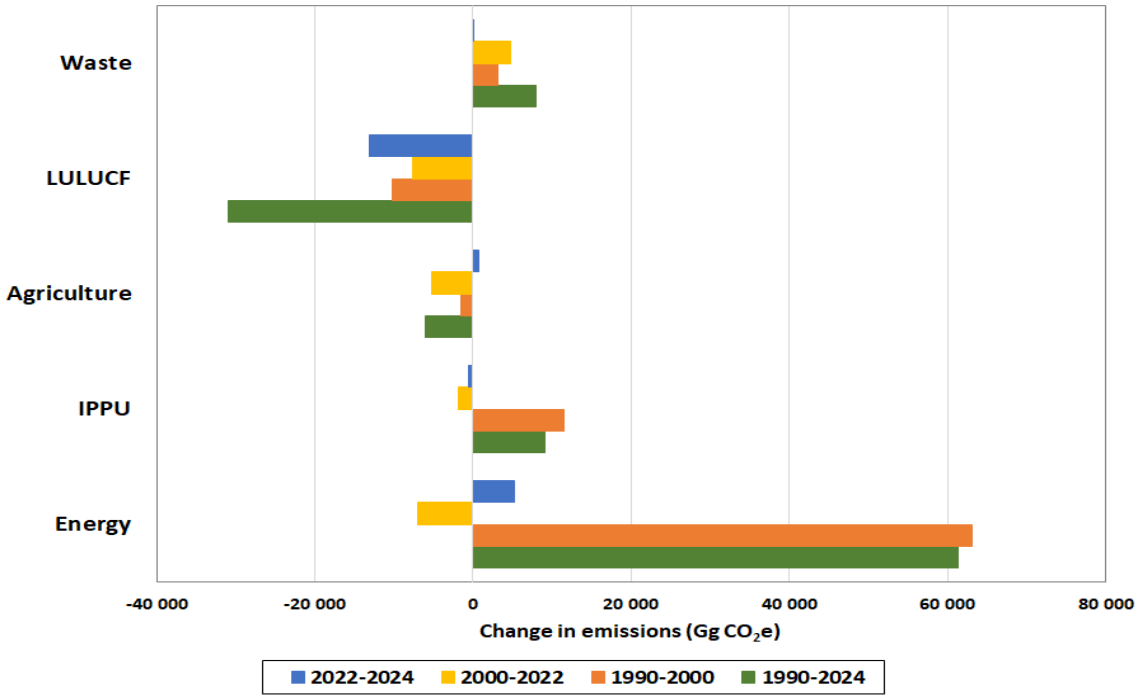


Figure 2.8: Change in sectoral emissions between 1990, 2000, 2022 and 2024

2.3.1 Energy

The Energy sector is the largest contributor to South Africa' emissions (Figure 2.7), contributing 78.6% to emissions (excl. LULUCF) in 2024 and on average since 1990. In 1990, the Energy sector contributed 77.4% to total emissions (excl. LULUCF), which means a small overall increase in contribution of around 1.2% over the 34-year period.

The Energy sector emissions have increased by 19.5% since 1990, but most of this increase is between 1990 and 2000 (Figure 2.8). Emissions showed a decline between 2000 and 2022. Between 2019 and 2020, the Energy sector's share of total emissions declined slightly from 80.9% to 79.6%, representing a reduction of approximately 1.3%. This is due to an annal reduction of 6% in 2020 which is likely to be caused by the impacts of COVID-19.

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Energy sector emissions started to show an increase again (1.4%) between 2022 and 2024. In 2023 annual change in energy emissions decreased by 2% and then increased by 3.5% in 2024. The 2% decline in emissions observed in 2023 may have been influenced by intensified loadshedding, which reduced electricity generation and associated emissions. In contrast, the 3.5% increase in 2024 corresponds with reduced loadshedding and a rebound in energy supply.

2.3.2 IPPU

In 2024 the IPPU sector produced 30 372 Gg CO_2e which is 6.4% and 6.8% of South Africa's emission excluding and including LULUCF. The IPPU sector shows a modest increase in its contribution, shifting from 5.2% in 1990 to 6.4% in 2024 (excl. LULUCF).

The IPPU sector produced CO_2 emissions (75.8%), fluorinated gases 22.6% and small amounts (<1.5%) of CH_4 and N_2O in 2024. Carbon dioxide and any other emissions from combustion of fuels in these industries are reported under the Energy sector.

The largest source category is the *Ferroalloy production* category. which contributes 52.6% to the total IPPU sector emissions. The *Mineral industry* and the *Product used as substitutes for ozone depleting substances* subsectors contribute 16.4% and 22.9%, respectively, to the IPPU sector emissions.

IPPU sector emissions have increased by 43.0% since 1990 but, as with the Energy sector, much of this increase is between 1990 and 2000 (Figure 2.8). After 2000 there was a decrease in emissions. Even though the South African economy recovered after the COVID-19 pandemic, estimated emissions from the IPPU sector are 2 411 Gg CO_2e (7.4%) lower than the emissions in 2000. The decline can be attributed to the decline in metals production (39.0%), specifically Iron and Steel, and Aluminium. This can be ascribed to a decrease in global demand. The chemicals industry also declined (31.4%). *Cement Production* and *Non-Energy Product Use from Fuels and Solvents* increased emissions from 2000 by 2 081 Gg CO_2e. The local demand for cement increased dramatically from 2000.

2.3.3 Agriculture

The Agriculture sector contributed between 10% and 14% to total emissions (excluding and including LULUCF) over the period 1990 to 2024 (Figure 2.7). Overall Agriculture sector emissions have declined by 4 573 Gg CO_2e since 1990, representing a decrease of 10.3% over the period (**Error! Reference source not found.**). The largest portion of this

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decline was between 2000 and 2022, with a small increase (1.3%) between 2022 and 2024 (Figure 2.8). The main driver of change in the Agriculture sector is the livestock population, as livestock contribute to emissions from *Enteric fermentation*, *Manure management*, and direct and indirect N_2O emissions from managed soils.

The Agriculture sector demonstrates a noticeable decline in contribution to the total emissions from 14.5% in 1990 to 11.0% in 2024. The declining share may be attributed to changes in livestock populations, improvements in agricultural management practices, and shifts in land use patterns that reduce enteric fermentation and associated emissions relative to other sectors.

Livestock-related emissions contribute approximately 77% to total Agriculture sector emissions in 2024. The largest contributor is CH_4 emissions from *Enteric fermentation* (about 68.3%), while *Manure management* contributes about 8.3% to total Agriculture sector emissions. Emissions from *Enteric fermentation* shows a declining trend, reflecting reductions in livestock population numbers. Dairy cattle, pigs, and poultry are the largest contributors to *Manure management* emissions and increasing poultry numbers have contributed to a gradual rise in *Manure management* emissions over the 1990–2024 period.

Agricultural soils contribute approximately 18.4% to total Agriculture sector emissions, while the smallest contributions are from *Liming* (about 3.6%), *Urea application* (about 1.3%), and *Field burning of agricultural residues* (about 0.1%).

2.3.4 LULUCF

The LULUCF sector is a sink of 33 412 Gg CO_2e in 2024, and this is a sink increase of 20 769 Gg CO_2e since 1990 (Figure 2.8). There has been annual variation in the removals and emissions in the LULUCF sector, but overall the sink has been increasing gradually over time. Between 2022 and 2024 the sink increased by a further (64.5%).

Between 1990 and 2024 the greatest percentage increases were seen in the *Forest land*, while for the periods 2000 to 2024, and 2022 to 2024 the *Grassland* and *Wetland* categories showed the largest changes. Converted lands were the largest contributors to all land category emission and removals except *Settlements*.

Forest lands are estimated to be a sink of 55 037 Gg CO_2e. The dominant *Forest land* sinks are thickets and woodlands. Between 1990 and 2000 the *Forest land* sink was smaller than the later years and this is attributed to the burnt area data that was extrapolated over this period. The increased annual variability, particularly in *Forest lands*, from 2001

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onwards was due to changes in burnt area and the associated losses. The trends show an increase in the *Forest land* sink between 2018 and 2024 attributed to an increasing conversion of *Grasslands* to *Forest land*.

While *Forest Lands* are the largest contributor to the sink, all other land categories, except for a small sequestration from *Settlements*, are a source of emissions in 2024, with *Other lands* being the largest. *Other lands* show an increase in emissions between 2014 and 2024, due to an increase in conversion of *Forest land* to *Other land* between 2014 and 2018 and an increase in conversion of *Grasslands* to *Other lands* from 2018 onwards. Much of these conversions are, however, thought to be related to seasonal variation rather than being actual change. *Croplands* are a consistent source across the time-series except for an increase in emissions between 2019 and 2020 due to an increase in conversion from *Forest land* to *Croplands*. *Grasslands* show increased emissions over time due mainly to the conversion of *Forest lands* to *Grasslands*. The *Wetland* source is small but increases from 1990 to 2024 as there is an increase in conversion of all other land types to *Wetlands*.

2.3.5 Waste

The Waste sector's share of total national emissions increases over the period from about 2.8% in 1990 to 4.0% in 2024. The Waste sector showed a 69.6% increase in emissions since 1990 and this increase has occurred slowly over time (Figure 2.8).

In South Africa the total Waste sector emissions for 2024 are 19 245 Gg CO_2e. Most of these emissions are from *Wastewater treatment and discharge* contributing 9 007 Gg CO_2e (47%) of the total Waste sector emissions. *Solid waste disposal* contributed a further 7 377 Gg CO_2e (38%) of waste emissions while *biological treatment of solid waste* contributed 2 620 Gg CO_2e (14%). Emissions from *Incineration and Open Burning of Waste* were estimated to be 241 Gg CO_2e (1%), this excludes emissions from pyrolysis.

Solid waste disposal emissions have increased 47.6% since 2000. *Incineration and open burning of waste* emissions increased by 53.1% since 2000, while emissions from *Wastewater treatment and discharge* increased slightly across the time series. This overall increase in emissions is largely driven by increases of 35.6% in *Domestic wastewater treatment and discharge* emissions, whilst there was a 9.4% decline in *Industrial wastewater treatment and discharge* emissions.

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2.4 Chapter 2 References

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Chapter 3: Energy (CRT Sector 1)

3.1 Sector overview

South Africa's Energy sector inventory includes:

- Exploration and exploitation of primary energy sources;
- Conversion of primary energy source into more useable energy forms in refineries and power plants;
- Transmission and distribution of fuels; and
- Final use of fuels in stationary and mobile applications.

The Energy sector is South Africa's largest emitting sector. This sector is the largest source of CO_2 emissions (Figure 3.1) and the second largest source of N_2O emissions mainly as a result of *Fuel Combustion* activities.

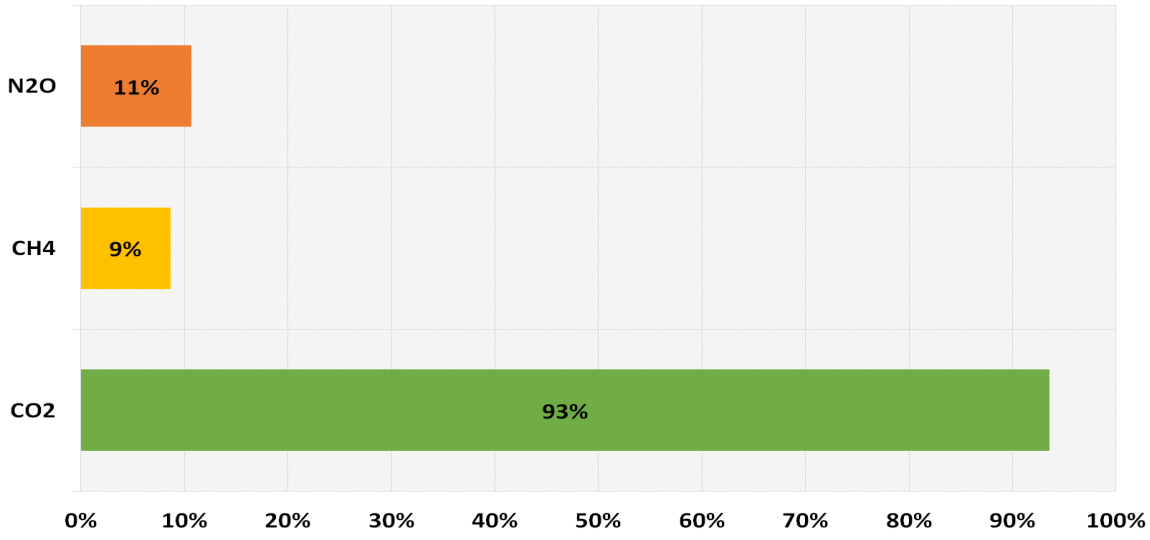


Figure 3.1: Energy sector contribution by gas for 2024

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The primary energy supply for South Africa is dominated by coal and renewables and waste as shown in Figure 3.2. The share of renewable energy in South Africa's total primary energy supply has increased from approximately 11% in 2020 to about 15% in 2022, reflecting a gradual but steady expansion of renewable energy sources in the national energy mix.

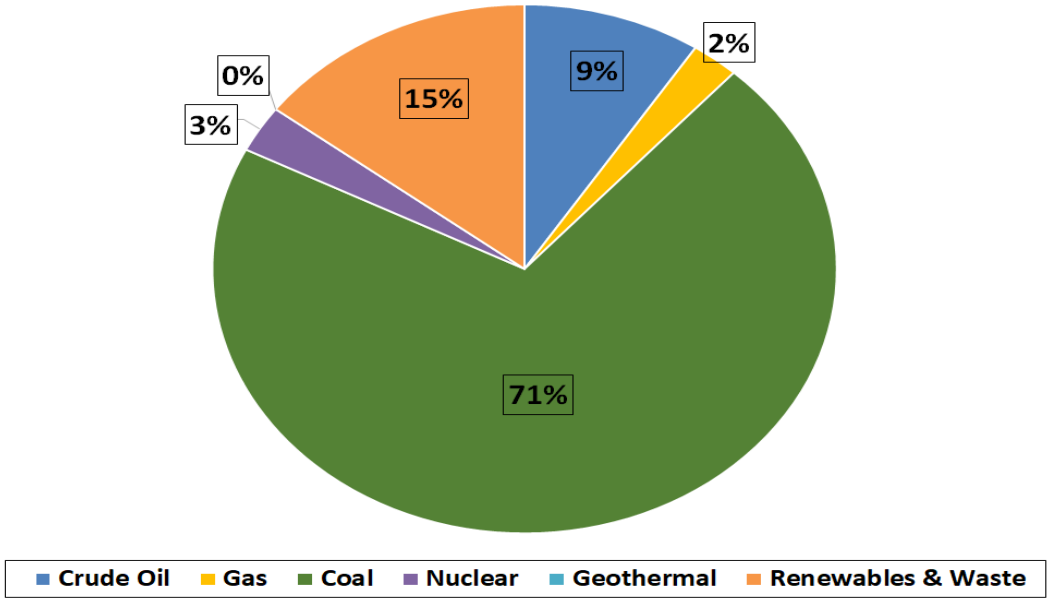


Figure 3.2: Total primary energy supply in South Africa, 2022[3]

3.1.1 Shares and trends in emissions

The total emissions from the Energy sector for 2024 are shown in Table 3.1. Emissions from *Fuel Combustion* activities account for 92% of the Energy sector emissions, Within this category, Energy Industries were the dominant source, accounting for approximately 65% of emissions from *Fuel Combustion* activities, reflecting the significant contribution of electricity and heat production to the sector's overall emissions profile. Fugitive Emissions from Fuels contributed 8% of total Energy sector emissions

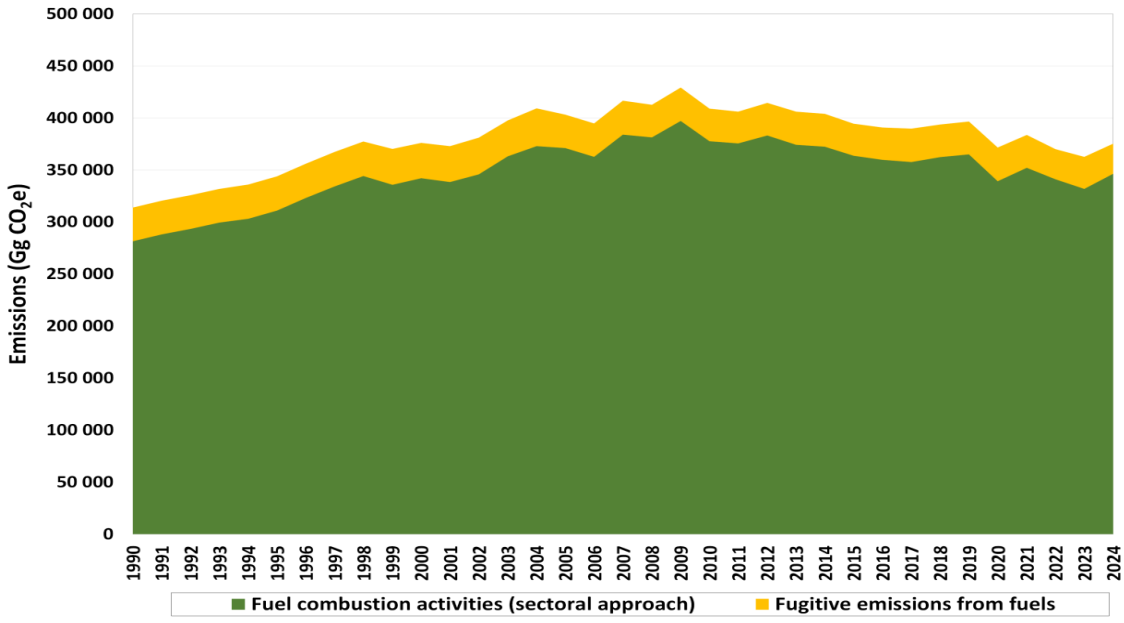
[3] *Values from the 2022 Energy Balance, DMRE 2024 Statutes & Practices | Department: Energy | REPUBLIC OF SOUTH AFRICA*

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Table 3.1: Summary of emissions from the Energy sector in 2024

GHG source and sink categories	CO_2	CH_4		N_2O		Total
	Gg CO_2e	Gg	Gg CO_2e	Gg	Gg CO_2e	Gg CO_2e
1. ENERGY	**368 289**	**187**	**5 223**	**6**	**1 703**	**375 216**
1A Fuel combustion activities	344 347	16	459	6	1 699	346 505
1B Fugitive emissions from fuels	23 942	170	4 764	0	5	28 711
1C CO_2 transport and storage	NO	NO	NO	NO	NO	NO

The time series of energy emissions by sector is shown in Figure 3.3. Total emissions from the energy sector show a long-term upward trend from 1990 to around 2009, followed by a period of fluctuation and a gradual decline towards 2024. Fuel combustion activities form the dominant source of emissions throughout the period, consistently contributing the largest share. Emissions from combustion increased steadily through the 1990s and early 2000s, peaking around 2008-2009, before stabilising and gradually decreasing in the following decade.



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Figure 3.3: Energy emissions by sub-sector, 1990-2024

Fugitive emissions from fuels represent a much smaller portion of total energy sector emissions. These emissions remained relatively stable over time, with moderate increases observed in the mid-2000s and slight variations thereafter.

The changes in Energy sector emissions since 1990, at an aggregated level, are shown in Figure 3.4. The annual change in emissions from 1990 to 2024 shows a fluctuating pattern, characterised by alternating periods of moderate increases and decreases. Early years (1990–2000) reflect generally modest growth, with annual changes mostly between 0% and 4%. Between 2001 and 2010, emissions became more variable, with sharper increases of up to 5% and occasional declines of between 2% and 5%, indicating sensitivity to economic and operational factors.

From 2011 onward, annual changes stabilised, although small fluctuations persisted, typically within the –2% to +2% range. A significant drop of 6% is observed in 2020, likely linked to reduced activity during the COVID-19 pandemic, followed by a strong rebound of 3% in 2021. The most recent years (2022–2024) show a return to moderate variability, with a decline of 4% in 2023 and a subsequent increase of 4% in 2024.

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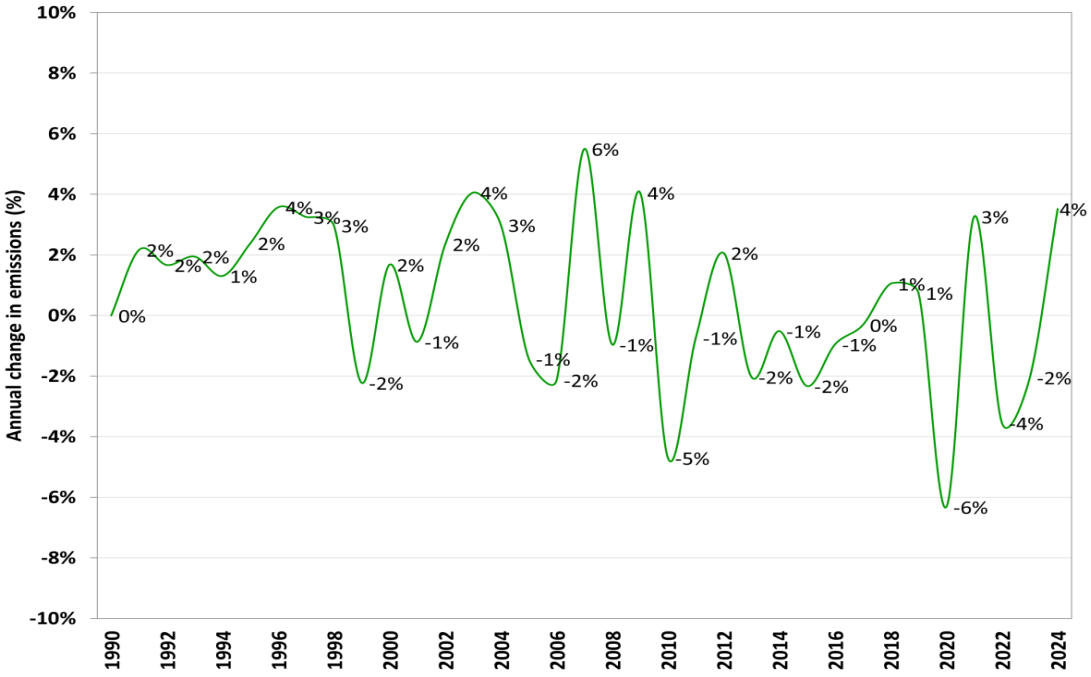


Figure 3.4: Trend in annual change in the total Energy sector emissions, 1990-2024

Table 3.2 shows the disaggregated changes in emissions from 1990 and from 2024. Energy industries, particularly Electricity and heat production, show the largest absolute increase (+60,481 Gg CO_2e; +43.6% from 1990-2024), confirming continued reliance on fossil-fuel-based power generation. Transport (1.A.3) emissions rose significantly by 26.7% from 1990–2024, largely driven by Road transportation (1.A.3.b) (+36.1%), indicating increasing vehicle activity and fuel consumption. Conversely, Other sectors (1.A.4) declined sharply (-53.1%), mainly due to reductions in Residential emissions (-83.1%), likely reflecting electrification and reduced direct fuel use in households.

Total fugitive emissions show a moderate long-term decline, these masks contrasting trends: strong reductions in oil and gas-related fugitives, offset partly by increases in solid fuel-related emissions. Overall, the Energy sector exhibits long-term growth with shifting sub-sector dynamics, while recent trends indicate a modest 1% increase between 2022 and 2024.

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Table 3.2: Summary of the change in emissions from the Energy sector, 1990-2024

Greenhouse gas source and sink categories	Emissions ($Gg\ CO_2e$)				Difference ($Gg\ CO_2e$)			Change (%)		
	1990	2000	2022	2024	1990-2024	2000-2024	2022-2024	1990-2024	2000-2024	2022-2024
1.ENERGY	**312 936**	**376 305**	**370 030**	**375 216**	**62 280**	**-1 089**	**5 186**	**19.9**	**-0.3**	**1.4**
1.A Fuel combustion activities	**281 795**	**342 204**	**341 185**	**346 505**	**64 710**	**4 301**	**5 321**	**0.2**	**1.3**	**1.6**
1.A.1 Energy industries	**166 631**	**221 901**	**226 694**	**228 181**	**61 550**	**6 281**	**1 487**	**36.9**	**2.8**	**0.7**
1.A.1.a Electricity and heat production	*138 634*	*187 325*	*198 016*	*199 114*	*60 481*	*11 789*	*1 099*	*43.6*	*6.3*	*0.6*
1.A.1.b Petroleum refining	*2 550*	*4 012*	*1 080*	*1 493*	*-1 056*	*-2 519*	*413*	*-41.4*	*-62.8*	*38.2*
1.A.1.c Manufacture of solid fuels	*25 448*	*30 563*	*27 599*	*27 574*	*2 126*	*-2 990*	*-25*	*8.4*	*-9.8*	*-0.1*
1.A.2 Manufacturing industries and construction	**15 786**	**18 946**	**24 367**	**21 927**	**6 141**	**2 981**	**-2 440**	**38.9**	**15.7**	**-10.0**
1.A.2.a Iron & Steel	*1 185*	*1 424*	*1 583*	*1 674*	*489*	*250*	*90*	*41.3*	*17.5*	*5.7*
1.A.2.b Non-ferrous Metals	*432*	*474*	*732*	*366*	*-66*	*-108*	*-365*	*-15.3*	*-22.8*	*-49.9*
1.A.2.-ab 1A2 Remainder	*14 169*	*17 048*	*22 052*	*19 887*	*5 718*	*2 839*	*-2 165*	*40.4*	*16.7*	*-9.8*
1.A.3 Transport	**47 244**	**41 664**	**52 786**	**59 868**	**12 624**	**18 205**	**7 082**	**26.7**	**43.7**	**13.4**
1.A.3.a Domestic aviation	*3 434*	*2 333*	*689*	*781*	*-2 653*	*-1 552*	*92*	*-77.2*	*-66.5*	*13.4*

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1.A.3.b Road transportation	*42 643*	*38 245*	*51 159*	*58 025*	*15 382*	*19 780*	*6 866*	*36.1*	*51.7*	*13.4*
1.A.3.c Railways	*733*	*613*	*395*	*449*	*-284*	*-164*	*53*	*-38.8*	*-26.8*	*13.4*
1.A.3.d Water-borne navigation (domestic)	*394*	*432*	*500*	*568*	*174*	*135*	*67*	*44.2*	*31.3*	*13.4*
1.A.3.e Other transportation	*40*	*40*	*42*	*46*	*6*	*6*	*4*	*14.2*	*14.2*	*9.3*
1.A.4 Other sectors	**39 464**	**45 184**	**18 487**	**18 502**	**-20 962**	**-26 682**	**15**	**-53.1**	**-59.1**	**0.1**
1.A.4.a Commercial/Institutional	*16 069*	*18 388*	*11 843*	*11 820*	*-4 250*	*-6 569*	*-24*	*-26.4*	*-35.7*	*-0.2*
1.A.4.b Residential	*21 307*	*24 404*	*3 559*	*3 608*	*-17 699*	*-20 796*	*49*	*-83.1*	*-85.2*	*1.4*
1.A.4.c Agriculture/Forestry/Fishing/Fish farms	*2 088*	*2 391*	*3 085*	*3 074*	*986*	*683*	*-10*	*47.2*	*28.6*	*-0.3*
1.A.5 Non-specified	*12 669*	*14 510*	*18 849*	*18 026*	*5 357*	*3 516*	*-823*	*42.3*	*24.2*	*-4.4*
1.B Fugitive emissions from fuels	**31 141**	**34 100**	**28 845**	**28 711**	**-2 431**	**-5 390**	**-135**	**-0.1**	**-15.8**	**-0.5**
1.B.1 Solid fuels	*1 549*	*2 028*	*2 314*	*2 411*	*862*	*383*	*97*	*55.7*	*18.9*	*4.2*
1.B.2 Oil and natural gas	*784*	*976*	*121*	*86*	*-699*	*-890*	*-35*	*-89.1*	*-91.2*	*-28.9*
1.B.3 Other emissions from energy production	*28 808*	*31 325*	*26 410*	*26 214*	*-2 594*	*-5 111*	*-197*	*-9.0*	*-16.3*	*-0.7*
1.C Carbon dioxide transport and storage	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**

Note: Columns may not add up exactly due to rounding off.

3.1.1.1 *Fuel combustion activities*

The trends and subcategory contributions to emissions from *Fuel Combustion activities* since 1990 are shown in Figure 3.5. *Energy Industries* continues to be the largest source of emissions and this due to the high carbon intensity of South Africa's electricity production sector. The second largest source of emissions from *Fuel Combustion* activities is the *Transport* sector, which is largely dominated by emissions from road transportation.

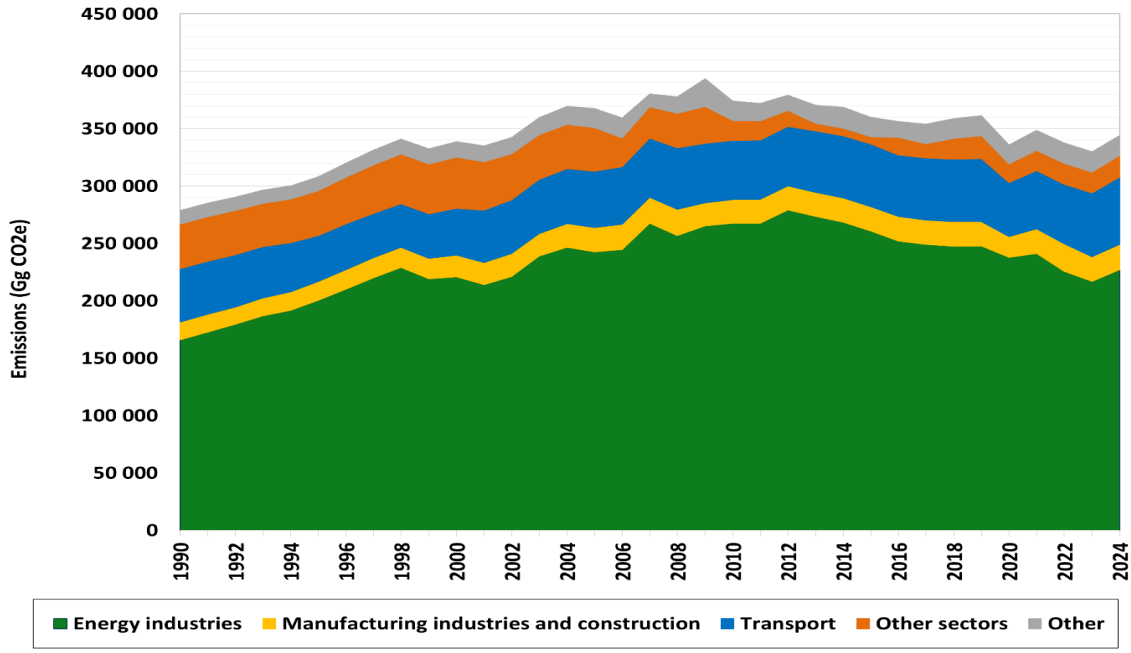


Figure 3.5: Trends and subcategory contributions to fuel combustion activity emissions, 1990-2024

Overall emissions increased steadily from 1990, reaching a peak around 2007–2010, before gradually declining and stabilising in the period after 2015. Energy industries remained the dominant source of emissions throughout the time series, showing strong growth during the 1990s and early 2000s, followed by a plateau and slight reduction in recent years. Transport emissions also rose consistently over the time series, contributing significantly to the overall upward trend, particularly between 2000 and

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2015. Overall, the figure demonstrates that while total Energy sector emissions expanded during the first two decades, structural and operational changes in the energy system have contributed to stabilisation and slight reductions in more recent years.

All the *Fuel Combustion* activity subcategories experienced a drop in emissions in 2020 due to stringent COVID19 lockdown restrictions.

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3.1.1.1.1 *Energy industries*

Emissions from *Electricity and Heat Production* contribute the most to the *Energy Industries* sub-sector with *Petroleum Refining* contributing the least (Figure 3.6).

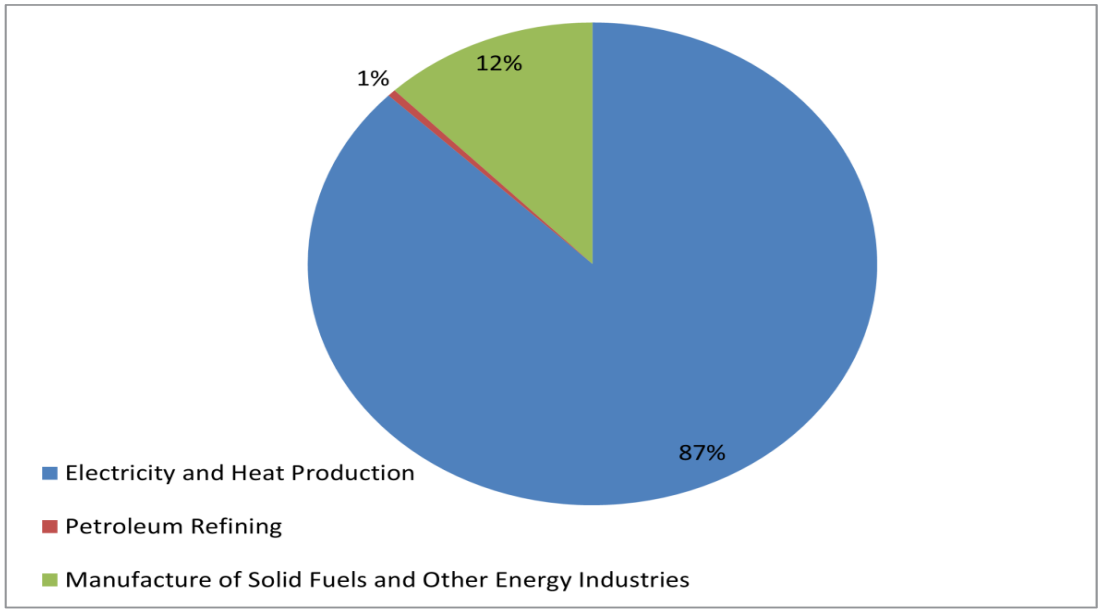


Figure 3.6: Contributions to *Energy Industries* emissions, 2024

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Main electricity producer (1.A.1.a)

Table 3.3 shows historical emissions from electricity produced by the main electricity producer in South Africa. Emissive electricity in South Africa is mainly produced from coal, diesel and fuel oil.

Table 3.3: Emission trends for the main electricity producer, 1990 – 2024

	CO_2	CH_4	N_2O	Total
	Gg CO_2	Gg CH_4 (CO2e)	Gg N_2O (CO2e)	Gg CO_2e
1990	125 011	36	513	125 561
1991	133 424	39	548	134 011
1992	141 838	41	583	142 461
1993	150 348	44	618	151 009
1994	153 938	45	632	154 615
1995	160 675	46	660	161 381
1996	169 643	49	697	170 389
1997	178 700	52	734	179 486
1998	185 870	54	763	186 687
1999	175 174	51	720	175 944
2000	175 174	51	720	175 944
2001	174 803	51	718	175 572
2002	182 292	53	749	183 094
2003	196 045	57	805	196 907

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2004	205 802	60	845	206 707
2005	207 331	60	851	208 243
2006	208 592	60	857	209 509
2007	229 351	66	942	230 359
2008	219 703	64	902	220 669
2009	225 762	66	926	226 754
2010	232 623	68	954	233 645
2011	234 418	69	960	235 447
2012	244 784	73	1 001	245 858
2013	238 705	72	974	239 751
2014	233 324	71	950	234 346
2015	225 166	70	914	226 150
2016	218 228	64	894	219 187
2017	215 762	63	884	216 710
2018	214 442	63	878	215 383
2019	211 948	64	865	212 876
2020	204 017	61	833	204 912
2021	208 398	63	849	209 310
2022	194 961	60	793	195 814
2023	186 053	58	754	186 866
2024	196 649	60	801	197 509

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GHG emissions from the main electricity producer increased in 2024 compared to 2022. This increase is primarily attributable to higher electricity generation coal in 2024, reflecting improved operational availability of the power system. In particular, South Africa experienced significantly reduced load shedding in 2024 relative to 2022, resulting in increased utilisation of coal-fired power plants to meet electricity demand. Figure 3.8 shows a steady increase in electricity generated from renewable energy, marked by strong growth in wind and solar PV, stabilisation of CSP, and variable performance in hydro.

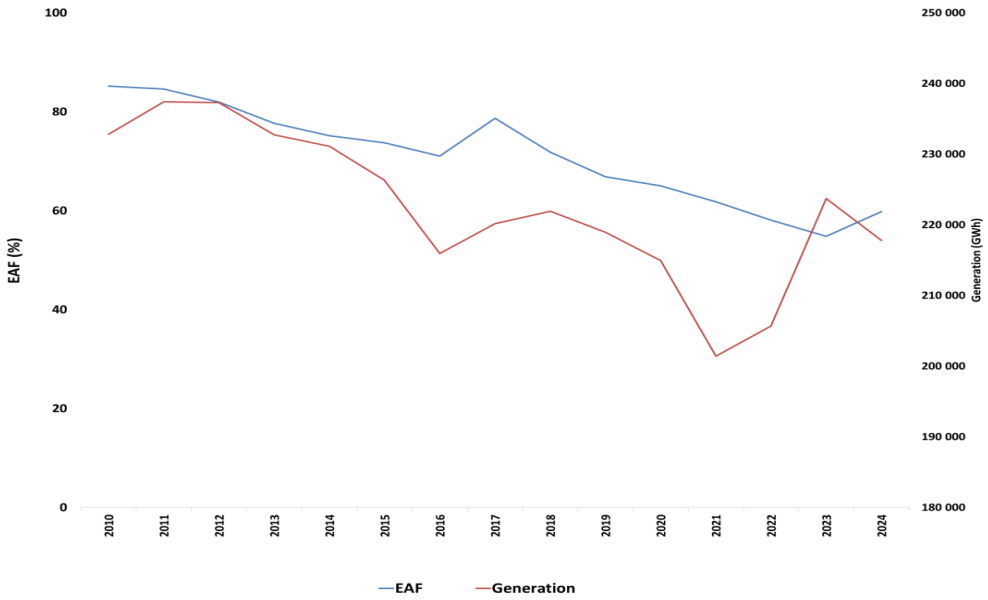


Figure 3.7: Historical energy availability factors and electricity generation information[4]

[4] *Data from Eskom's Annual Integrated reports 2011 – 2022.* *Integrated results - Eskom* and from CSIR Statistics of utility-scale power generation in South Africa reports, 2020 - 2024

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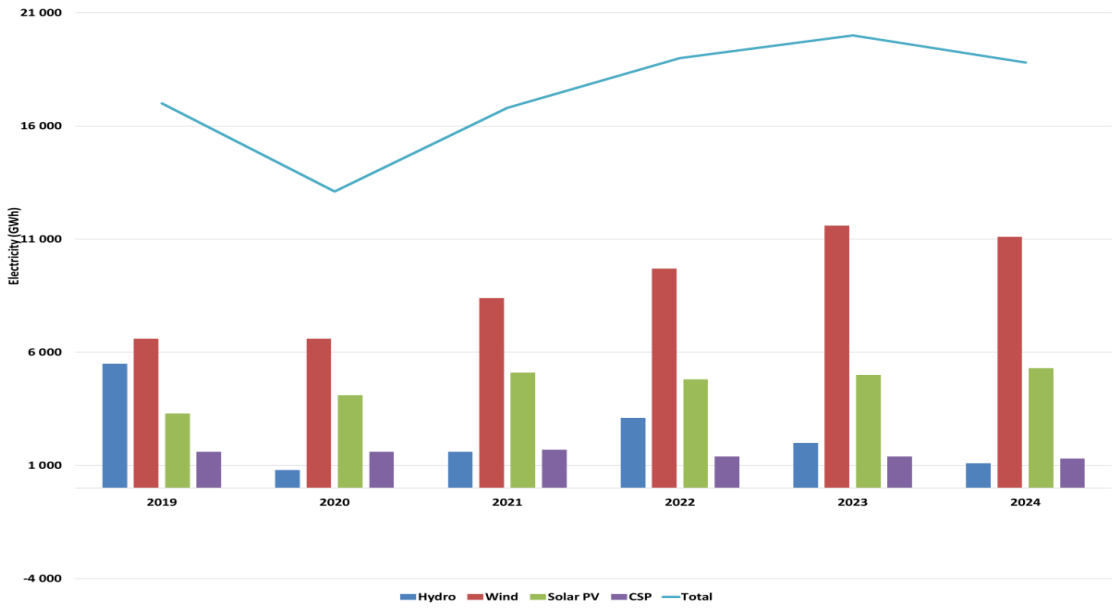


Figure 3.8: Annual electricity from renewable energy, 2019 - 2024[5]

Other electricity producers (1.A.1.a)

Emissions from other electricity producers have varied since 1990, as shown in Table 3.4. However, since 2019 these emissions have been decreasing and this is likely due to the increasing infiltration of renewable energy in this sector.

Table 3.4: Trend in emissions from other electricity producers, 1990-2024

	CO_2	CH_4	N_2O	Total
	Gg CO_2	Gg CH_4 (CO_2e)	Gg N_2O (CO_2e)	Gg CO_2e
1990	13 016	3.9	53.2	13 073
1991	11 671	3.5	47.7	11 723
1992	10 327	3.1	42.2	10 372
1993	8 982	2.7	36.7	9 022
1994	9 027	2.7	36.9	9 067

[5] *Data from CSIR Statistics of utility-scale power generation in South Africa reports, 2020 - 2024*

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	CO_2	CH_4	N_2O	Total
	Gg CO_2	Gg CH_4 (CO_2e)	Gg N_2O (CO_2e)	Gg CO_2e
1995	10 105	3.0	41.3	10 150
1996	9 699	2.9	39.7	9 742
1997	9 968	3.0	40.8	10 012
1998	10 743	3.2	43.9	10 790
1999	11 094	3.3	45.4	11 143
2000	11 331	3.4	46.3	11 381
2001	4 623	1.4	18.9	4 643
2002	5 010	1.5	20.5	5 032
2003	8 010	2.4	32.8	8 046
2004	6 282	1.9	25.7	6 309
2005	2 737	0.8	11.2	2 749
2006	3 869	1.1	15.8	3 886
2007	4 239	1.3	17.3	4 257
2008	3 521	1.0	14.4	3 536
2009	6 009	1.8	24.6	6 036
2010	1 987	0.6	8.1	1 996
2011	805	0.2	3.3	809
2012	1 081	0.3	4.4	1 086
2013	1 074	0.3	4.4	1 079
2014	1 101	0.3	4.5	1 106
2015	1 086	0.3	4.4	1 090
2016	187	0.1	0.8	188
2017	665	0.2	2.7	667
2018	665	0.2	2.7	667
2019	3 867	2.8	11.8	3 881
2020	2 235	1.2	7.9	2 244
2021	2 917	1.6	10.2	2 929
2022	2 193	1.4	7.3	2 202
2023	1 787	1.0	12.1	1 801
2024	1 589	1.4	15.1	1 605

Petroleum refining (1.A.1.b)

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Figure 3.9 illustrates the emission trends for 1A1b Petroleum refining and 1A1c Manufacture of solid fuels and other energy industries over the period 1990–2024.

Emissions from petroleum refining (1A1b) increased steadily from the early 1990s, rising from about 2 500 Gg CO_2e in 1990 to a peak of around 4 000 Gg CO_2e in the late 1990s and early 2000s. This growth reflects increased refinery throughput and higher demand for refined petroleum products.

From the mid-2000s onwards, emissions fluctuated but showed an overall gradual decline, with a more pronounced reduction after 2018. The sharp decrease observed between 2020 and 2022 is consistent with reduced refining activity, likely associated with lower fuel demand and operational disruptions. By 2024, emissions remain significantly below their historical peak, indicating a structural decline in refinery-related emissions.

Manufacture of solid fuels and other energy industries (1.A.1.c)

Emissions from the manufacture of solid fuels and other energy industries (1A1c) remained substantially higher throughout the time series. Emissions increased from approximately 26 000 Gg CO_2e in 1990 to a maximum of about 32 000–33 000 Gg CO_2e in the early 2000s, reflecting expansion in coal-based energy and related industrial activities. After this peak, emissions fluctuated at a relatively high level until the mid-2010s, followed by a gradual downward trend.

The decline after 2015 suggests reduced activity in solid fuel manufacturing and efficiency improvements in energy industries. By 2024, emissions decreased to below 28 000 Gg CO_2e, though they remain a dominant source within the energy sector.

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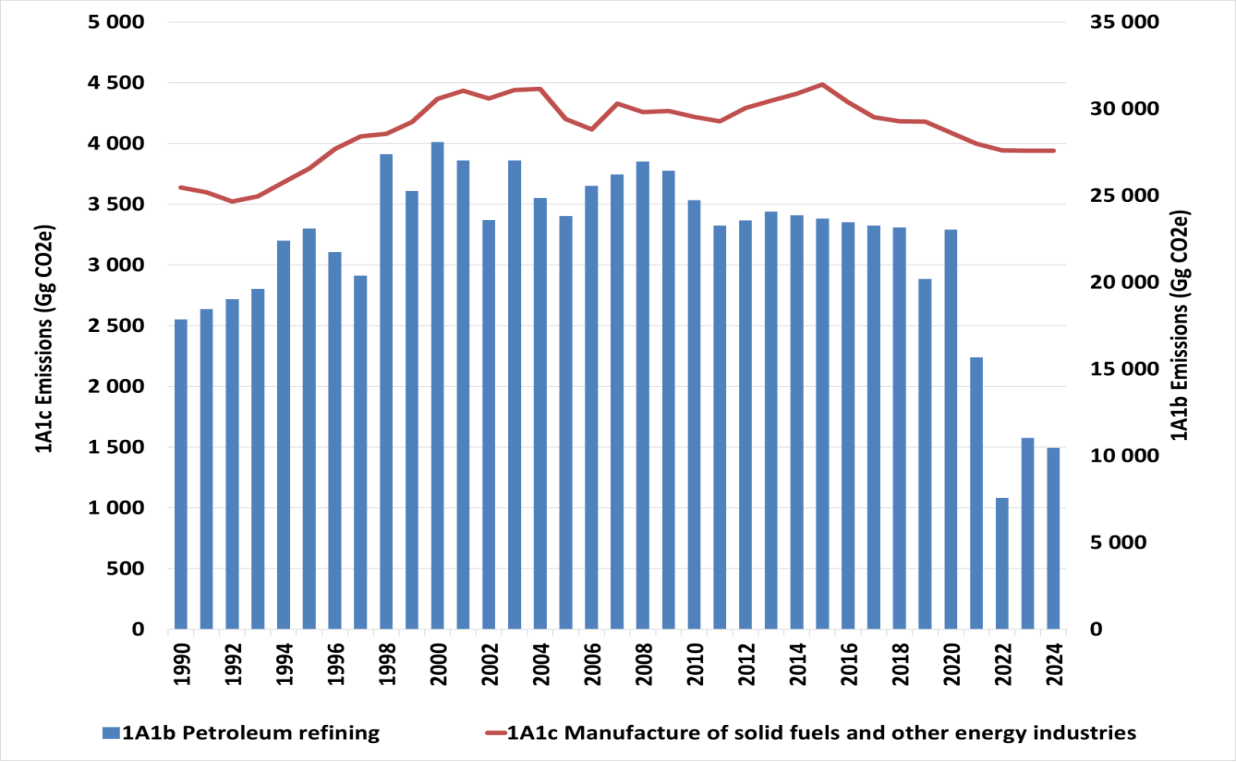


Figure 3.9: Historical emissions from *Petroleum Refining (1A1b) and Manufacture of solid fuels and other energy industries (1A1c)*

3.1.1.1.2 *Manufacturing industries and construction*

Total emissions from fuel combustion activities in the *Manufacturing industries and construction* sectors are shown in Figure 3.10. Emissions from this sector include disaggregated estimates from the *Iron and Steel* and *Non-ferrous Metals* and aggregated emissions for the remainder of 1A2. Emissions from the remainder of 1A2 emissions are reported at an aggregated level because of insufficient data to disaggregate these emissions per manufacturing industry.

Emissions from Manufacturing Industries and Construction show a long-term increase from 1990 to the late 2000s, followed by periods of stabilisation and variability through to 2024, with 1A2 (remainder) consistently dominating sectoral emissions. A decline around 2009 reflects reduced industrial activity during the global economic downturn,

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while a sharper decrease in 2020 is associated with COVID-19-related impacts on manufacturing output.

Emissions increased again after 2020, with higher levels in 2024 linked to the recovery of industrial activity and improved electricity supply conditions, including reduced load shedding.

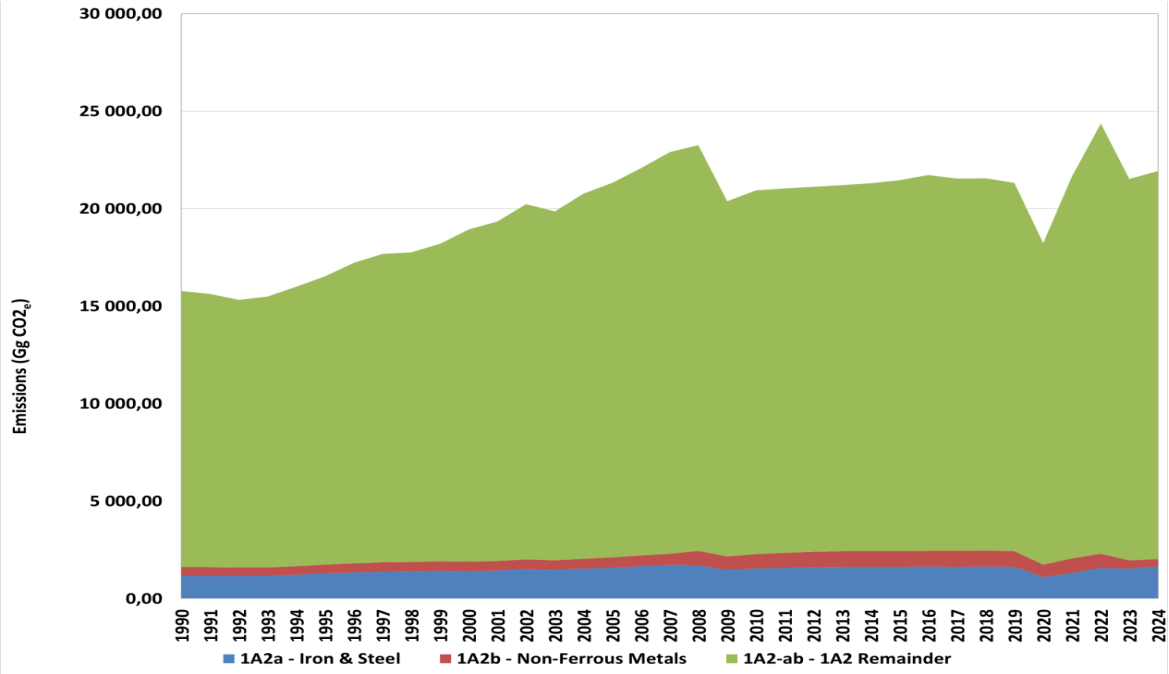


Figure 3.10: 1A2 Disaggregated emissions for subcategory 1A2, 1990-2024

Figure 3.11 shows the trends in fuel use in the *Manufacturing industries and construction* sector. Coal usage dominants the energy demand in industry in South Africa.

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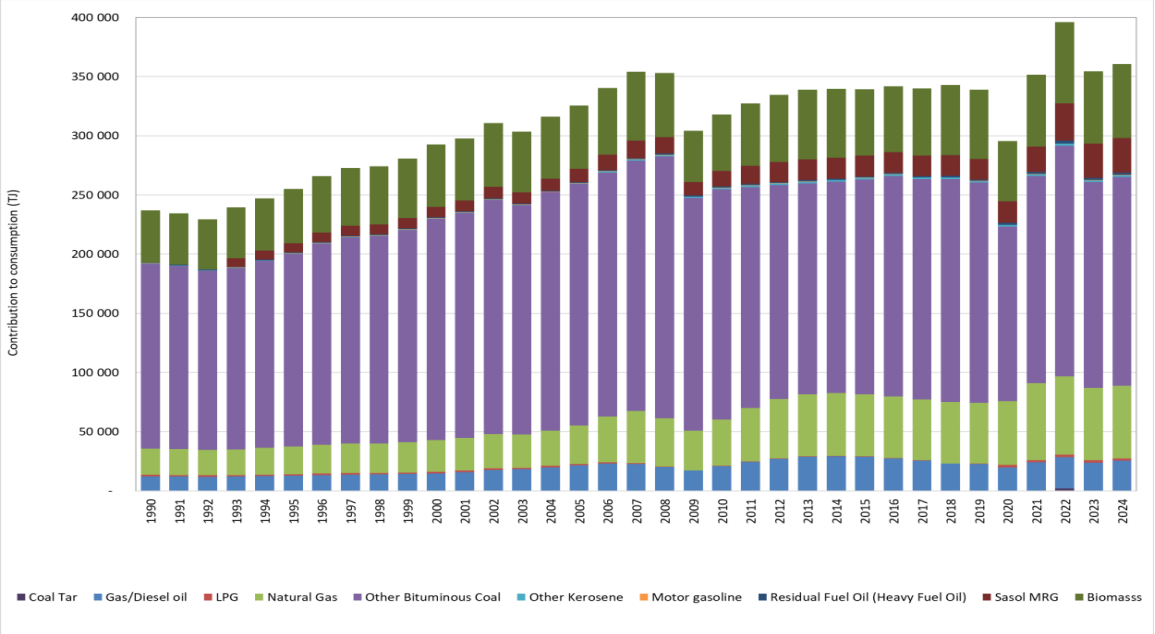


Figure 3.11: Manufacturing industries and construction – fuel consumption contributions

Total fuel consumption in Manufacturing Industries and Construction (Figure 3.11) increased steadily from 1990 to the mid-2000s, driven primarily by coal-based fuels, particularly other bituminous coal, which consistently represent the largest share of energy use. A decline is observed around 2009 and again in 2020, reflecting reduced industrial activity associated with the global economic downturn and COVID-19 impacts, respectively. Consumption recovered thereafter, with higher levels in 2022–2024 linked to increased industrial output and improved electricity supply conditions, while natural gas and liquid fuels remain secondary contributors to total energy use.

Historical emissions from different modes of transport are shown in Table 3.2. *Road transport* has always contributed the most to Transport sector emissions. Figure 3.12 shows the sub-sector contributions for 2024

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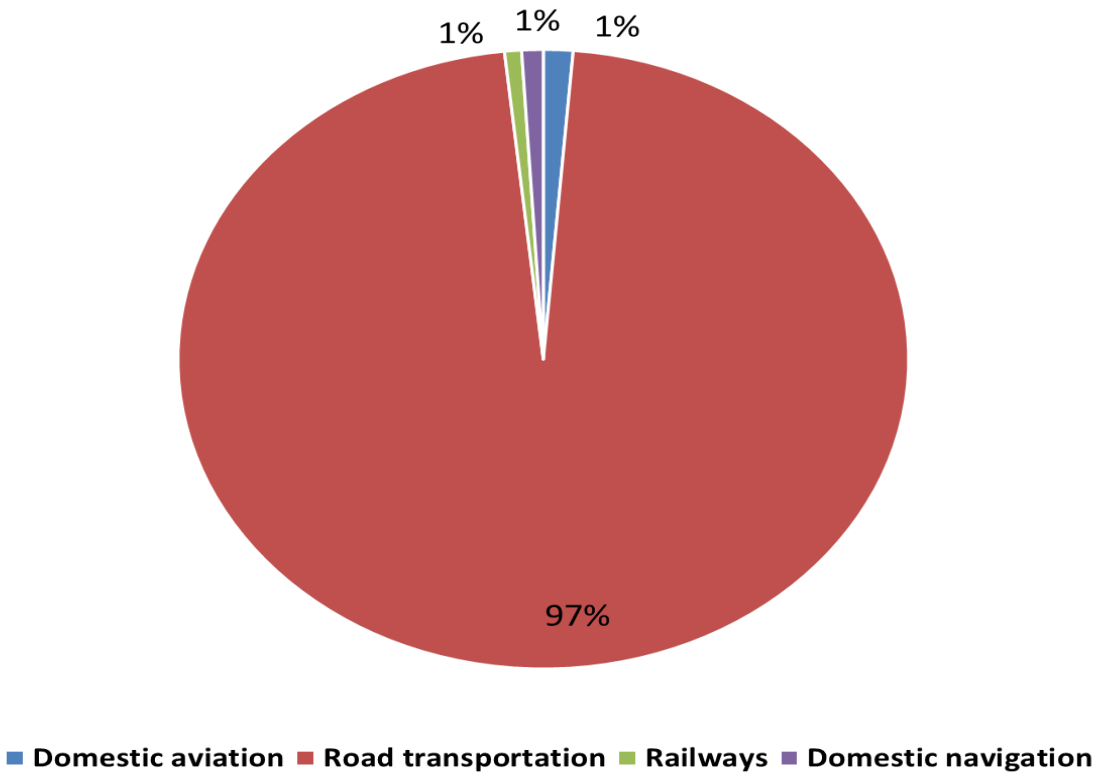


Figure 3.12: Transport sector emission contributions, 2024

Civil Aviation, Railway Transport & Waterborne navigation (1.A.3.a, 1.A.3.c & 1.A.3.d)

Emissions from civil aviation, railway transport and waterborne navigation cumulatively contribute 3 % of the *Transport* sector emissions in 2024. In South Africa these three modes of transportation typically use jet fuel, diesel and fuel oil.

Figure 3.13 shows the annual changes of volumes sold for these fuels since 2018. In 2020, jet fuel experienced the largest decrease sales which in turn resulted in a large drop in emissions from *Civil aviation*.

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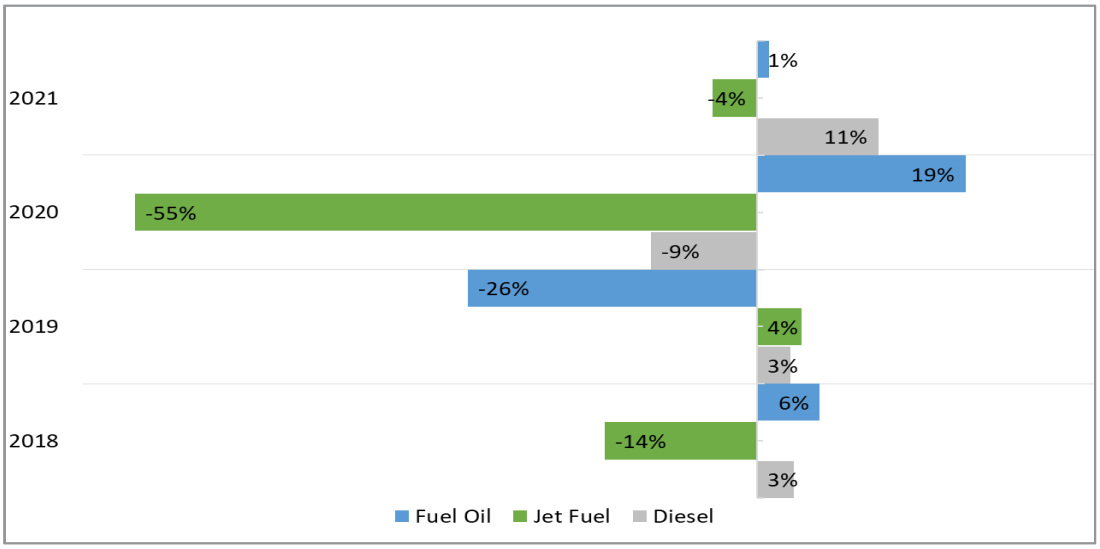


Figure 3.13:: Annual volume changes for fuel oil, jet fuel and diesel sold since 2018[6]

Road Transport (1.A.3.b)

The contribution of motor gasoline to total liquid fuel consumption shows a clear declining trend from approximately 66% in 1990 to about 45% in 2024, while the share of gas/diesel oil increased correspondingly over the same period (Figure 3.14). This shift reflects structural changes in fuel use, including increased reliance on diesel for freight transport, industrial applications, and back-up power generation, particularly during periods of electricity supply constraints.

From around 2016 onwards, gas/diesel oil became the dominant liquid fuel, indicating a sustained transition in consumption patterns.

The share of diesel consumption for *Road transportation* has increased significantly since 2000, from 34% to 55%. This trend has resulted in a decrease in motor gasoline consumption from 66 % to 45 % (Figure 3.14). The historical shares of motor gasoline and diesel consumption in the road transport sector indicate a clear structural shift in fuel use over the period 1990–2024. In the early 1990s, motor gasoline dominated road transport energy consumption, accounting for approximately two-thirds of total fuel use,

[6] *Data from SAPIA 2021 Annual Report, https://www.sapia.org.za/wp-content/uploads/2023/01/SAPIA_AR-2021_Final_LR.pdf*

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while diesel contributed about one-third. This pattern remained relatively stable until around 2000.

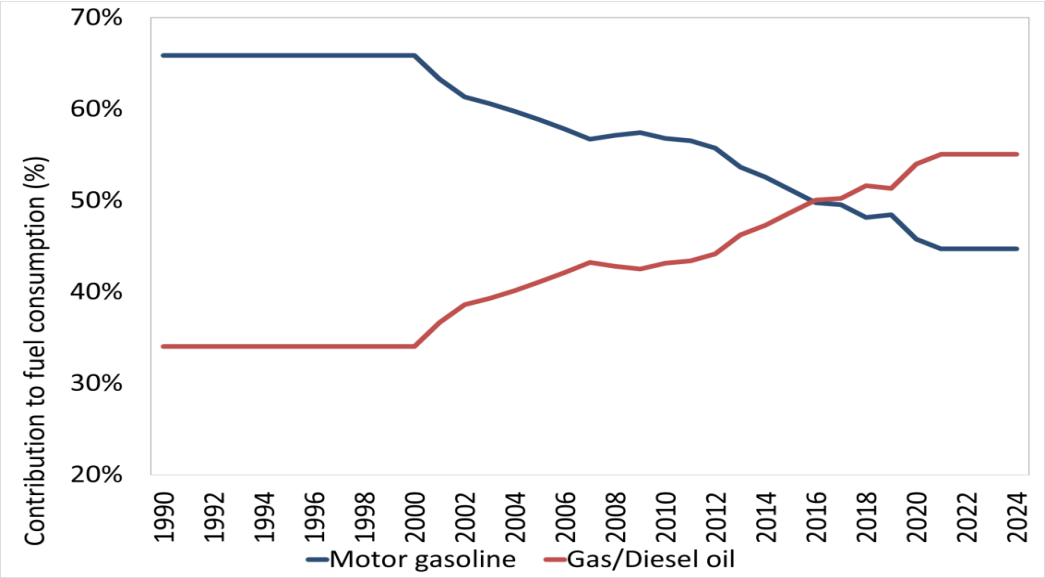


Figure 3.14: Historical share of diesel and motor gasoline consumption for road transportation

3.1.1.1.3 *Other Sectors*

Table 3.5 shows the disaggregated and total emissions from *Other* sectors. The *Commercial/institutional* and *Residential* sectors have both significantly contributed to emissions *Other* sectors.

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Table 3.5: Trend in emissions from *Other sectors*, 1990-2024

	Commercial/ Institutional	Residential	Agriculture/ Forestry/ Fishing/ Fish farms	Total
	Gg CO_2e			
1990	16 069	21 307	2 088	39 464
1991	16 018	21 239	2 081	39 339
1992	15 855	21 023	2 060	38 938
1993	15 516	20 574	2 016	38 106
1994	15 708	24 404	2 041	42 153
1995	16 210	20 827	2 106	39 144
1996	16 713	21 494	2 171	40 378
1997	17 432	22 160	2 259	41 851
1998	17 885	23 113	2 324	43 321
1999	17 974	23 714	2 335	44 023
2000	18 388	23 832	2 391	44 612
2001	18 158	22 168	2 399	42 725
2002	18 001	20 110	2 423	40 534
2003	18 785	18 246	2 487	39 518
2004	20 102	16 377	2 547	39 025
2005	19 481	16 405	2 557	38 443
2006	8 180	14 529	2 588	25 297
2007	8 805	16 122	2 642	27 569
2008	10 199	17 550	2 678	30 427
2009	11 424	18 498	2 737	32 659
2010	7 054	7 506	2 907	17 468
2011	5 152	8 710	3 095	16 956
2012	3 267	7 879	3 043	14 190
2013	1 615	2 453	2 997	7 064
2014	1 639	2 288	2 990	6 917
2015	1 444	2 159	3 003	6 607
2016	10 388	2 065	3 050	15 503
2017	6 631	2 646	3 091	12 368
2018	13 253	2 069	3 133	18 455
2019	14 435	2 778	3 122	20 335
2020	10 773	2 941	3 034	16 748
2021	11 442	3 501	3 048	17 991
2022	11 843	3 559	3 085	18 487

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	Commercial/ Institutional	Residential	Agriculture/ Forestry/ Fishing/ Fish farms	Total
	Gg CO_2e			
2023	11 852	3 708	3 085	18 645
2024	11 859	3 708	3 085	18 652

The historical fuel consumption profile for the Commercial sector over the period 1990–2024 shows significant changes in both total energy use and fuel composition (Figure 3.15). In the early part of the time series, total consumption was relatively high and dominated by other bituminous coal, with notable contributions from residual fuel oil and smaller shares of motor gasoline, diesel, LPG, and kerosene. This fuel mix reflects legacy energy-use patterns in commercial and institutional applications, including space heating and on-site energy generation.

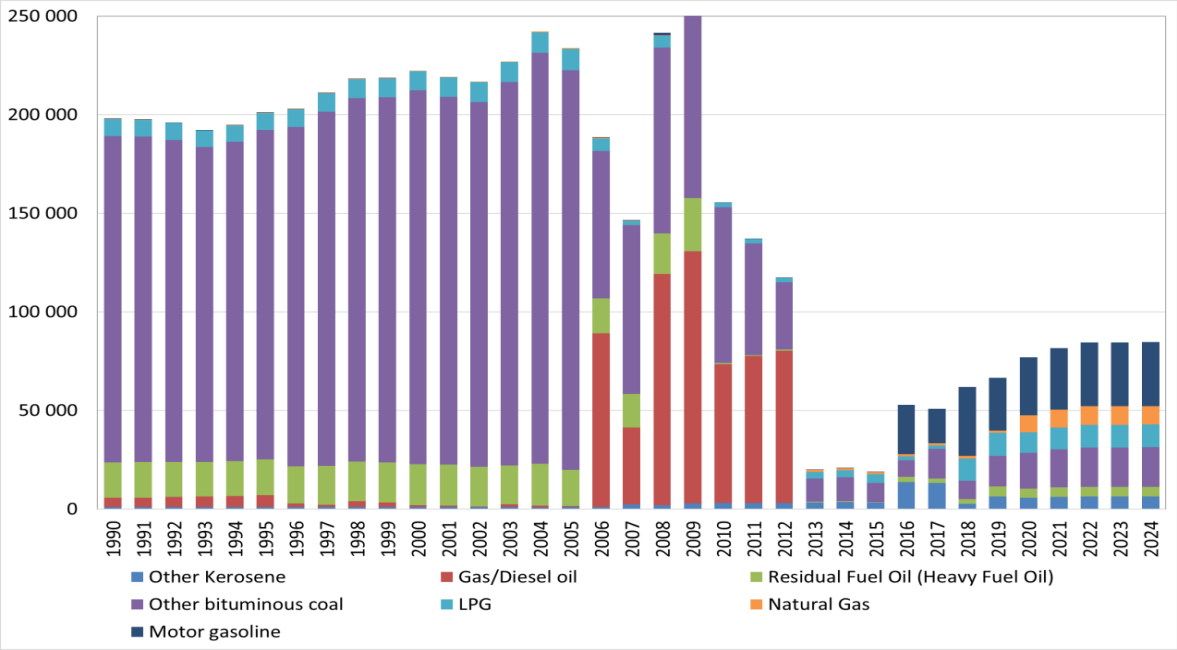


Figure 3.15: Fuel consumption trends for the Commercial/Institutional sector

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From approximately 2005 onwards, a pronounced structural shift in the fuel mix is observed. Consumption of other bituminous coal and residual fuel oil declined sharply, while gas/diesel oil increased substantially, becoming the dominant fuel by the late 2000s. This transition is consistent with fuel switching in the Commercial sector, driven by energy efficiency improvements, regulatory changes, and the gradual phase-out of solid and heavy liquid fuels.

Between 2010 and 2015, total fuel consumption in the Commercial sector decreased markedly, indicating reduced energy demand and/or improved efficiency in commercial activities. From 2016 onwards, a gradual recovery is observed, led primarily by increases in motor gasoline and gas/diesel oil, with emerging contributions from natural gas and LPG in the later years of the time series.

Emissions from the *Residential* sector have significantly decreased steadily by 86% since 2000 and this is aligned with the energy supply trends in households seen in Figure 3.16. The number of households using electricity and other electricity (i.e. generators) has increased since 2002 and because of this the number of households using fuels for cooking have also decreased since 2002, with the exception of the use of gas which has been increasing since 2012.

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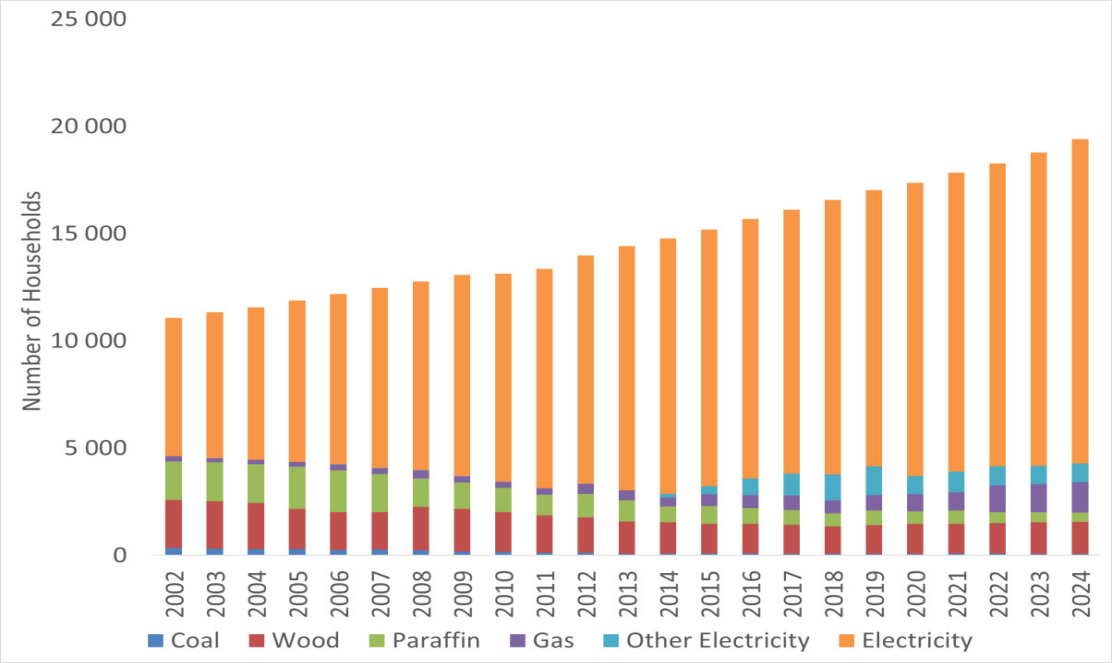


Figure 3.16: Trends in household energy supply for cooking[7]

3.1.1.1.4 *Non-specified*

The *Non-specified* category is used to report on other *Fuel Combustion* activities that do not fall under the other four sectors (*Energy industries*, *Manufacturing and construction*, *Transport* & *Other*). Emissions allocated to the category are shown in Table 3.2. In 2024, this category made up 7% of the emissions from *Fuel Combustion* activities.

3.1.1.2 Fugitive emissions from fuels

The *Fugitive emissions from fuels* sector in 2024 contributed 7.7% to total emissions from the *Energy* sector. The majority of these emissions are from the *Other emissions from energy production*.

[7] *Figure 3.16 shows the cooking energy supply trends of households since 2002. This data excludes the "Other" proportion (which contributes on average about 1% each year) from the StatsSA data. GHS 2020 P0318 (statssa.gov.za)*

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Table 3.6 shows total historical disaggregated emissions. Fugitive emissions from fuels (Category 1.B) exhibit a stable to moderately declining trend over the time series, increasing gradually to a peak in the mid-2010s before declining to 28 711 Gg CO_2e in the most recent year. The trend is dominated by other emissions from energy production (1.B.3), which account for the majority of emissions and largely drive the observed changes. Emissions from solid fuels (1.B.1) remain small and increase modestly over time, while oil and natural gas (1.B.2) emissions are very low and show a declining trend, contributing a negligible share to total energy-sector emissions.

Table 3.6: Trend in fugitive emissions, 1990-2024

	Solid Fuels	Oil and Natural Gas	Other Emissions from Energy Production	Total
	Gg CO_2e			
1990	1 549	784	28 808	31 141
1991	1 580	753	29 037	31 370
1992	1 602	722	29 266	31 590
1993	1 686	691	29 495	31 871
1994	1 753	839	29 723	32 315
1995	1 849	807	29 952	32 608
1996	1 843	775	30 181	32 799
1997	1 967	703	30 410	33 080
1998	2 047	1 452	30 638	34 137
1999	2 033	1 343	30 867	34 243
2000	2 028	976	31 096	34 100
2001	2 077	1 025	31 325	34 426
2002	2 193	1 825	31 830	35 848
2003	2 647	1 175	30 190	34 012
2004	2 467	1 533	32 027	36 026
2005	2 633	1 332	28 217	32 181
2006	2 658	1 146	28 057	31 861
2007	2 701	1 055	28 523	32 279
2008	2 667	1 167	27 129	30 963
2009	3 063	1 300	27 426	31 789
2010	2 917	1 015	27 206	31 138

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	Solid Fuels	Oil and Natural Gas	Other Emissions from Energy Production	Total
	Gg CO_2e			
2011	2 685	767	26 817	30 270
2012	2 655	693	27 821	31 169
2013	2 794	686	28 227	31 707
2014	2 765	783	27 783	31 331
2015	2 609	728	27 343	30 680
2016	2 526	744	27 548	30 818
2017	2 662	625	28 446	31 733
2018	2 697	755	27 548	31 000
2019	2 408	666	28 362	31 436
2020	3 292	434	28 381	32 108
2021	3 208	198	27 973	31 379
2022	2 314	121	26 410	28 845
2023	2 400	107	27 869	30 376
2024	2 411	86	26 214	28 711

3.1.1.2.1 Solid fuels

Solid fuels contribute a relatively small share of total fugitive emissions. Emissions from this subcategory increase gradually over time, with some interannual variability, but remain minor compared to 1.B.3. On average, solid fuels account for less than 1% of total energy-sector emissions, indicating a limited influence on overall trends.

3.1.1.2.2 Oil and natural gas

Oil and natural gas emissions are low in absolute terms and display a declining trend, particularly in the later years of the series. This reduction suggests changes in production, improved leakage control, or updated estimation assumptions, and the subcategory contributes only a negligible share (≈0.03%) to total energy emissions. Additionally, emissions from the *Oil and natural gas* industry have been decreasing steadily. Two refineries have shut down since 2020 and although the remaining refineries still operational they have not been processing any crude oil in the recent years.

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3.1.1.2.3 *Other emissions from energy production*

Within Category 1.B, Other emissions from energy production (1.B.3) are the dominant source throughout the time series, contributing most fugitive emissions. This subcategory largely drives the overall trend observed in total 1.B emissions, including the post-2015 decline, which may reflect improvements in operational practices, changes in production levels, or updated activity data.

3.1.2 Overview of methodology and completeness

Emissions for the *Energy* sector were estimated with a sectoral approach. Table 3.7 provides a summary of the methods and emission factors applied to each subsector.

Table 3.7: Summary of methods, emission factors and completeness for the Energy sector

GHG Source and sink category		CO_2		CH_4		N_2O		NO_x	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
1A	**Fuel combustion activities**										
1A1	***Energy industries***										
	a. Main activity electricity and heat production	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Petroleum refining	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Manufacture of solid fuels and other energy industries	T3	CS	T3	CS	T3	CS	NE	NE	NE	NE
1A2	***Manufacturing industries and construction***	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
1A3	***Transport***										
	a. Civil aviation	T1	CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Road transportation	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Railways	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	d. Water-borne navigation	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE

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GHG Source and sink category		CO_2		CH_4		N_2O		NO_x	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
	e. Other transportation	NO		NO		NO		NO	NO	NO	NO
1A4	***Other sectors***										
	a. Commercial/ Institutional	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Residential	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Agriculture/ Forestry/ Fishing/ Fish farms	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
1A5	***Non-specified***										
	a. Stationary	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Mobile	IE		IE		IE		IE	IE	IE	IE
1B	**Fugitive emissions from fuels**										
1B1	***Solid fuels***										
	a. Coal mining and handling	T2	CS	T2	CS						
	b. Uncontrolled combustion and burning coal dumps	NE		NE		NE		NE	NE	NE	NE
	c. Solid fuel transformation	T1	DF	T1	DF	T1	DF	NE	T1	NE	NE
1B2	***Oil and natural gas***										
	a. Oil	T3		T3		T3		NE	NE	NE	
	b. Natural gas	T3		T3		T3		NE	NE	NE	
1B3	***Other emissions from energy production***	T3		T3		NO		NE	NE	NE	NE
1C	**Carbon dioxide transport and storage**										
1C1	***Transport of CO_2***										
	a. Pipelines	NE									
	b. Ships	NE									
	c. Other	NE									
1C2	***Injection and storage***										
	a. Injection	NE									

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GHG Source and sink category		CO_2		CH_4		N_2O		NO_x	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
	b. Storage	NE									
1C3	***Other***	NE									

3.1.3 Improvements and recalculations

Recalculations were performed for the Energy sector due to methodological improvements, specifically the application of country-specific CO_2 emission factors for solid fuels in place of default IPCC values. These factors were derived from a Study, completed in 2022, consequently, emissions for the entire time series were recalculated for the applicable fuel combustion activities to ensure methodological consistency and improved national representativeness.

Figure 3.17 shows the historical trend in total energy sector GHG emissions from 1990 to 2024, comparing the current submission with the previous submission.

Minor differences between the current and previous submissions result from recalculations undertaken to maintain time-series consistency in line with the IPCC 2006 Guidelines. The improvements mentioned above resulted in the current inventory being lower than the previous inventory estimates, indicating a slight reduction in total emissions between the two inventory years

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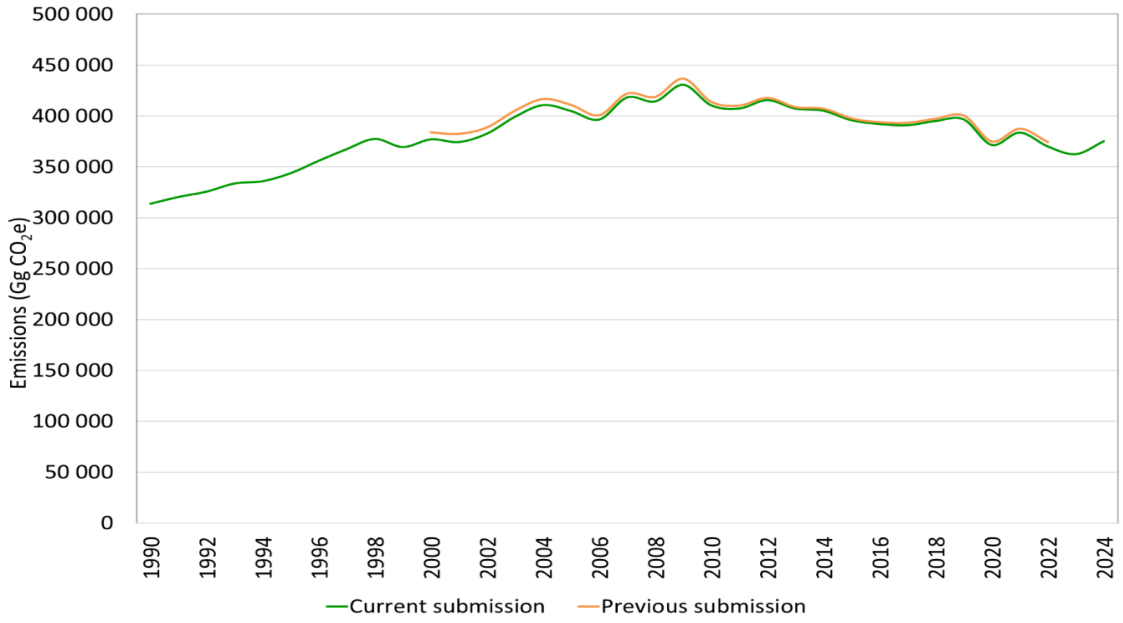


Figure 3.17: Recalculations for the Energy sector since the last submission in 2022

3.1.4 Key categories in the energy sector

The key categories for the Energy sector as determined by the level (L) and trend (T) assessment are shown in Table 3.8.

Table 3.8: Key categories identified in the Energy sector

IPCC code	IPCC Category	GHG#	Criteria
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO_2	L,T
1.A.4	Other Sectors - Solid Fuels	CO_2	L,T
1.A.3.b	Road Transportation	CO_2	L,T
1.A.4	Other Sectors - Liquid Fuels	CO_2	L,T
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO_2	L,T
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L,T
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L,T
1.A.3.a	Domestic Aviation	CO_2	L,T

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IPCC code	IPCC Category	GHG#	Criteria
1.B.3	Fugitive emissions from - Other emissions from energy production	CO_2	L,T
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L,T
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO_2	L,T
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	T
1.B.2	Oil and Natural Gas	CO_2	T

3.1.5 QA/QC process and verification

Generic QA/QC measures were conducted for the *Energy* sector calculation file, as indicated in Table 3.9.

Table 3.9: QA/QC measures for the Energy sector inventory

QA/QC principle	Check
Accuracy	Activity data source
Accuracy	Correct units
Accuracy	Unit carry through
Accuracy	Method validity
Accuracy	Calculations check
Accuracy	Uncertainties
Accuracy	Double counting
Accuracy	Correct GWP
Accuracy	Notation keys
Accuracy	Calorific values
Accuracy	Oxidation factors
Accuracy	Carbon content
Accuracy, Completeness, Consistency, Transparency	Trend check
Accuracy, Transparency	Emission factor applicability
Accuracy, Transparency, Consistency, Completeness	Recalculations
Completeness, Comparability	Sub-category completeness
Consistency	Time series consistency
Transparency	Documentation
Transparency, Completeness, Consistency, Accuracy	Colour coding
Accuracy, Comparability	Cross check data
Accuracy	Spot checks
Transparency, Consistency	Data source referencing
Transparency	Links to source data

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QA/QC principle	Check
Transparency	Raw primary data
Accuracy	QA review

3.1.6 Planned improvements

Improvements planned for the Energy sector are as follows:

- Improving activity data for fuel wood consumption in different sub-sectors.
- Including emissions from abandoned mines and spontaneous combustion.
- Disaggregating the uncertainty assessment to align with the disaggregation used for key category analysis.

3.2 Fuel combustion (CRT 1.A)

3.2.1 Comparison between sectoral and reference approach

The emissions reported for *Fuel combustion* activities are estimated using the Sectoral Approach. The Reference Approach was also used estimate emissions, and the comparison of the two approaches is shown in Figure 3.18. The comparison is done until 2022 in accordance with the latest available energy balance data from the DEE.

The Reference Approach resulted in higher estimates than the Sectoral Approach, as was the case with previous inventories. The comparison between the Reference Approach (RA) and Sectoral Approach (SA) shows that both time-series follow a similar overall trajectory, with steady growth in CO_2 emissions from 1992 to approximately 2008, followed by a period of stabilisation and moderate inter-annual fluctuations. Emissions increased significantly during the pre-2008 period, reflecting expansion in fossil fuel combustion, particularly in electricity generation and industrial activities. A noticeable dip is observed around 2020, consistent with reduced economic activity, followed by a recovery in 2021 and 2022.

However, the magnitude of emissions differs substantially between the two approaches, with the Reference Approach consistently reporting higher values than the Sectoral Approach, and the gap widening over time. While differences were minimal in the early

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1990s, they become pronounced from the mid-2000s onward, indicating growing divergence between energy balance data and sectoral fuel consumption statistics.

The increasing discrepancy between the Reference Approach (RA) and the Sectoral Approach (SA) over time is primarily attributable to structural and methodological differences in the underlying datasets and calculation procedures. The RA is based on national energy balance statistics and includes adjustments for stock changes, transformation sector inputs, and energy industry own-use, whereas the SA relies on disaggregated sectoral fuel consumption data reported by end-users. Differences may therefore arise from inconsistencies between energy supply and sectoral consumption data, variations in calorific values applied, the treatment of non-energy use, and the allocation of transformation losses. As total fuel consumption increased over the time series, minor inconsistencies in activity data or conversion parameters may have been amplified, contributing to the widening divergence observed in recent years.

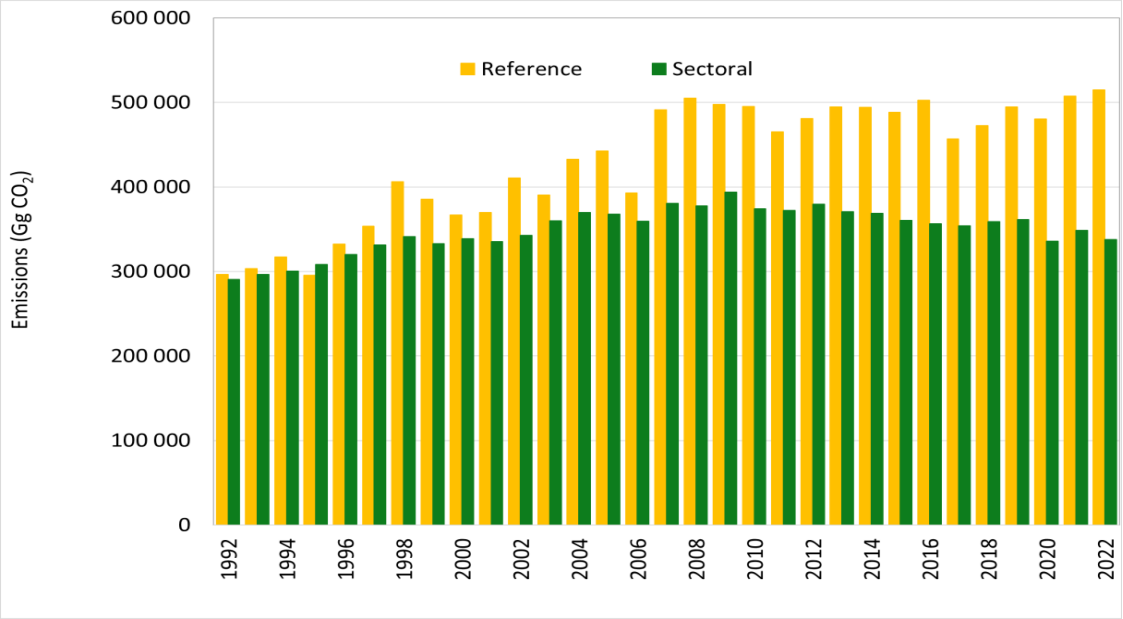


Figure 3.18: Comparisons between the reference and sectoral approach of determining the CO_2 emissions for the energy sector

Annex III shows the comparison between the Reference and Sectoral Approach for solid, fuel and gaseous fuels consumption between 1992 and 2022. The comparison of fuel

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consumption data from 1990 to 2022 reveals varying levels of alignment across fuel categories. Solid fuel consumption shows a persistent and widening gap, with the Reference Approach consistently exceeding the Sectoral Approach by approximately 30%, suggesting potential under-reporting in end-use sectors or significant transformation losses. Gaseous fuels exhibited a similar structural discrepancy for much of the time series, often showing a Reference-to-Sectoral ratio of 2:1, until a notable convergence in 2021–2022 indicated improved data reconciliation. Conversely, liquid fuels demonstrated the strongest alignment, particularly between 2004 and 2018, despite early-period volatility and a significant Reference spike in 2002.

Overall, while the inventory shows improving trends in data consistency for gaseous and liquid fuels, the sustained discrepancy in solid fuels highlights a key area for further investigation into national energy balance statistics and sectoral coverage. The difference in consumption and estimates for both approaches is due to:

- Missing information on stock changes that may occur at the final consumer level. The relevance of consumer stocks depends on the method used for the Sectoral Approach.
- Unrecorded consumption of gas or other fuels may lead to an underestimation of the Sectoral Approach.
- The treatment of transfers and reclassifications of energy products may cause a difference in the Sectoral Approach estimation since different net calorific values and emission factors may be used depending on how the fuel is classified.
- Activity data on liquid fuels in the Sectoral Approach particularly for energy industries is sourced directly from the companies involved and has been reconciled with other publicly available datasets.
- Inconsistencies on the sources of activity data within the time series and in some cases the application of extrapolation.
- The misallocation of the quantities of fuels used for conversion into derived products (other than power or heat) or quantities combusted in the energy sector.

3.2.2 International bunker fuel

As per the IPCC 2006 Guidelines international aviation as well as marine bunkers must be reported separately from the national total emissions. The activity data for both international aviation and Navigation bunkers was sourced from the fuels consumption study. The Fuel Consumption Study looked into estimating fuel consumption from all

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domestic, international, cargo, courier and other non-passenger flights, including non-scheduled flights. This was done by considering data from the Airports Company South Africa such as the record statement of air traffic movements.

Table 3.10 provides the emissions data from international bunker fuels, covering two major sources: International Aviation and International Navigation Bunkers. Total emissions increased during the early 1990s, reaching a peak in the early 1990s primarily driven by higher emissions from international waterborne navigation. Following this peak, total emissions declined through the mid-1990s, reflecting reduced maritime activity. From the late 1990s to around 2008, total emissions showed a generally upward trend, supported by steady growth in international aviation emissions and relatively stable but elevated emissions from international waterborne navigation.

Table 3.10:Emissions from International Bunker Fuels

Year	International Aviation Emissions (Gg CO_2e)	International Waterborne Navigation Emissions (Gg CO_2e)	Total Emissions (Gg CO_2e)
1990	3 996	8 608	12 605
1991	3 996	8 591	12 587
1992	3 193	12 216	15 408
1993	2 833	9 594	12 427
1994	2 717	9 286	12 004
1995	2 787	7 698	10 485
1996	2588	7671	10 259
1997	2 407	10 118	12 525
1998	2 229	8 044	10 272
1999	2 264	7 198	9 462
2000	2 813	8 703	11 516
2001	3 017	8 740	11 757
2002	3 333	7 997	11 330
2003	3 616	8 157	11 773
2004	3 857	7 537	11 394
2005	4 109	8 085	12 194
2006	4 354	7 789	12 142
2007	4 517	8 074	12 591
2008	4 559	8 166	12 724
2009	4 536	7 717	12 252
2010	4 530	2 218	6 749
2011	4 578	2 100	6 678

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Year	International Aviation Emissions (Gg CO_2e)	International Waterborne Navigation Emissions (Gg CO_2e)	Total Emissions (Gg CO_2e)
2012	4 642	3 767	8 409
2013	4 808	2 182	6 990
2014	4 839	1 512	6 351
2015	4 897	1 824	6 721
2016	4 945	1 558	6 502
2017	5 102	1 681	6 783
2018	5 115	1 376	6 490
2019	5 317	1 376	6 693
2020	2 378	1 375	3 754
2021	2 285	1 375	3 660
2022	2 328	1 376	3 704
2023	2 491	1 472	3 963
2024	2 641	1 560	4 201

A pronounced decline in total emissions is observed around 2009–2010, corresponding to a sharp reduction in international waterborne navigation emissions. This period aligns with the global economic downturn, which significantly affected international trade and shipping activity. After 2010, emissions partially recovered but remained below pre-2009 levels, with moderate inter-annual variability.

International aviation emissions increased steadily up to 2019, indicating growth in international air traffic, while emissions from international waterborne navigation remained comparatively lower and more stable. A substantial decrease in both categories is evident in 2020, reflecting the impact of COVID-19 travel restrictions and disruptions to global transport. Although some recovery is observed after 2021, emissions in 2024 remain below historical maxima, particularly for international aviation.

Overall, the trends indicate that international waterborne navigation has historically been the dominant contributor to total emissions, while international aviation shows stronger long-term growth and higher sensitivity to economic shocks. The post-2010 and post-2020 declines highlight the influence of global economic conditions and structural changes in international transport activity on South Africa's international bunker fuel emissions.

3.2.3 Feedstock and non-energy use of fuels

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There are cases where fuels are used as raw materials in production processes. For example, in iron and steel production, coal is used as a feedstock in the manufacture of steel. The IPCC 2006 Guidelines emphasize the significance of separating energy and process emissions to prevent double counting the industrial and energy sectors. Therefore, to avoid double counting, coal used for metallurgical purposes has been accounted for under the IPPU sector. Information on feed stocks and non-energy use of fuels has been sourced from the national energy balance tables. The sources considered include coal used in iron and steel production, the use of fuels as solvents, lubricants and waxes, and the use of bitumen in road construction.

3.2.4 Common Data used for Fuel Combustion Activities

This section outlines the net calorific values, densities (Table 3.11) and emission factors (Table 3.12) used to estimate emissions from fuels used in under the various Fuel Combustion subcategories.

Table 3.11: Country-specific net calorific values and densities for solid, liquid and gaseous fuels[8]

Fuel	Net calorific value	Unit	Density (kg/l)
Coal: Eskom Average	20.1	MJ/kg	
Coal: General purpose	24.3	MJ/kg	
Coal: Coking	30.1	MJ/kg	
Coke	27.9	MJ/kg	
Biomass (wood dry typical)	17	MJ/kg	
Wood charcoal	31	MJ/kg	
Paraffin	37.5	MJ/l	0.765
Diesel	35.5	MJ/l	0.826
Heavy Fuel Oil	43	MJ/kg	0.994
Fuel Oil 18 Yeah0	42	MJ/kg	0.99
Petrol	32.5	MJ/l	0.741
Avgas (100LL)	33.9	MJ/l	0.714
Jet Fuel (Jet-A1)	37.5	MJ/l	0.79
LPG	46.29	MJ/Nm^3	0.555
Sasol gas (MRG)	33.6	MJ/Nm^3	
Natural gas	38.1	MJ/Nm^3	
Blast furnace gas	3.1	MJ/Nm^3	
Refinery gas	20	MJ/Nm^3	

[8] *Values are from the South African Petroleum Industry Association (SAPIA) and from the study Development of country-specific CO_2 emissions factors for key liquid and gaseous fuels in South Africa* https://energyjournal.africa/article/view/13592

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Fuel	Net calorific value	Unit	Density (kg/l)
Coke oven gas	17.3	MJ/Nm^3	

Table 3.12: IPCC default and country-specific emission factors for fuel combustion[9]

Fuel[10]		CO_2		CH_4	N_2O
		DF (Tier 1)	CS (Tier 2)	DF (Tier 1)	DF (Tier 1)
Liquid	Motor gasoline	69 300	72 430	3	0.6
	Aviation gasoline	70 000	65 752	3	0.6
	Jet gasoline	70 000	65 752	3	0.6
	Jet kerosene	71 500	73 463	3	0.6
	Other kerosene	71 900	64 640	3	0.6
	Gas/Diesel oil	74 100	74 638	3	0.6
	Residual fuel oil	77 400	73 090	3	0.6
	Liquified petroleum gases	63 100	64 852	1	0.1
	Bitumen	80 700	NA	3	0.6
	Petroleum coke	97 500	NA	3	0.6
Solid	Anthracite	98 300	93 331	1	1.5
	Coking coal	94 600	87 099	1	1.5
	Other bituminous coal	94 600	76 710	1	1.5
	Sub-bituminous coal	96 100	96 773	1	1.5
	Coke oven coke and lignite coke	107 000	NA	1	1.5
	Gas coke	107 000	NA	1	0.1
	Gas works gas	44 400	NA	1	0.1
	Coke oven gas	44 400	NA	1	0.1
	Blast furnace gas	260 000	NA	1	0.1
	Oxygen steel furnace gas	182 000	NA	1	0.1
Gases	Natural gas	56 100	55 709	1	0.1
Biomass	Wood/wood waste	112 000	NA	30	4
	Other primary solid biomass	100 000	NA	30	4
	Charcoal	112 000	NA	30	4

South Africa's country-specific CO_2 emission factors were higher than the IPCC default emission factors for motor gasoline (5%), jet kerosene (3%), diesel (1%), LPG (3%) and sub-bituminous coal (0.2%). On the other hand, the country-specific CO_2 emission factors

[9] *Country-specific emission factors for liquid and gaseous fuels are from the study Development of country-specific CO_2 emissions factors for key liquid and gaseous fuels in South Africa* https://energyjournal.africa/article/view/13592
[10] These fuels are defined as per the definitions given in the IPCC 2006 Guidelines.

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were lower than the default emission factors for aviation gasoline (6%), jet gasoline (6%), other kerosene (10%) and residual fuel oil (6%).

The country-specific CO_2 emission factors in Table 3.12 were developed from studies that included collecting fuel samples from across the country and during different seasons, where applicable.[11] Hence, even though these emission factors may differ from the IPCC default emissions factors, they more accurately represent the fuels used in the country.

3.2.5 Energy industries (CRT 1.A.1)

3.2.5.1 Category description

The *Energy Industries* sub-category includes fuel combustion activities from the following industries:

- 1A1a *Electricity and heat production* – In South Africa's inventory this is further disaggregated into main electricity producer and other electricity producers and hence includes all emissive electricity production plants that feed into the national grid. Emissions from auto-producers are accounted for under the respective main industry for which the fuel combustion occurs.
- 1A1b *Petroleum refining* – this includes all fuel combustion emissions from crude oil refining as well as natural extraction. Emissions from this activity have been decreasing due to limited oil reserves and the closure of major refineries in the recent years.
- 1A1c *Manufacture of solid fuels and other energy industries* – this includes fuel combustion emissions associated with the production of secondary and tertiary fuels, including natural gas processing and upgrading. This sub-category currently does not include combustion emissions from charcoal and coke production. Combustion emissions from both are currently included elsewhere under the respective 1A2 sub-categories due mass balance approaches that currently do not disaggregate these emissions explicitly.

3.2.5.2 Methodological issues

Table 3.7 indicates the type of methods and emission factors used for all categories under the Energy sector, including at sub-category level.

[11] *LPG is the only exception due to limitations on analysis. More details on this can be found in the journal article for the study.* https://energyjournal.africa/article/view/13592

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The activities shown in Table 3.13 were indicated as key categories in the 1990-2024 inventory. Emissions from 1A1a *Electricity and Heat Production* (solid) and 1A1c *Manufacture of solid fuels and other energy industries* (liquid) were estimated using higher tier methods for the 1990-2024 inventory. Hence, no change in methodology was required for these sub-categories for the 1990-2024 inventory.

However, to ensure that good practise was followed, changes in methodology were required for emissions from 1A1a *Electricity and Heat Production* (liquid) and 1A1b *Petroleum Refining* (gas). These changes are indicated in Table 3.13. The only deviation is the estimation of emissions from refinery gas under 1A1b *Petroleum Refining*, which still uses Tier 1 and the IPCC default emission factor. This deviation is due to a lack of country specific emission factors.

Table 3.13: Methodological details - *Energy Industries*

1990-2024 Key category	2000-2022 inventory		1990-2024 inventory		Notes
	Method	Emission Factor	Method	Emission Factor	
1A1a Electricity and heat production (solid, CO_2)	T1	DF	T2	CS	Emissions from solid fuels estimated using CS parameters.
1.A.4 Other Sectors - Solid Fuels	T2	CS	T2	CS	Emissions from all liquid fuels estimated using CS parameters.
1.A.3.b Road Transportation	T1	DF	T1, T2	DF, CS	Natural gas: T2, CS MRG: T2, CS Refinery gas: T1, DF
1.A.4 Other Sectors - Liquid Fuels	T3	NA	T3	NA	NA

3.2.5.2.1 *Activity data*

Table 3.14 shows the type and sources of activity data used to estimate emissions from 1A1 *Energy industries*. Majority of the activity data for 2000-2024 for the *Energy industries* sub-category was retrieved from the GHG Reporting Program with the assistance of the NGER. Activity data for the period 1992–2000 were obtained from the national energy balance compiled by the Department of Electricity and Energy. No corresponding activity data were available for the years 1990–1991. To address this data

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gap, gross domestic product (GDP) data from Statistics South Africa (Stats SA) were used to back-cast and extrapolate the missing activity data for the early years of the time series.

Table 3.14: Activity data used for 1A1 *Energy Industries*

Sub-category	Activity Data	Source
1A1a ***Electricity & heat production***	Fuel consumption for both main and other electricity producers	Energy balance, SAGERS and Manual GHG reporting program
	NCVs & densities	SAGERS and Manual GHG reporting program Kornelius *et al 2023*
1A1b ***Petroluem refining***	Fuel consumption	Refineries SAGERS and Manual GHG reporting
	NCVs & densities	Kornelius *et al 2023*
1A1c ***Manufacture of solid fuels & other energy industries***	NA – Emissions sourced from	Producers SAGERS and Manual GHG reporting

For the 1A1c sub-category emissions from South Africa's GHG Reporting Programme are used directly in the inventory. These emissions are from a mass balance approach used by the relevant companies over their operations. This approach and the resulting emissions have been independently verified as part of the GHG Emissions Verification Programme. Where petroleum refining and petrochemical production occurs at the same facility, the resulting emissions are differentiated.

Table 3.15 presents fuel consumption trends for public electricity producers, auto electricity producers, and petroleum refining over the period 1990–2024, expressed in terajoules (TJ).

Fuel consumption by public electricity producers dominates the time series and shows a strong long-term increase from 1.29 million TJ in 1990 to a peak of approximately 2.54 million TJ in 2012. This growth reflects the expansion of coal-based electricity generation to meet rising electricity demand. After 2012, fuel consumption declined gradually, reaching about 2.20 million TJ in 2019, consistent with reduced electricity generation, operational constraints, and increasing supply challenges in the power sector. A sharper reduction is observed in 2020, coinciding with lower economic activity. Partial recovery occurs thereafter; however, by 2024 fuel consumption (2.04 million TJ) remains below the historical peak, indicating a structural moderation in electricity sector fuel use.

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Table 3.15: Trend in fuel consumption for the various categories in the energy industry sector, 1990-2024

	Public electricity producer	Auto electricity producer	Petroleum refining
	Fuel consumption (TJ)		
1990	1 291 796	134 888	37 898
1991	1 378 736	120 954	39 153
1992	1 465 676	1 261	40 408
1993	1 553 616	93 086	41 663
1994	1 590 714	93 550	47 545
1995	1 660 325	104 725	49 046
1996	1 752 999	100 517	46 153
1997	1 846 589	103 304	43 260
1998	1 920 677	111 337	58 131
1999	1 810 155	114 971	53 626
2000	1 810 155	117 430	59 638
2001	1 806 320	47 910	57 599
2002	1 883 709	51 923	50 680
2003	2 025 822	83 014	57 487
2004	2 126 649	65 100	53 292
2005	2 142 682	28 363	51 610
2006	2 155 477	40 100	55 121
2007	2 369 988	43 928	56 073
2008	2 271 791	36 489	57 870
2009	2 335 101	62 276	56 523
2010	2 406 936	20 594	52 520
2011	2 426 965	8 346	50 235
2012	2 537 365	11 206	51 049
2013	2 477 632	11 129	51 890
2014	2 423 731	11 414	51 504
2015	2 343 934	11 250	51 118
2016	2 259 087	1 943	50 731
2017	2 233 426	6 887	50 345
2018	2 221 443	6 887	50 147
2019	2 199 965	46 215	49 952
2020	2 116 465	25 074	52 844
2021	2 165 560	32 941	35 140

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	Public electricity producer	Auto electricity producer	Petroleum refining
	Fuel consumption (TJ)		
2022	2 028 038	25 307	17 065
2023	1 938 547	18 531	24 060
2024	2 043 594	16 462	22 664

Fuel consumption by auto electricity producers is substantially lower and exhibits high inter-annual variability. Levels declined markedly from 134 888 TJ in 1990 to very low values in the early 1990s, followed by intermittent increases and decreases throughout the time series. Periods of relatively higher consumption, such as in the late 1990s, early 2000s, and again in 2019, suggest episodic operation of auto-generation facilities, likely driven by site-specific industrial demand and electricity supply constraints. From 2020 onwards, auto-producer fuel consumption declines again, reaching 16 462 TJ in 2024, indicating reduced reliance on or operation of auto-generation facilities.

Fuel consumption in petroleum refining increased gradually from 37 898 TJ in 1990 to levels exceeding 55 000 TJ in the late 1990s and mid-2000s, reflecting stable refinery operations and demand for refined petroleum products. From around 2010 onwards, fuel consumption shows a downward trend, with a pronounced decline after 2020. The sharp reduction observed between 2021 and 2022, followed by continued low levels through 2024, is consistent with reduced refinery throughput, refinery closures or maintenance outages, and structural changes in the domestic refining sector.

Overall, the trends indicate that public electricity production remains the primary driver of fuel consumption within the energy industries, while auto electricity production and petroleum refining contribute comparatively smaller but more variable shares. The post-2012 and post-2020 declines across all three categories highlight the combined influence of economic conditions, operational constraints, and structural changes in South Africa's energy and refining sectors.

3.2.5.2.2 Emission factors

The emission factors used are shown in Table 3.12. Where a country-specific emission factor is available, it was used to estimate emissions from that fuel.

3.2.5.3 Uncertainty

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The uncertainties for activity data and the emission factors used to estimate emission from *Energy Industries* is shown in Table 3.16.

Table 3.16: Uncertainty for the *Energy Industries* category.

Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CO_2	1A1a Electricity generation – liquid	5	IPCC 2006	7	IPCC 2006
	1A1a Electricity generation – solid	5	IPCC 2006	7	IPCC 2006
	1A1b Petroleum refining – liquid	5	IPCC 2006	7	IPCC 2006
	1A1b Petroleum refining – gaseous	5	IPCC 2006	7	IPCC 2006
	1A1c Manufacture of solid fuels – liquid	5	IPCC 2006	7	IPCC 2006
CH_4	1A1a Electricity generation – liquid	5	IPCC 2006	75	IPCC 2006
	1A1a Electricity generation – solid	5	IPCC 2006	75	IPCC 2006
	1A1b Petroleum refining – liquid	5	IPCC 2006	75	IPCC 2006
	1A1b Petroleum refining – gaseous	5	IPCC 2006	75	IPCC 2006
	1A1c Manufacture of solid fuels – liquid	5	IPCC 2006	75	IPCC 2006
N_2O	1A1a Electricity generation – liquid	5	IPCC 2006	75	IPCC 2006
	1A1a Electricity generation – solid	5	IPCC 2006	75	IPCC 2006
	1A1b Petroleum refining – liquid	5	IPCC 2006	75	IPCC 2006
	1A1b Petroleum refining – gaseous	5	IPCC 2006	75	IPCC 2006
	1A1c Manufacture of solid fuels – liquid	5	IPCC 2006	75	IPCC 2006

3.2.5.4 Time-series consistency

3.2.5.4.1 1A1a Electricity and heat production

The time-series for 1A1a *Electricity and heat production* is complete and consistent from 1990-2024.

3.2.5.4.2 1A1b Petroleum refining

The time-series for 1A1b *Petroleum refining* is complete and consistent from 1990-2024.

3.2.5.4.3 1A1c Manufacture of solid fuels and other energy industries

The time-series for 1A1c *Manufacture of solid fuels and other energy industries* is complete and consistent from 1990-2024.

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3.2.5.5 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category. In addition to this the following category-specific checks are done.

For 1A1a:
- Energy balance data on fuels used for electricity production
- Public domain reports on electricity production
- GHG Emissions Verification Programme

1A1b:
- 1B2 emissions trends
- GHG Emissions Verification Programme

1A1c:
- GHG Emissions Verification Programme

3.2.5.6 Category specific improvements and recalculations

Recalculations were performed for the *Energy industries* sector because of the following improvement:

- The use of country-specific emission factors for commonly used liquid and gas fuels. The emission factors result from a study that was completed in 2022. Emissions from the entire time-series were recalculated for the applicable *Fuel combustion* activities.

3.2.5.7 Category specific planned improvements

Improvements planned specifically for the *Energy Industries* sector are as follows:

- Updating the uncertainty values to incorporate uncertainty of the country-specific emission factors and plant specific emissions used.
- Completing the time-series for:
  - diesel consumption from other electricity producers prior to 2019 for 1A1a Electricity and Heat Production.
  - diesel, natural gas, MRG and LPG consumption prior to 2019 for 1A1b Petroleum *refining*.

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3.2.6 Manufacturing industries and construction (CRT 1.A.2)

3.2.6.1 Category description

The *Manufacturing industries and construction* sub-category includes fuel combustion activities from the industries shown in Table 3.17. In previous inventories emissions from this sub-category were reported at an aggregated level due to lack of information from South Africa's GHG Reporting Programme to disaggregate the fuel use. Table 3.17 also shows the disaggregation used for reporting the 1990 – 2024 inventory. Data from the Energy Balance data is disaggregated, however, for 2000-2022 is not used because it overestimates the amount of energy supplied to industry for combustion purposes by including the portion of fuels that are used for non-energy purposes in industrial processes. For example, fuels (i.e., coal) that are used as reducing agents or as feedstocks to processes. This is confirmed by the empty line items under the Non-energy Use section of the Energy Balance.[12]

Emissions from off-road and mobile machinery are included elsewhere under 1A3b Road Transportation. This is to avoid double counting.

Table 3.17: Disaggregation of Manufacturing industries and construction category for reporting

Reporting group	Activities included
1A2a	1A2a Iron & Steel
1A2b	1A2b Non-ferrous Metals
1A2-ab	1A2c Chemicals 1A2d Pulp, Paper & Print 1A2e Food Processing, Beverages & Tobacco 1A2f Non-metallic Minerals 1A2g Transport Equipment 1A2h Machinery 1A2i Mining & Quarrying

[12] An example of this can be found in the 2020 Energy Balance file (https://www.energy.gov.za/files/energyStats_frame.html.) under the Aggregate balance tab. Disaggragation of energy used by different industries is shown in rows 33 to 47 and the amount of fuels allocated for non-energy purposes in rows 64 to 67.

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	1A2j Wood & Wood Products 1A2k Construction 1A2l Textile & Leather 1A2m Brick Manufacturing 1A2n Manufacture of ceramic products

3.2.6.2 Methodological issues

Table 3.7 indicates the type of methods and emission factors used for all categories under the Energy sector, including at sub-category level.

The activities shown in Table 3.18 were identified as key categories in the 1990–2024 inventory. In order to ensure adherence to good practice principles, methodological revisions were implemented for emissions associated with all fuel types used in the Manufacturing Industries and Construction sector.

These revisions included the implementation of higher-tier methodologies for solid fuels, as presented in Table 3.12. The adoption of country-specific emission factors has improved the accuracy, transparency, and consistency of the emission estimates, thereby strengthening the overall quality of the inventory.

Table 3.18: Methodological details for the *Manufacturing industries and construction* category.

2000-2020 Key category	2000-2022 inventory		1990-2024 inventory		Notes
	Method	Emission Factor	Method	Emission Factor	
1A2 Manufacturing industries & construction (solid, CO_2)	T1	DF	T1, T2	DF, CS	Country Specific Emission factors from Solid Fuel study applied.
1A2 Manufacturing industries & construction (liquid, CO_2)	T1, T2	DF, CS	T1, T2	DF, CS	Coal Tar: T1, DF All others: T2, CS
1A2 Manufacturing industries & construction (gas, CO_2)	T2	CS	T2	CS	NA

3.2.6.2.1 Activity data

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Fuel consumption data for the *Manufacturing industries and construction* sector (Table 3.19) is taken from SAGERS from 2020 to 2022 and calculated from 2000-2019 based on SAGERS data and the Fuel Consumption Study. The Fuel Consumption Study looked at energy use in different industries as well as the portion that each fuel contributes to total fuel consumption.

Table 3.19: Fuel consumption (TJ) in the manufacturing industries and construction category, 1990 – 2024.[13]

Period	Coal Tar	Gas/Diesel oil	LPG	Natural Gas	Other Bituminous Coal	Other Kerosene	Motor Gasoline	Residual Fuel Oil (Heavy Fuel Oil)	Sasol MRG	Biomass	Total
	(TJ)										
1990	-	12 313	1 169	22 309	156 098	360	237	574	-	43 859	236 919
1991	-	12 187	1 157	22 082	154 508	357	234	568	-	43 413	234 506
1992	-	11 927	1 132	21 610	151 206	349	229	556	-	42 485	229 494
1993	-	12 074	1 146	21 876	153 071	353	232	563	7 292	43 009	239 616
1994	-	12 460	1 183	22 576	157 970	365	240	581	7 525	44 385	247 285
1995	-	12 847	1 219	23 276	162 867	376	247	599	7 759	45 761	254 951
1996	-	13 399	1 272	24 277	169 870	392	258	624	8 092	47 729	265 913
1997	-	13 748	1 305	24 908	174 287	402	264	641	8 303	48 970	272 828
1998	-	13 816	1 312	25 033	175 158	405	266	644	8 344	49 215	274 193
1999	-	14 148	1 343	25 634	179 362	414	272	659	8 545	50 396	280 773
2000	-	14 742	1 399	26 710	186 895	432	284	687	8 903	52 513	292 565
2001	-	15 897	1 377	27 397	190 082	340	310	714	9 132	52 631	297 880

[13] *LPG – Liquified petroleum gases, NG – natural gas, Coal – other bituminous coal, OK – other kerosene, HFO – residual fuel oil, MRG – Sasol methane rich gas, Bio - biomass*

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2002	-	17 572	1 367	29 020	197 860	269	346	752	9 673	53 940	310 799
2003	-	18 173	1 234	28 118	193 902	227	356	729	9 373	51 561	303 673
2004	-	19 914	1 147	29 720	201 606	301	378	741	9 907	52 401	316 115
2005	-	21 522	1 011	32 792	204 047	524	384	747	10 931	53 482	325 440
2006	-	23 107	827	38 731	206 229	903	390	795	12 910	56 529	340 421
2007	-	22 618	617	44 093	211 501	1 217	377	869	14 698	58 169	354 159
2008	-	19 948	435	41 040	221 143	1 192	328	935	13 680	54 440	353 141
2009	-	17 084	288	33 500	196 613	1 004	249	877	11 167	43 401	304 183
2010	-	20 740	299	39 014	194 689	1 194	267	982	13 005	47 957	318 147
2011	-	24 319	336	45 460	186 577	1 326	288	1 051	15 153	52 853	327 363
2012	-	27 028	363	50 089	180 869	1 362	300	1 036	16 696	56 997	334 740
2013	-	28 701	376	52 315	178 419	1 417	309	979	17 438	59 023	338 977
2014	-	29 242	379	52 841	178 613	1 454	306	913	17 614	58 325	339 687
2015	-	28 617	373	52 494	181 544	1 457	293	867	17 498	56 290	339 433
2016	-	27 476	366	52 045	186 114	1 453	277	934	17 348	55 934	341 947
2017	-	25 438	354	51 412	186 102	1 425	258	1 098	17 137	56 829	340 053
2018	-	22 822	348	51 999	188 114	1 418	244	1 199	17 333	59 290	342 767
2019	-	22 568	344	51 420	186 020	1 403	241	1 185	17 140	58 630	338 951
2020	125	19 641	2 106	53 916	147 643	1 242	218	1 580	18 106	51 154	295 731
2021	290	23 691	2 059	64 986	174 905	1 471	259	1 827	21 217	60 802	351 507
2022	1 866	26 500	2 310	66 140	194 761	1 649	290	2 379	31 539	68 484	395 918
2023	-	23 621	2 346	61 094	173 943	1 468	266	1 886	28 678	61 346	354 648

2024	-	25 500	1 944	61 256	176 521	1 492	264	1 884	29 412	62 385	360 658

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3.2.6.2.2 *Emission factors*

The emission factors used are shown in Table 3.12. Where a country-specific emission factor is available, it was used to estimate emissions from that fuel.

3.2.6.3 *Uncertainty*

The uncertainties for activity data and the emission factors used to estimate emission from *Energy Industries* is shown in Table 3.20.

Table 3.20: Uncertainty for the *Manufacturing industries and construction* category.

Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CO_2	1A2 Manufacturing industries and construction – liquid	10	IPCC 2006	7	IPCC 2006
	1A2 Manufacturing industries and construction – solid	10	IPCC 2006	7	IPCC 2006
	1A2 Manufacturing industries and construction – gaseous	10	IPCC 2006	7	IPCC 2006
CH_4	1A2 Manufacturing industries and construction – liquid	10	IPCC 2006	75	IPCC 2006
	1A2 Manufacturing industries and construction – solid	10	IPCC 2006	75	IPCC 2006

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Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
	1A2 Manufacturing industries and construction – gaseous	10	IPCC 2006	75	IPCC 2006
N_2O	1A2 Manufacturing industries and construction – liquid	10	IPCC 2006	75	IPCC 2006
	1A2 Manufacturing industries and construction – solid	10	IPCC 2006	75	IPCC 2006
	1A2 Manufacturing industries and construction – gaseous	10	IPCC 2006	75	IPCC 2006

3.2.6.4 Time-series consistency

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3.2.6.5

The time-series for 1A2 *Manufacturing industries and construction* is complete.

3.2.6.6 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category. In addition to this the following category-specific checks are done.

- Energy Balance data on fuels used in different industries
- StatsSA data on manufacturing trends
- GHG Emissions Verification Programe

3.2.6.7 Category-specific recalculations

Recalculations were performed for the *Manufacturing industries and construction* sector because of the following improvements:

- To incorporate updated emission factors derived from the Solid Fuel Study. The study developed country-specific emission factors for solid fuel combustion, which replaced the previously applied default emission factors for this sector. No changes were made to the underlying activity data or methodological approach; the recalculations reflect only the application of nationally derived emission factors to improve the accuracy and country representativeness of the estimates for 1A2.

3.2.6.8 Category-specific planned improvements

Improvements planned specifically for the *Manufacturing industries and construction* sector are as follows:

- Disaggregating the remainder of the 1A2.
- Updating the uncertainty values to incorporate uncertainty of the country-specific emission factors used.

3.2.7 Transport (CRT 1.A.3)

3.2.7.1 Category description

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The *Transport* sub-category includes fuel combustion activities from the following types of transportation:

- 1A3a *Civil aviation* – domestic aviation with international aviation indicated as a memo item.
- 1A3b *Road transportation* – this includes the use of agricultural vehicles on paved roads as well as off-road and mobile machinery.
- 1A3c *Railways* – this includes both freight and passenger travel.
- 1A3d *Waterborne navigation* – this includes navigation bunkers as memo line items.
- 1A3e *Other Transportation* – this includes emissions from fuel combustion activities that support pipeline transportation in South Africa.

Emissions from military aviation and navigation have not been estimated and hence are not included in the inventory due to lack of data.

3.2.7.2 Methodological issues

Table 3.7 indicates the type of methods and emission factors used for all categories under the *Energy* sector, including at sub-category level.

The activities shown in Table 3.21 were indicated as key categories in the 1990-2024 inventory. To ensure that good practise was followed, changes in methodology were required for emissions from all fuels used in the *Transport* sector. The country-specific CO_2 emission factors indicated Table 3.12 were used .

Table 3.21: Methodological details for the *Transport* category.

1990-2024 Key category	1990-2024 inventory	
	Method	Emission Factor
1A3b Road transport (liquid, CO_2)	T2	CS
1A3d Waterborne navigation (liquid, CO_2)	T2	CS

3.2.7.2.1 Activity data

Table 3.22 shows the type and sources of activity data used to estimate emissions from 1A3 *Transport*.

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For the 1A3a sub-category the Fuel Consumption Study looked into estimating fuel consumption from all domestic, international, cargo, courier and other non-passenger flights, including non-scheduled flights. This was done by considering data from the Airports Company South Africa such as the record statement of air traffic movements.

For the 1A3b sub-category the Fuel Combustion Study used a VKT approach to estimate fuel consumption for the road transport sector. The VKT approach was used instead of the fuel based approach because the fuel based approach would not allow for the easy separation of fuels used for road transportation and fuels used for other purposes such as for backup power generation.

Additionally, it should be noted that the use of biofuels for road transportation is not included in the inventory because of the insignificance of these emissions. A study by the Water Research Commission from November 2015, shows that for 2014 a total annual capacity of 1 309 ML was licensed for operation, of which 384 ML were allocated to bioethanol and 925 ML were allocated to biodiesel. Total annual emissions from this capacity is 176 $GgCO_2e$ which is below 0.05 % of the total inventory (239 $GgCO_2e$). Noting that 0.05 % of the total inventory is lower than 500 Gg in this case.

For the 1A3d sub-category the Fuel Consumption Study considered the total number of containers transported along the South African coast as well as the ratio of domestic and international bound containers.

Table 3.22: Activity data used for 1A3 *Transport*

Sub-category	Activity Data	Source
1A3a *Civil aviation*	Fuel consumption	Fuel consumption study
1A3b *Road Transport*	VKT for Fuel consumption estimation	Fuel consumption study
1A3c *Railways*	Fuel consumption	SAPIA; SAGERS; and GHG Manual reporting
1A3d *Water-borne navigation*	Fuel consumption	Fuel consumption study
1A3e Other Transportation	Fuel consumption	SAGERS; Public information

Figure 3.19 shows the fuel consumption contribution per sub-category to the total Transport sector fuel consumption from 1990-2024. The majority of the fuel consumption is as a result of road transportation.

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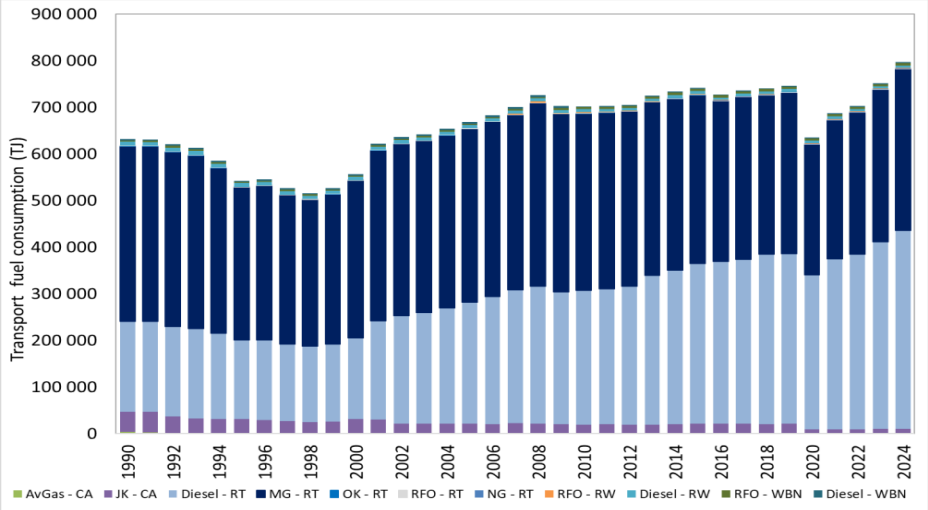


Figure 3.19: Fuel consumption for the *transport* sector (1A3), 1990-2024[14]

3.2.7.2.2 *Emission factors*

The emission factors used are shown in Table 3.12. Where a country-specific emission factor is available, it was used to estimate emissions from that fuel.

3.2.7.3 Uncertainty

The uncertainties for activity data and the emission factors used to estimate emission from the *Transport* sector is shown in Table 3.23.

Table 3.23: Uncertainty for South Africa's transport emission estimates

Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
	1A3a Civil aviation – liquid	5	IPCC 2006	1.5	IPCC 2006

[14] AvGas – aviation gasoline, JK – jet kerosene, MG – motor gasoline, OK – other kerosene, RFO – residual fuel oil, NG – natural gas, CA – civil aviation, RT – road transportation, RW- railways , WBN – waterborne navigation. Fuel consumption for international aviation and international bunkers are not included.

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Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CO_2	1A3b Road liquid	5	IPCC 2006	2	IPCC 2006
	1A3c Railways liquid	5	IPCC 2006	2	IPCC 2006
	1A3d Waterborne navigation – liquid	5	IPCC 2006	3	IPCC 2006
	1A3e Other Transportation - Gas	5	IPCC 2006	7	IPCC 2006
CH_4	1A3a Civil aviation – liquid	5	IPCC 2006	50	IPCC 2006
	1A3b Road liquid	5	IPCC 2006	9	IPCC 2006
	1A3c Railways – liquid	5	IPCC 2006	9	IPCC 2006
	1A3d Waterborne navigation – liquid	5	IPCC 2006	50	IPCC 2006
	1A3e Other Transportation - Gas	5	IPCC 2006	75	IPCC 2006
N_2O	1A3a Civil aviation – liquid	5	IPCC 2006	50	IPCC 2006
	1A3b Road liquid	5	IPCC 2006	72	IPCC 2006
	1A3c Railways - liquid	5	IPCC 2006	72	IPCC 2006
	1A3d Waterborne navigation – liquid	5	IPCC 2006	50	IPCC 2006
	1A3e Other Transportation - Gas	5	IPCC 2006	75	IPCC 2006

3.2.7.4 Time-series consistency

The time-series for all four sub-categories are complete and consistent.

3.2.7.5 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category. In addition to this the following category-specific checks are done:

- Comparison of Activity Data with other sources - DMRE data on fuels used in different transport sectors

3.2.7.6 Category-specific improvements and recalculations

Recalculations were performed for the *Transport* sector because of the following improvement:

- The use of country-specific emission factors for commonly used liquid and gas fuels. The emission factors result from a study that was completed in 2022. Emissions from the entire time-series were recalculated for the applicable *Fuel combustion* activities.

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3.2.7.7 Category-specific planned improvements

Improvements planned specifically for the *Transport* sector is as follows:

- Updating the VKT and fuel consumption studies.
- Updating the uncertainty values to incorporate uncertainty of the country-specific emission factors used.

3.2.8 Other sectors (CRT 1.A.4)

3.2.8.1 Category description

The *Other sectors* sub-category includes fuel combustion activities from the following industries:

- 1A4a *Commercial/Institutional* – includes all fuel combustion in commercial and institutional buildings.
- 1A4b *Residential* – includes all fuel combustion from households.
- 1A4c *Agriculture/Forestry/Fishing/Fish Farms* – this includes fuel combustion from agriculture, forestry, fishing and fish farms.

3.2.8.2 Methodological issues

Table 3.7 indicates the type of methods and emission factors used for all categories under the *Energy* sector, including at sub-category level.

Table 3.7 indicates the type of methods and emission factors used for all categories under the *Energy* sector, including at sub-category level. The methodology used to estimate GHG emissions in "other sectors," including Commercial/Institutional, Residential, and Agriculture/Forestry/Fishing/Fish farms is also shown in table 3.7. The methodology used for each sub-sector included T1 and T2 (default and country-specific) emission factors. Energy consumption data were reported for the Commercial/Institutional, Residential, and Agriculture/Forestry/Fishing/Fish farms sectors. Energy consumption in the Commercial/Institutional sector included other kerosene, gas/diesel oil, gas works gas, natural gas, sub-bituminous coal, and residual fuel oil, all sourced from the Energy Balance (DMRE). Residential sector consumption included coal, LPG, sub-bituminous coal, and other fuels, also from the Energy Balance (DMRE). Agriculture/Forestry/Fishing/Fish farms reported consumption of other kerosene, gas/diesel oil, and other fuels, as recorded in the Energy Balance (DMRE).

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For other sectors, Fuel consumption for the period 1990–1999 was estimated using GDP values sourced from the World Bank for the period 1990–2024. The average annual GDP growth rate was used to extrapolate consumption backwards.

The changes also included the adoption of Tier 2 (country-specific) CO_2 emission factors, with updates applied to natural gas in the commercial/institutional sector and to other bituminous coal in other sectors.

The activities shown in Table 3.24 were indicated as key categories in the 1990-2024 inventory. To ensure that good practise was followed, changes in methodology were required for the sub-sector key categories. Changes included the use of T2 (country-specific) emission factors for CO_2. The emission factors for some gaseous fuels (natural gas) used in the commercial/institutional sector were updated to country-specific emission factors (Tier 2). The emission factor for some solid fuels (other bituminous coal) used in other sectors was also updated to Tier 2.

Table 3.24: Methodological details for the *Other sectors* category

1990-2024 Key category	1990-2024 inventory	
	Method	Emission Factor
1A4a Other Sectors - Solid Fuels (CO_2)	T2	CS
1A4a Other Sectors - Liquid Fuels (CO_2)	T2	CS
1A4a Other Sectors - Gaseous Fuels (CO_2)	T2	CS

3.2.8.2.1 *Activity data*

Table 3.25 shows the type and sources of activity data used to estimate emissions from 1A4 *Other Sectors*.

Table 3.25: Activity data used for 1A4 *Other Sectors*

Sub-category	Activity Data	Source
1A4a *Commercial/Institutional*	Fuel consumption	Energy balance
1A4b *Residential*	Fuel consumption	Energy balance & Fuel consumption study
1A4c *Agriculture/Forestry/Fishing/Fish farms*	Fuel consumption	Fuel consumption study

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Figure 3.20 and Figure 3.21 show the fuel consumption trends for the 1A4 *Other sectors* sub-categories, since 1990.

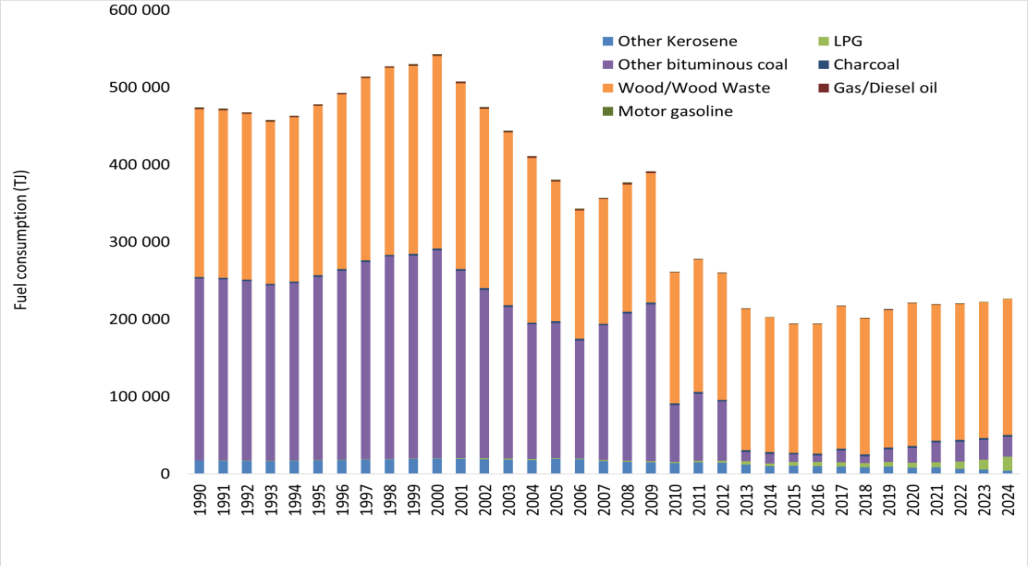


Figure 3.20: Fuel consumption for the 1A4b *residential* category, 1990-2024

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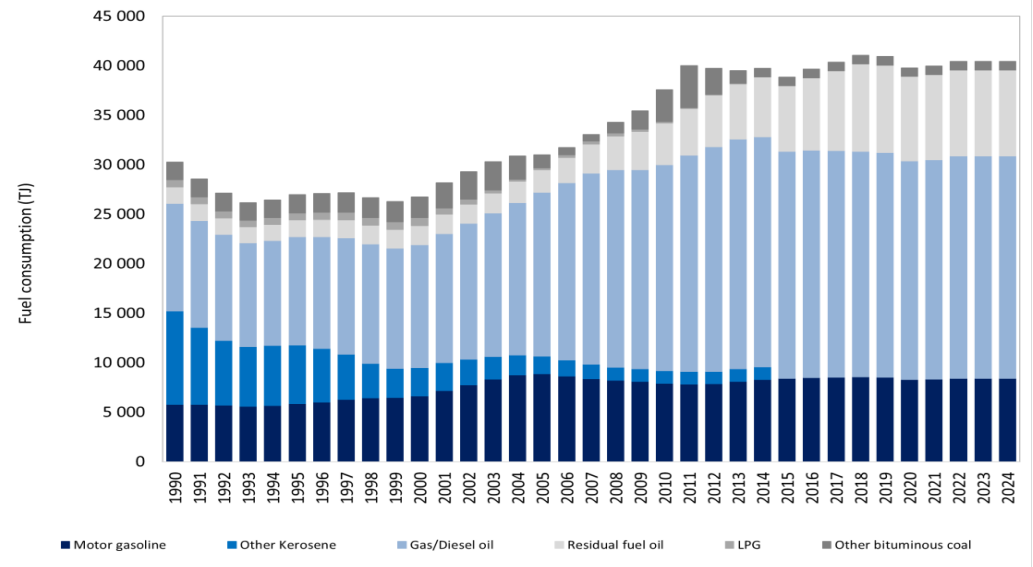


Figure 3.21: Fuel consumption for the 1A4c agriculture/forestry/fishing/fish farms category, 1990-2024

3.2.8.2.2 *Emission factors*

The emission factors used are shown in Table 3.12. Where a country-specific emission factor is available, it was used to estimate emissions from that fuel.

3.2.8.3 Uncertainty

The uncertainties for activity data and the emission factors used to estimate emission from *Other sectors* is shown in Table 3.26.

Table 3.26: Uncertainty for South Africa's *Other sectors* emission estimates

Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CO_2	1A4 Other sectors – liquid	10	IPCC 2006	7	IPCC 2006
	1A4 Other sectors – solid	10	IPCC 2006	7	IPCC 2006
	1A4 Other sectors – gaseous	10	IPCC 2006	7	IPCC 2006

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Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CH_4	1A4 Other sectors – liquid	10	IPCC 2006	75	IPCC 2006
	1A4 Other sectors – solid	10	IPCC 2006	75	IPCC 2006
	1A4 Other sectors – gaseous	10	IPCC 2006	75	IPCC 2006
N_2O	1A4 Other sectors – liquid	10	IPCC 2006	75	IPCC 2006
	1A4 Other sectors – solid	10	IPCC 2006	75	IPCC 2006
	1A4 Other sectors – gaseous	10	IPCC 2006	75	IPCC 2006

3.2.8.4 Time-series consistency

The time-series for 1A4 *Other sectors* is complete.

3.2.8.5 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category. In addition to this the following category-specific checks are done:

Comparison of Activity Data with other Sources:

- South Africa's GHG Reporting Programme
- StatsSA household statistics data

3.2.8.6 Category-specific recalculations

Recalculations were performed for *Other sectors* because of the following improvement:

- The use of country-specific emission factors for natural gas and other bituminous coal. The natural gas emission factor results from a study that was completed in 2022, while the other bituminous coal emission factor results from a study that was completed in 2024. Emissions from the entire time-series were recalculated for the applicable *Fuel combustion* activities.

3.2.8.7 Category-specific planned improvements

There are no category-specific improvements planned for *Other sectors.*

3.2.9 Other (CRT 1.A.5)

3.2.9.1 Category description

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The *Other* sub-category includes fuel combustion activities from the following industries, referred to as Non-Specified Sectors in previous inventories:

- 1A5a *Stationary* – includes all fuel combustion not allocated in the other Fuel Combustion activities.
- 1A5b *Mobile*– no emissions are estimated for this sub-category.

3.2.9.2 Methodological issues

Table 3.7 indicates the type of methods and emission factors used for all categories under the *Energy* sector, including at sub-category level. For the 1990–2024 inventory period, the only key category identified under the Other category was 1A5a stationary combustion, specifically solid fuels (CO_2) and liquid fuels (CO_2).

In the 1990-2024 inventory emissions from this key category were estimated using Tier T1 and T2 (default and country-specific) emission factors. The methodology included the adoption of Tier 2 (country-specific) CO_2 emission factors, with updates applied to natural gas and to other bituminous coal.

3.2.9.2.1 Activity data

Fuel consumption data for the *Other* category is taken from the energy balance. Figure 3.22 shows the fuel consumption trends for 1A5 *Other* since 1990.

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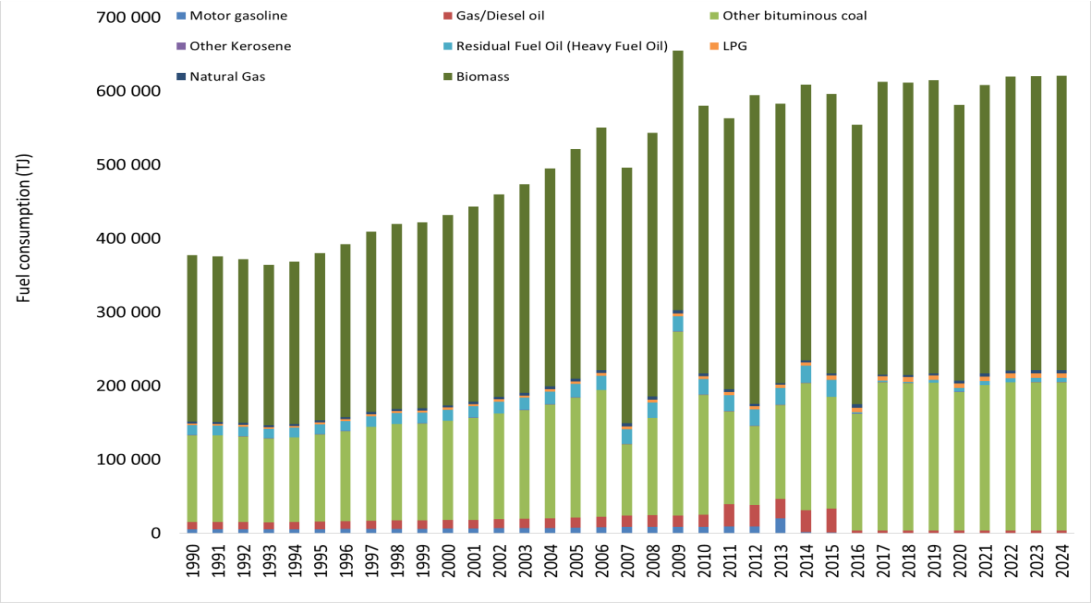


Figure 3.22: Fuel consumption for 1A5 *Other*, 1990-2024

3.2.9.2.2 Emission factors

The emission factors used are shown in Table 3.12. Where a country-specific emission factor is available, it was used to estimate emissions from that fuel.

3.2.9.3 Uncertainty

The uncertainties for activity data and the emission factors used to estimate emission from *Other* is shown in Table 3.27.

Table 3.27: Uncertainty for South Africa's *Non-specified sectors* emission estimates

Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CO_2	1A5 Other sectors – liquid	5	IPCC 2006	7	IPCC 2006
	1A5 Other sectors – solid	5	IPCC 2006	7	IPCC 2006
	1A5 Other sectors – gaseous	5	IPCC 2006	7	IPCC 2006

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Gas	Sectors	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CH_4	1A5 Other sectors – liquid	5	IPCC 2006	75	IPCC 2006
	1A5 Other sectors – solid	5	IPCC 2006	75	IPCC 2006
	1A5 Other sectors – gaseous	5	IPCC 2006	75	IPCC 2006
N_2O	1A5 Other sectors – liquid	5	IPCC 2006	75	IPCC 2006
	1A5 Other sectors – solid	5	IPCC 2006	75	IPCC 2006
	1A5 Other sectors – gaseous	5	IPCC 2006	75	IPCC 2006

3.2.9.4 Time-series consistency

The time-series is complete this category.

3.2.9.5 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category.

3.2.9.6 Category-specific recalculations

Recalculations were performed for *Non-specified sectors* because of the following improvement:

- The use of country-specific emission factors for natural gas and other bituminous coal. The natural gas emission factor results from a study that was completed in 2022, while the other bituminous coal emission factor results from a study that was completed in 2024. Emissions from the entire time-series were recalculated for the applicable *Fuel combustion* activities

3.2.9.7 Category-specific planned improvements

There are no category specific improvements planned for *Non-specified sectors.*

3.3 Fugitive emissions from fuels (CRT 1.B)

Fugitive emissions are intentional or unintentional releases of GHG's to the atmosphere during the extraction, processing, transformation and delivery of fossil fuels to the point of final use.

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3.3.1 Solid fuels (CRT 1.B.1)

3.3.1.1 Category description

The *Solid Fuels* sub-category includes fugitive emissions from the following activities:

- 1B1a *Coal mining and handling* – this includes emissions from stored gases during coal and surrounding strata breakage, as well as emissions from the processing, storage and transport of coal from surface and underground mines.
- 1B1c *Solid fuel transformation* – this includes all fugitive emissions associated with the manufacture of charcoal and coke.

This sub-category does not include emissions from abandoned mines or uncontrolled combustion and burning coal dumps.

3.3.1.2 Methodological issues

Table 3.7 indicates the type of methods and emission factors used for all categories under the *Energy* sector, including at sub-category level. The only key category identified for the 1B1 *Solid fuels* sector in the 1990-2024 inventory was 1B1a Coal mining and handling (CH_4).

In the 1990-2024 inventory emissions from this key category were estimated using Tier 2 and country-specific emission factors. Hence, no change in the methodology was required for the 1990-2024 to ensure good practise was implemented.

3.3.1.2.1 Activity data

Table 3.28 shows the type and sources of activity data used to estimate emissions from 1B1 *Solid fuels*.

Table 3.28: Activity data used for 1B1 *Solid Fuels*

Sub-category	Activity Data	Source
1B1a *Undergound and surface mines*	Amount of coal produced from both underground and surface mines	SAMI and Minerals Council SA
1B1c *Solid fuel transformation - charcoal*	Amount of charcoal produced	FAO
1B1c *Solid fuel transformation - coke*	Amount of coke produced Amount of iron produced locally	SAGERS : Manual Reporting and Minerals Council SA

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Table 3.29 shows the production figures for coal (from surface and underground mines) and charcoal since 1990.

Table 3.29: Amount of coal and charcoal produced, 1990-2024[15,16]

	Surface	Underground	Charcoal	Coke
	Amount produced (tonnes)			
1990	139 841 736	83 905 041	13 000	2 674 171
1991	142 630 994	85 578 596	13 000	2 973 160
1992	141 756 654	85 053 992	25 000	2 709 065
1993	147 025 874	88 215 524	35 000	2 554 432
1994	157 008 861	94 205 316	20 000	2 611 792
1995	164 349 645	98 609 786	26 000	2 716 713
1996	163 835 750	98 301 450	26 000	2 551 325
1997	175 241 338	105 144 803	26 000	2 757 343
1998	178 851 390	107 310833	41 000	2 887 120
1999	177 642 178	106 585 307	41 000	2 306 350
2000	174 918 853	106 308 704	41 000	2 451 940
2001	179 330 802	108 990 110	41 000	2 547 566
2002	189 951 547	115 444 975	41 000	2 646 801
2003	191 768 929	116 549 508	200 600	2 891 467
2004	193 506 539	117 605 558	127 300	2 975 656
2005	193 348 574	117 509 553	188 900	2 874 759
2006	195 639 060	118 901 619	188 900	2 881 078
2007	199 587 383	121 301 252	188 900	2 970 030
2008	196 569 036	119 466 821	188 900	2 694 892
2009	175 784 200	141 515 800	188 900	2 003 359
2010	184 150 000	133 350 000	188 900	2 528 025
2011	195 727 800	120 472 200	188 900	2 356 492
2012	211 200 000	118 800 000	188 900	2 009 041
2013	204 681 600	126 518 400	188 900	2 225 078
2014	213 399 640	124 900 360	188 900	2 291 173
2015	207 716 400	116 283 600	188 900	1 798 356
2016	207 415 000	111 685 000	188 900	1 474 697
2017	212 733 600	116 066 400	209 783	1 718 018
2018	227 288 282	105 101 718	295 500	1 681 607

[15] Coal production data calculated based on information published in the SAMI Annual reports and Minerals Council SA Facts & Figures reports.
[16] Charcoal data from the FAO

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	Surface	Underground	Charcoal	Coke
	Amount produced (tonnes)			
2019	234 234 200	99 765 800	223 195	1 813 063
2020	217 240 013	103 472 569	231 779	1 433 006
2021	200 219 454	95 365 587	220 334	1 597 100
2022	197 015 943	93 839 738	220 334	1 504 969
2023	204 477 266	97 393 606	223 195	1 502 202
2024	206 630 588	98 419 244	220 334	1 508 354

3.3.1.2.2 Emission factors

1B1a coal mining and handling

Country-specific emission factors are available for CO_2 and CH_4 for surface and underground mining in South Africa (Table 3.30). The local study on emissions from coal mines indicated that the IPCC approach and hence the default methane emission factors from coal mining overstated emissions from South African coal since South African coal is not saturated in methane and the gas content of the mine air is significantly less than expected. The country-specific emission factors were developed on *in situ* gas contents and were supported by measurements of methane concentrations in mine ventilation and residual gas contents. The study considered underground mines with a typical depth, covering a range of *in situ* methane concentrations in coal typical of the whole industry.[17]

Table 3.30: Country-specific emission factors for coal mining and handling

Mining method	Activity	GHG	Emission factor (m^3 $tonne^{-1}$)	
			South African EF	IPCC default
Underground mining	Coal mining	CH_4	0.77	18
	Post-mining (handling and transport)		0.18	2.5
Surface mining	Coal mining		0	1.2
	Post-mining (storage and transport)		0	0.1
Underground mining	Coal mining	CO_2	0.077	NA
	Post-mining (handling and transport)		0.018	NA
Surface mining	Coal mining		0	NA
	Post-mining (storage and transport)		0	NA

[17] Methane release from South African Coal Mines Lloyd and Cook

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1B1c solid fuel transformation

Emissions from charcoal and coke production were estimated using Tier 1 and the IPCC default emission factors shown in Table 3.31, with the exception of CO_2 emissions from coke production that are based on measurements.

Table 3.31: Tier 1 emission factors for charcoal and coke production

Activity	GHG	Emission factors (kg/tonne)	Source
Charcoal production	CO_2	1 570	IPCC 2019 Refinement
	CH_4	40.3	IPCC 2019 Refinement
	N_2O	0.08	IPCC 2019 Refinement
	CO	220	IPCC 2019 Refinement
Coke production	CH_4	0.049	IPCC 2019 Refinement

3.3.1.3 *Uncertainty*

The uncertainties for activity data and the emission factors used to estimate emission from *Solid Fuels* is shown in Table 3.32.

Table 3.32: Uncertainty for 1B1 *Solid fuels* category

Gas	Sub-category	Activity data uncertainty		Emission factor uncertainty	
		%	Source	%	Source
CO_2	1B1ai1 Mining	10	IPCC 2006	63	IPCC 2006
	1B1ai2 Post-mining seam gas emissions	10	IPCC 2006	50	IPCC 2006
	1B1ci Charcoal production	10	IPCC 2006	63	IPCC 2006
CH_4	1B1ai1 Mining	10	IPCC 2006	63	IPCC 2006
	1B1ai2 Post-mining seam gas emissions	10	IPCC 2006	50	IPCC 2006
	1B1ci Charcoal production	10	IPCC 2006	63	IPCC 2006
	1B1cii Coke production	10	IPCC 2006	63	IPCC 2006
N_2O	1B1ci Charcoal production	10	IPCC 2006	63	IPCC 2006
CO	1B1ci Charcoal production	10	IPCC 2006	63	IPCC 2006

3.3.1.4 *Time-series consistency*

The time-series is complete for coal, charcoal and coke production.

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3.3.1.5 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category. In addition to this the following category-specific checks are done:

Comparison of Activity Data with other Sources:

- For 1B1a Coal Mining:
  - Coal production data and splits from the Minerals Council of South Africa
  - Coal production statistics from DMRE and Mineral Council of South Africa.
- For 1B1ci Coke Production:
  - Iron ore production changes data from Mineral Council of South Africa.
  - Iron ore production data from the Minerals Council of South Africa

3.3.1.6 Category-specific recalculations

No category specific recalculations were conducted for coal mining. The improvement for this sector was the inclusion of emissions from charcoal and coke production.

3.3.1.7 Category-specific planned improvements

Improvements planned for the *1B1 Solid fuels* sector are as follows:

- Including emissions from abandoned mines and spontaneous combustion.

3.3.2 Oil and natural gas and other emissions from energy production (CRT 1.B.2)

3.3.2.1 Category description

The *Oil and natural gas* sub-category include fugitive emissions from the following activities:

- 1B2a *Oil* – this includes fugitive emissions from venting, flaring and all other sources associated with the exploration, production, transmission, upgrading and refining of crude oil and the distribution of crude oil products.
- 1B2b *Natural gas* – this includes fugitive emissions from venting, flaring and all other sources associated with the exploration, production, processing, transmission, storage, upgrading and the distribution of natural gas.

3.3.2.2 Methodological issues

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No 1B2 activities were indicated as key categories in the 1990-2020 inventory.

3.3.2.2.1 *Activity data*

Emissions from this category are based on direct measurements, mass balance approaches and the use of Tier 1 default emission factors from the relevant companies. Prior to the implementation of South Africa's GHG Reporting Programme, consolidated emissions were estimated for oil and natural gas companies. The emissions reported cover flaring, venting, production, processing, upgrading, refining, transport, transmission, storage and distribution activities for oil and natural gas.

3.3.2.2.2 *Emission factors*

Emissions from this category are based on direct measurements and mass balance approaches of the relevant companies. Hence, no activity data or emission factors were used to estimate emissions.

3.3.2.3 Uncertainty

The uncertainty of the emission estimates (Table 3.33) is based on the assumption of a normal distribution of the emission estimates.

Table 3.33: Uncertainty for 1B2 *Oil and natural gas* category

Gas	Sub-category	Emissions uncertainty	
		%	Source
CO_2	1B2 Oil & natural gas	65	GHG reporting Programme
CH_4		0.005	GHG reporting Programme
N_2O		0.02	GHG reporting Programme

3.3.2.4 Time-series consistency

The time-series is complete for 1B2a *Oil*, however the time-series is not consistent as emissions estimates are sourced from SAGERS from 2019 onwards.

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For 1B2b *Natural gas* the time-series is not complete as emissions only from 2019 onwards from SAGERS are included in the inventory.

3.3.2.5 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category. In addition to this Energy Balance data on production, imports and exports is used as a check.

3.3.2.6 Category-specific recalculations

No category specific recalculations were conducted for the 1B2 *Oil and natural gas* sector. The improvement for this sector was the inclusion of emissions from natural gas activities from 2019.

3.3.2.7 Category-specific planned improvements

An improvement planned for the *Oil and natural gas* sector is ensuring time-series completeness for fugitive emissions from natural gas

3.3.3 Other emissions from energy production (1.B.3)

3.3.3.1 Category description

The *Other emissions from energy production* sub-category includes fugitive emissions from the following activities:

- 1B3 *Other emissions from energy production* – this includes other fugitive emissions from energy production not included in 1B2 *Oil and natural gas*, such as emissions from coal to liquid and gas to liquid activities.

3.3.3.2 Methodological issues

Carbon dioxide from *Other emissions from energy production* was indicated as a key category in the 1990-2024 inventory. Emissions from this sector were already based on direct measurements, hence, no methodological changes were required for the 1990-2024 inventory to ensure alignment with good practise.

3.3.3.2.1 Activity data

Emissions from this category are based on direct measurements from the relevant producers. Hence, no activity data or emission factors were used to estimate emissions.

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3.3.3.2.2 *Emission factors*

Emissions from this category are based on direct measurements from the relevant producers. Hence, no activity data or emission factors were used to estimate emissions.

3.3.3.3 Uncertainty

The uncertainty of the emission estimates (Table 3.34) is based on the assumption of a normal distribution of the emission estimates.

Table 3.34: Uncertainty for 1B3 *Other emissions from energy production* category

Gas	Sub-category	Emissions uncertainty	
		%	Source
CO_2	1B3 *Other emissions from energy production*	0.001	GHG reporting Programme
CH_4		0.001	GHG reporting Programme

3.3.3.4 Time-series consistency

The times-series of emissions from 1B3 *Other emissions from energy production* is complete and consistent.

3.3.3.5 Category specific QA/QC and verification

The QA/QC measures indicated in Table 3.9 were used for this category as well as the GHG Emissions Verification Programme.

3.3.3.6 Category-specific recalculations

No category specific recalculations were conducted for the 1B3 *Other emissions from energy production* sector.

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3.3.3.7 Category-specific planned improvements

There are no category-specific improvements planned for the 1B3 *Other emissions from energy production* sector.

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3.4 Chapter 3 References

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Chapter 4: Industrial Processes and Product Use (IPPU) (CRT sector 2)

4.1 Sector overview

The IPPU sector includes non-energy related emissions from industrial processing plants. The main emission sources are released from industrial processes that chemically or physically transform raw materials and thereby release GHGs, (e.g., ammonia products manufactured from fossil fuels), GHG emissions released during these processes are CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Table 4.1 shows the industrial processes included in South Africa's IPPU sector.

Table 4.1: Industrial processes included in South Africa's IPPU sector emission estimates

IPPU Category	Industrial Process / Product Use
Mineral Industry	Cement Production
	Lime Production
	Glass Production
	Soda Ash Production
	Other Product Uses of Carbonates
Chemical Industry	Ammonia Production
	Nitric Acid Production
	Hydrogen Production
	Titanium Dioxide Production
	Other Chemicals Production
Metal Industry	Ferroalloys Production
	Production of Steel from Iron and Scrap Steel
	Aluminium Production
	Lead Production
	Zinc Production
	Vanadium Production
	Carbide Production
Petroleum & Petrochemical Industry	Petrochemical and Carbon Black Production
	Paraffin Wax Use
	Lubricant Use
Product Uses as Substitutes for ODSs	Use of HFCs, PFCs, SF6 etc. in refrigeration, air conditioning, foam blowing, fire protection, aerosols

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HFCs and PFCs are used in many products and in refrigeration and air conditioning equipment. PFCs are also emitted because of anode effects in aluminium smelting. Therefore, the IPPU sector includes estimates of PFCs from aluminium production, and HFCs from refrigeration and air conditioning. SF_6 is also included in IPPU due to the use of electrical equipment.

The estimation of GHG emissions from non-energy sources is often difficult because they are widespread and diverse. The difficulties in the allocation of GHG emissions between fuel combustion and industrial processes arise when by-product fuels or waste gases are transferred from the manufacturing site and combusted elsewhere in different activities.

The performance of the economy is the key driver for trends in the IPPU sector. The South African economy is related to the global economy, mainly through exports and imports. South Africa officially entered an economic recession in May 2009, which was the first in 17 years. Until the global economic recession affected South Africa in late 2008, economic growth had been stable and consistent.

As a result of the recession, GHG emissions during that period decreased across almost all categories in the IPPU sector. Since then, GDP annual growth has slowed compared to growth before the recession. The Covid 19 pandemic caused economic growth to decline during 2020, especially during the second half of the year when lockdown measures where stricter. During 2021 and 2022 economic growth recovered to pre-covid figures.

During 2022 South Africa moved away from Tier 1 reporting towards Tier 2 and Tier 3 calculations. In certain sectors, this made quite a difference. The Metal Industry was affected most, but the accuracy has improved. The 2023 and 2024 Verification programmes also enhanced accuracy of Tier 3 reporting. Due to these changes, comparison with historical figures is compromised in the short term.

The largest source of emissions in the IPPU sector in South Africa is the production of ferroalloys, iron and steel followed by 2.F.1 - Refrigeration and Air Conditioning.

4.1.1 Shares and trends in emissions

In 2024 the IPPU sector produced 30 372 Gg CO_2e which is 6.4% of South Africa's emission (excl. LULUCF).

The IPPU sector produces CO_2 emissions (75.8%), fluorinated gases 22.7% (Table 4.2). Carbon dioxide and any other emissions from combustion of fuels in these industries are reported under the Energy sector.

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The largest source category is the *ferroalloy* category. which contributes 52.6% to the total IPPU sector emissions. The *Mineral industry* and the *Product used as substitutes for ozone depleting substances* subsectors contribute 16.4% and 22.9%, respectively, to the IPPU sector emissions

A summary table of all emissions from the IPPU sector by gas is provided in Annex VI.

Table 4.2: Summary of the estimated emissions from the IPPU sector in 2024

GHG source categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	Gg CO_2e						
2.IPPU	**23 030**	**119**	**340**	**6 685**	**113**	**85**	**30 372**
2.A Mineral industry	4 956	NO	NO	NO	NO	NO	4 956
2.B Chemical industry	1 291	119	340	NE	NE	NE	1 750
2.C Metal industry	15 605	0	NO	NO	113	NO	15 718
2.D Non-energy products from fuels and solvents	1 178	NE	NE	NO	NO	NO	1 178
2.E Electronic industry	NE	NE	NE	NE	NE	NE	NE
2.F Product uses as substitute ODS	NO	NO	NO	6 685	NE	NO	6 685
2.G Other product manufacture and use	NE	NE	NE	NE	NE	85	85
2.H Other	NE	NE	NE	NE	NE	NE	NE

Numbers may not sum exactly due to rounding off.

Even though the South African economy recovered after the COVID-19 pandemic, estimated emissions from the IPPU sector are 2 411 Gg CO_2e (7.4%) lower than the emissions in 2000. The decline can be attributed to the decline in metals production (61.0%), specifically *Iron and Steel production* and *Aluminium production*. This can be ascribed to a deteriorating economy. The decline in the chemicals industry also made a huge difference (31.4%).

Figure 4.1 shows that IPPU emissions increased by 18.0% between 2000 and 2006, after which there was a 13.6% decline to 2009. This decrease was mainly due to the global economic recession and the electricity crisis that occurred in South Africa during this period. From 2010 emissions increased due to an increase in the *metal industry* and *products used as substitutes for ozone depleting substances* subsectors. The economy was also beginning to recover from the global recession.

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Emissions decreased from 2016 as demand for South African chemical and metals dropped. COVID-19 also had a major local and international impact between 2020 and 2021.

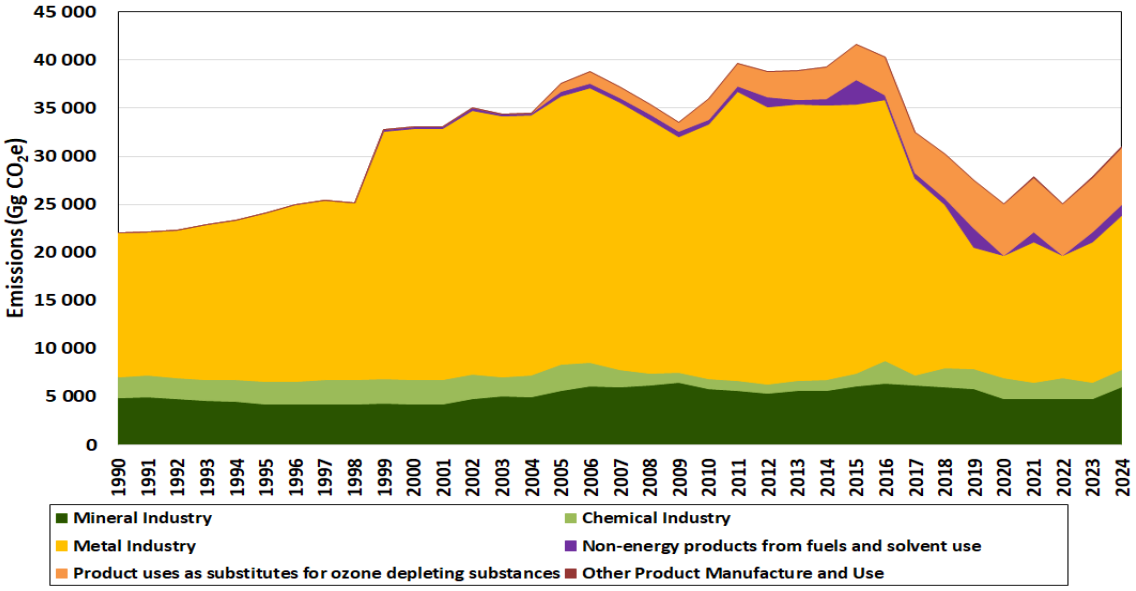


Figure 4.1: Trend in South Africa's IPPU sector emissions, 1990-2024

4.1.1.1 Mineral industry

In 2024 the mineral industries produced 4 898 Gg CO_2, which is 16.4% of the IPPU sector emissions. Cement production accounted for 78.5% of emissions from the Mineral industry. All the emissions in this category were CO_2 emissions.

The emissions for the mineral industry were 1.5% (77.2 Gg CO_2) higher than the 4 826 Gg CO_2 in 1990. There was a 49.9% increase in the *Mineral industry* emissions between 2000 and 2009, after which emissions declined by 17.3% in 2012 Figure 4.2. The increase between 2000 and 2009 was due to increased emissions from *cement* and *lime production* because of economic growth during this period. In 2009 the South African economy went into recession and the GDP decreased by 1.8% in that year.

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Cement demand in the residential market and construction industry in 2009/2010 decreased due to higher interest rates, increased inflation, and the introduction of the National Credit Act (DMR, 2010). *Other process uses of carbonates* was included in the category from the 2018 inventory. Emissions declined between 2019 and 2020 mainly due to the COVID-19 pandemic and the stringent lockdown regulations within South Africa during 2020. The market did recover after this.

Cement production is the largest contributor to the emissions from this category (Figure 4.2).

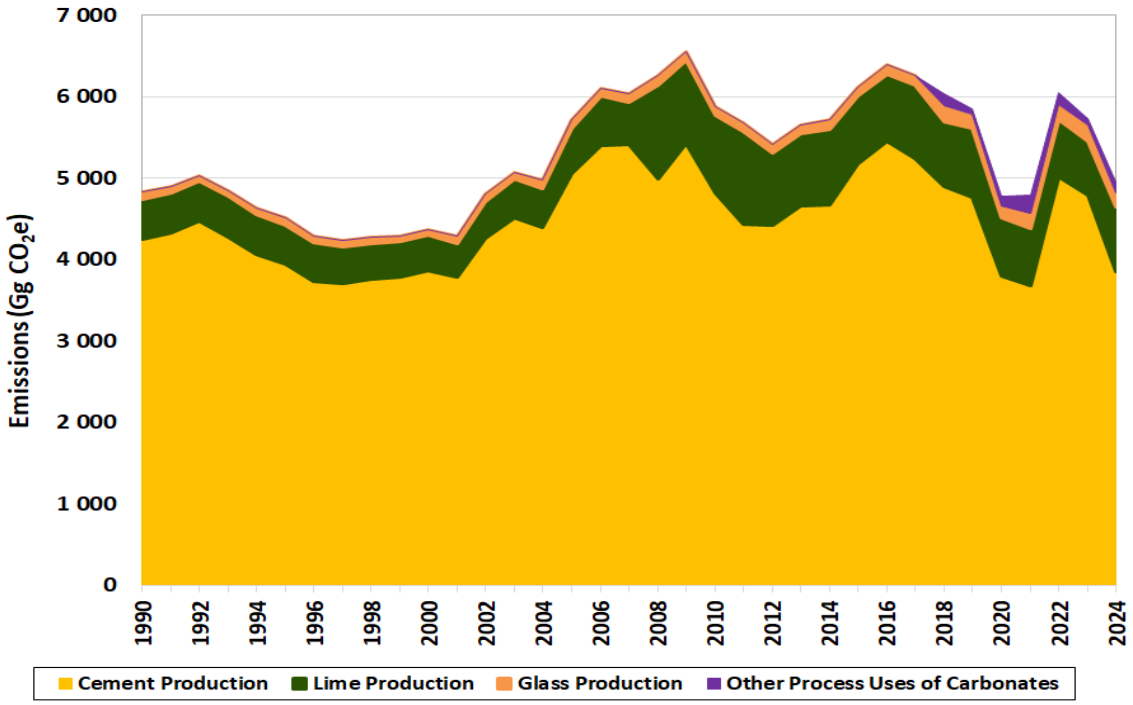


Figure 4.2: Category contribution and trend for the mineral subsector, 1990-2024

4.1.1.1.1 Cement production

Cement production was estimated to produce 13% of the IPPU sector emissions. Emissions were 0,9% above the 1990 level but fluctuate with economic conditions.

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4.1.1.1.2 Lime production

Lime production was estimated to produce 2.7% of the IPPU sector emissions. Emissions were 63% above the 1990 level. The fluctuations in *Lime production* were directly linked to developments and investments in the steel and metallurgical industries. It should however be noted that there is an inconsistency in the time series with the data prior to 2008. Only pyrometallurgical quicklime and hydrated lime (only included lime for water purification) were included.

The production data prior to 2008 is therefore much lower than the data for the later years. This means that the change from 2000 to 2020 is not only an increase due to emissions but also due to a change in the activity data. Emissions for 2018 and 2019 were extrapolated for quicklime due to a lack of activity data received. The 2019 inventory included the addition of dolomitic lime to the calculation, as previously this type of lime was not reported.

4.1.1.1.3 Glass production

Glass production was estimated to produce 0.6% of the IPPU sector emissions. Emissions were 109% above the 1990 level. Emissions increased steady until 2018 from when it stabilised.

4.1.1.1.4 Other Process Uses of Carbonates (OPUC)

Emissions from the *Other Process Uses of Carbonates* (*OPUC)* were only reported from the 2018 inventory due to a lack in activity data and emissions. No magnesia production occurs in South Africa. *OPUC* emissions were estimated to produce 0.5% of the IPPU sector emissions the main contributor is the Brick manufacturing activities.

4.1.1.2 Chemical industry

The *Chemical industries* were estimated to produce 1 720 Gg CO_2e in 2024, which is 5.8% of the IPPU sector emissions. The largest contributions are from *Titanium dioxide production*, *Nitric acid production and Ammonia production*.

Emissions from the *Chemical industries* decreased by 482 Gg CO_2e (22.6%) since 1990 (2 232 Gg CO_2e). Emissions from this subsector fluctuated considerably over the 30-year period (Figure 4.1) due to the nature of the business. Between 2000 and 2006 emissions fluctuated between 2 169 Gg CO_2e and 2 974 Gg CO_2e (Figure 4.1) then there was a decline of 55.4% between 2006 and 2008, largely due to N_2O emission reductions in

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Nitric acid production. *Hydrogen production* was included since 2018, while *Silicon carbide* and *Soda ash production* since 2019 and *Other chemicals* since 2020.

4.1.1.3 Metal industry

The *Metal industry* was estimated to produce 15 178 Gg CO_2e in 2024, which is 53% of the IPPU sector emissions. The largest contribution to the *Metal industries* comes from *Ferroalloy production* (6 942 Gg CO_2e or 44.2%), followed by *Iron and steel production* (6 942 Gg CO_2e or 44%).

Emissions from the *Metal industry* increased by 1 534Gg CO_2e (11%) above the 1990 emissions of 14 184 Gg CO_2e. Figure 4.3 shows that emissions from the *Metal industries* increased slowly (11.2%) between 2000 and 2006, mainly due to *Ferrometals production*. A sharp decline in production and related emissions from 2016 can be attributed to increased input cost, energy supply challenges and low-cost international alternatives in the *Iron and steel* and *Ferrometals* sectors. *Zinc production* was minimal for 2024. Various entities used the COVID-19 period to stop production in favour of major maintenance after which production increased again.

Aluminium production emissions more than doubled between 2010 and 2011 due to increased PFC emissions (Figure 4.3). In 2000 almost half (47.4%) of the *Aluminium production* emissions were PFC emissions. This rose to 65.0% in 2011 and 2012 due to the closure of the Soderberg and Side-Worked Pre-Bake processes in 2009. The aluminium plants released large amounts of C_2F_4 and CF_4 during 2011 and 2012 due to inefficient operations (switching on and off at short notice) as they were used to control the South African electricity grid. PFCs emissions afterwards stabilised to a point where it is currently (2024) contributing 8.97%.

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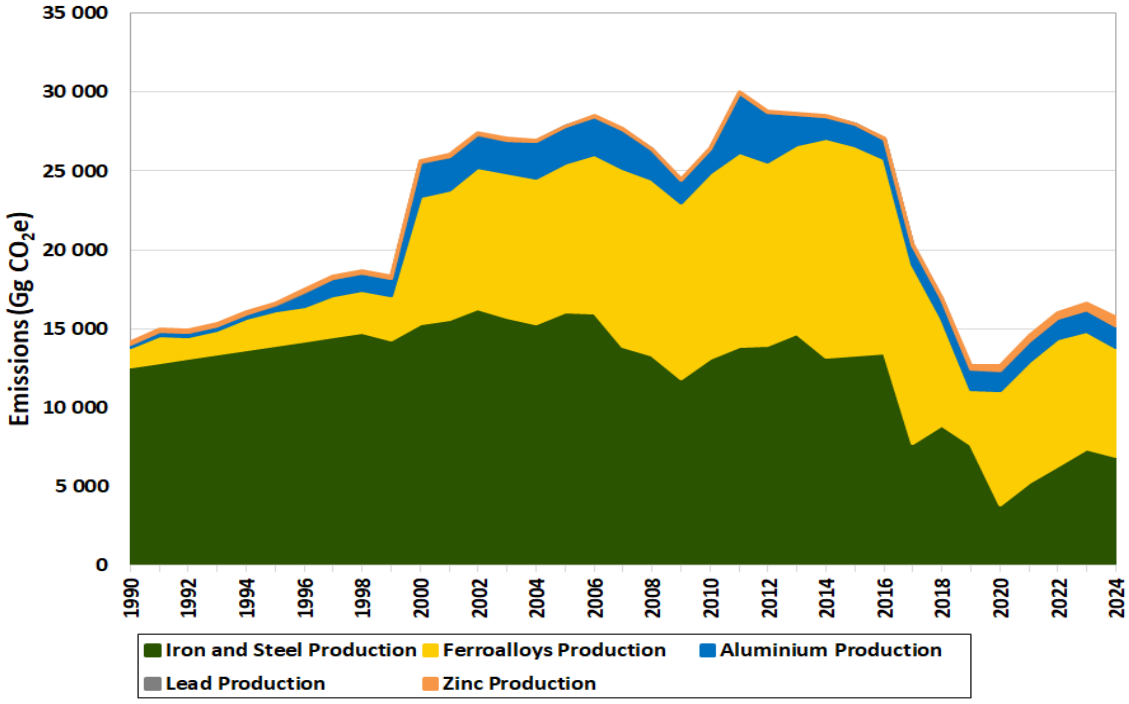


Figure 4.3: Trend and category contribution to emissions from the metal industries, 1990-2024

4.1.1.4 Non-energy products from fuels and solvents

The *Non-energy products from fuels and solvent use* were estimated to produce 1 178 Gg CO_2e in 2024, which is 3.9% of the IPPU sector emissions.

Emissions from the *Non-energy products from fuels and solvent use* category were 501% higher than the 2000 level of 196 Gg CO_2e. Emissions increased steadily from 2000 to 2015 to 2 495 Gg CO_2e as usage of lubricant wax increased. A sharp increase in paraffin wax usage was seen in 2015 which contributed largely to the steep increase in emissions (Figure 4.4). Emissions dropped from 2015 to 2018 to 639 Gg CO_2e as consumption of both lubricants and paraffin wax decreased. 2020 saw a steep decrease in the use of lubricants and paraffin wax, which is most probably ascribed to COVID-19. No information for 2021 and 2022 is available and extrapolation was done.

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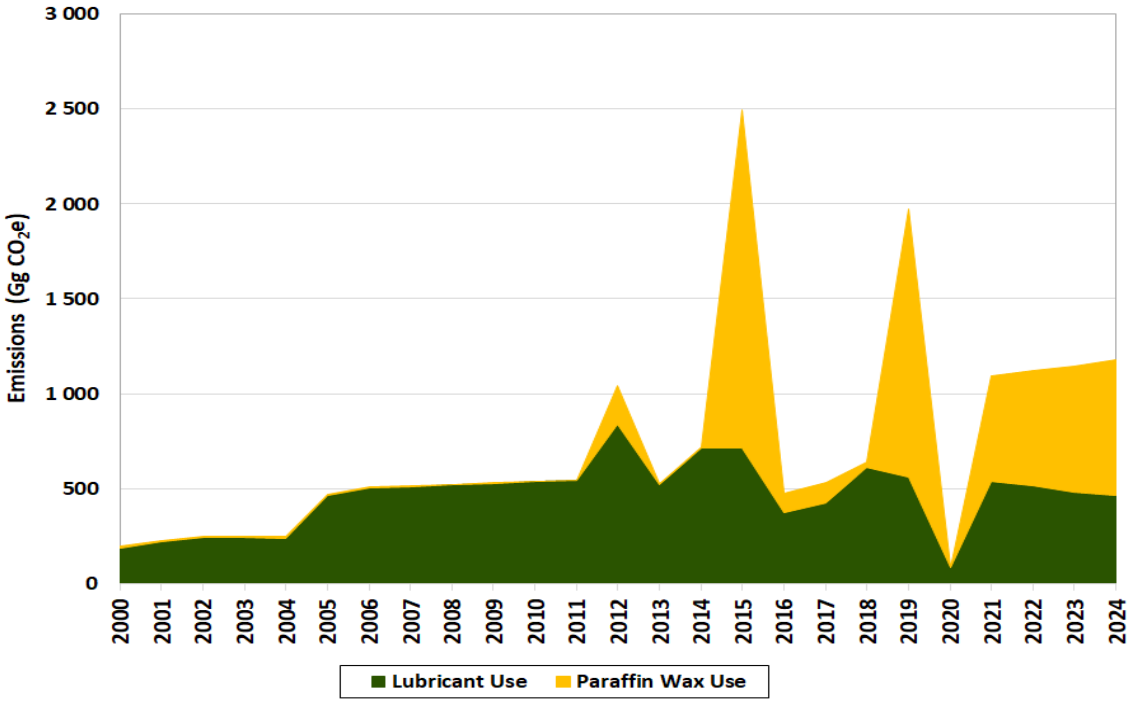


Figure 4.4: Trend and category contribution in the emissions from non-energy products from fuels and solvents, 2000-2024

4.1.1.5 Products used as substitutes ODS

The *Products used as substitutes for ODSs* category was estimated to produce 6 685 Gg CO_2e in 2024, which is 22,4% of the IPPU sector emissions. The largest contribution comes from *Refrigeration and air conditioning* (6 577 Gg CO_2e or 98.4%).

Emissions were only estimated from 2005 when emissions were estimated at 842 Gg CO_2e in 2005. In 2010 emissions more than doubled (Figure 4.5) due to an increase in the *Refrigeration and stationary air conditioning* emissions. In 2011 emissions from *Mobile air conditioning*, *Foam blowing agents*, *Fire protection* and *Aerosols* were added, therefore the emissions for this subcategory increased to 2 853 Gg CO_2e in 2013. Recalculations were not done for the years prior to 2011 due to a lack of data. *Refrigeration and air conditioning* as well as *Fire protection* has been extrapolated since 2016. Emissions from foam blowing agents and aerosols have not changed since 2015.

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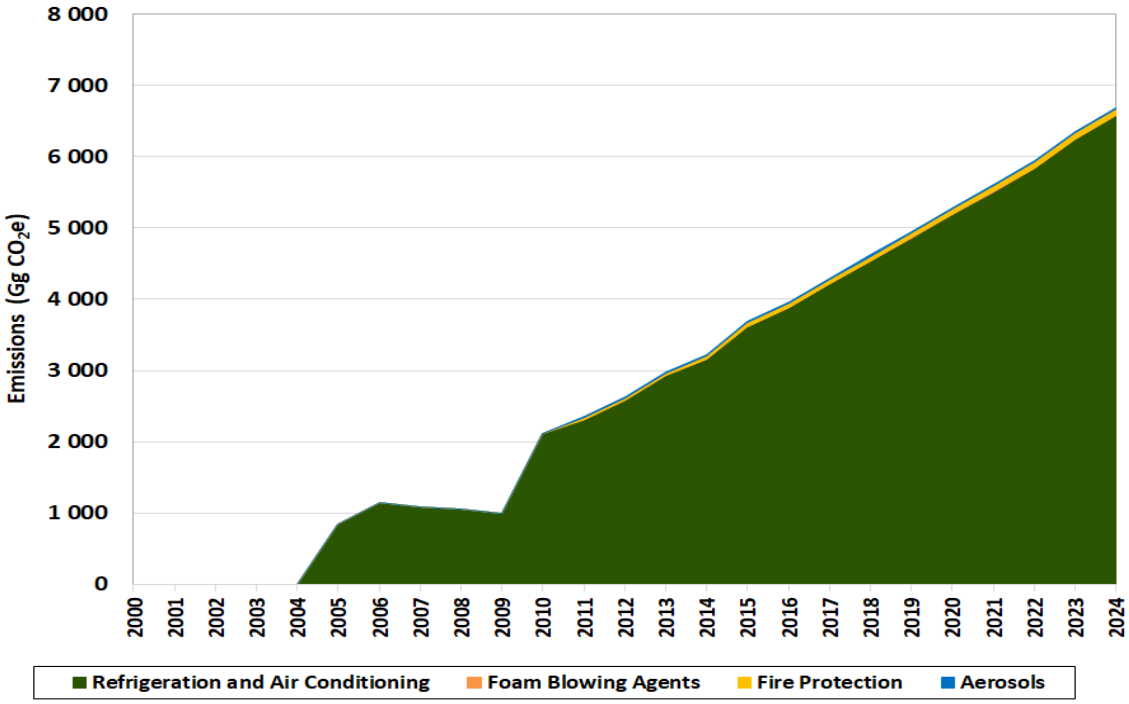


Figure 4.5: Trend and category contribution to the product uses as substitutes for ODS emissions, 2000-2024

4.1.2 Overview of methodology and completeness

Table 4.3 provides a summary of the methods and emission factors applied to each subsector of IPPU.

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Table 4.3: Summary of methods and emission factors for the IPPU sector and an assessment of the completeness of the IPPU sector emissions

GHG Source and sink category		CO_2		CH_4		N_2O		HFCs		PFCs		SF6		NOx	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method Applied	Emission Factor				
A	**Mineral industry**																
1	*Cement production*	T2 & T3	CS	NE										NE	NE	NE	NE
2	*Lime production*	T3	CS	NE										NE	NE	NE	NE
3	*Glass production*	T3	CS	NE										NE	NE	NE	NE
4	*Other process uses of carbonates*	T3	CS	NE										NE	NE	NE	NE
B	**Chemical industry**																
1	*Ammonia production*	T3	CS	T3	CS	NE								NE	NE	NE	NE
2	*Nitric acid production*	NE		NE		T3	CS							NE	NE	NE	NE
3	*Adipic acid production*	NO		NO		NO								NO	NO	NO	NO
4	*Caprolactam, glyoxal and glyoxylic acid production*	NO		NO		NO								NO	NO	NO	NO
5	*Carbide production*	T3	CS	T1	DF	NE								NE	NE	NE	NE
6	*Titanium dioxide production*	T3	CS	NE		NE								NE	NE	NE	NE
7	*Soda Ash production*	T3	CS	NE		NE								NE	NE	NE	NE
8a	*Methanol*	IE		IE		IE								NE	NE	NE	NE
8b	*Ethylene*	IE		IE		IE								NE	NE	NE	NE

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8c	*Ethylene Dichloride and Vinyl Chloride Monomer*	NO		NO		NO								NO	NO	NO	NO
8d	*Ethylene Oxide*	IE		IE		IE								NE	NE	NE	NE
8e	*Acrylontrile*	NO		NO		NO								NO	NO	NO	NO
8f	*Petrochemical and carbon black production*	T1	DF	T1	DF	NE								NE	NE	NE	NE
8g	*Hydrogen Production*	T3	CS	NE		NE								NE	NE	NE	NE
9	*Fluorochemical production*							NO		NO		NO		NO	NO	NO	NO
11	*Other*	T2	CS	T2	CS	NE		NE		NE		NE		NE	NE	NE	NE
C	**Metal industry**																
1	*Iron and steel production*	T3	CS	NE		NE								NE	NE	NE	NE
2	*Ferroalloy production*	T3	CS	T3	CS	NE								NE	NE	NE	NE
3	*Aluminium production*	T3	CS	NE						T3	CS			NE	NE	NE	NE
4	*Magnesium production*	NO						NO		NO		NO		NO	NO	NO	NO
5	*Lead production*	T1	DF											NE	NE	NE	NE
6	*Zinc production*	T1	DF											NE	NE	NE	NE
D	**Non-energy products from fuels and solvents**																
1	*Lubricant use*	T1	DF											NE	NE	NE	NE
2	*Paraffin wax use*	T1	DF	NE		NE								NE	NE	NE	NE
3	*Solvent use*													NE	NE	NE	NE
E	**Electronics industry**																
1	*Integrated circuit or semiconductor*	NE				NE		NE		NE		NE		NE	NE	NE	NE
2	*TFT flat panel display*							NE		NE		NE		NE	NE	NE	NE
3	*Photovoltaics*							NE		NE		NE		NE	NE	NE	NE

4	*Heat transfer fluid*													NE	NE	NE	NE
F	**Product uses as substitute ODS**																
1	*Refrigeration and air conditioning*	NE					T2a, T2b	DF	NE					NE	NE	NE	NE
2	*Foam blowing agents*	NE					T1	DF	NE					NE	NE	NE	NE
3	*Fire protection*	NE					T1	DF	NE					NE	NE	NE	NE
4	*Aerosols*						T1a, T2a	DF	NE					NE	NE	NE	NE
5	*Solvents*						NE		NE					NE	NE	NE	NE
G	**Other product manufacture and use**																
1	*Electrical equipment*								NE		NE			NE	NE	NE	NE
2	*SF6 and PFCs from other product uses*								NE		NE			NE	NE	NE	NE
3	*N_2O from product uses*					NE								NE	NE	NE	NE
H	**Other**																
1	*Pulp and paper industry*	NE		NE										NE	NE	NE	NE
2	*Food and beverage industry*	NE		NE										NE	NE	NE	NE

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4.1.3 Improvements and recalculations

Through the introduction of the NGER in 2017 (DEA, 2017a), amendments to these regulation in 2020 (DEFF, 2020) as well as the introduction of the SAGERS, the GHG reporting tool, there have been various additions to the inventory as well as recalculations up to 2020. During 2020 a major change was the introduction of Tier 2 and Tier 3 calculation methods as far as possible. This did lead to improved accuracy of the inventory. An external verification process was launched for key emission contributors which increased the level of accuracy. The accuracy improvement has not been quantified.

The 2024 national inventory does not contain any recalculations see Figure 4.6 Below.

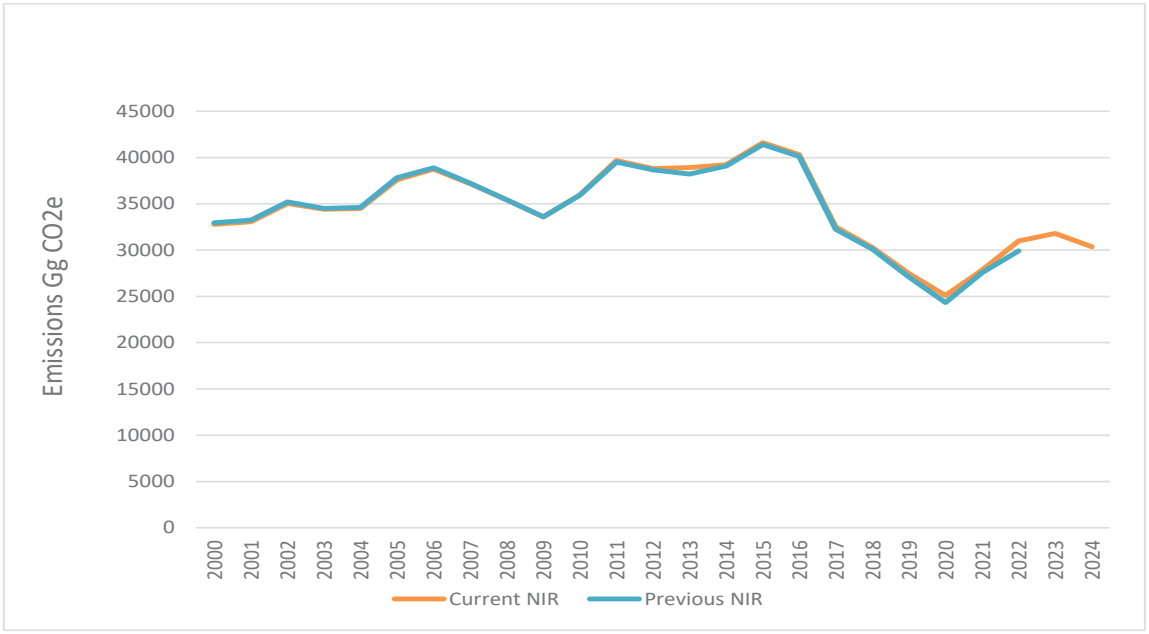


Figure 4.6. Recalculations

The 2024 NID incorporated the GHG emissions data from 1990 to 2024 and no categories were added from 2020.

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4.1.4 Key categories in the IPPU sector

The key categories identified in the IPPU sector by the level (L) and trend (T) analysis are shown in Table 4.4.

Table 4.4: Key categories identified in the IPPU sector.

IPCC Code	Category	GHG	Criteria
2A1	Cement Production	CO_2	L, T
2B2	Nitric Acid production	N2O	T
2C1	Iron and Steel Production	CO_2	L, T
2C2	Ferroalloys Production	CO_2	L, T
2C3	Aluminium Production	F-gases	T
2D2	Paraffin Wax Use	CO_2	T
2F1	Refrigeration and Air Conditioning	HFCs	L, T

4.1.5 QA/QC Process and Verification

Generic QA/QC measures were conducted for the IPPU sector calculation file, as indicated in Table 4.5.

Table 4.5: QA/QC measures for the IPPU sector inventory

QA/QC principle	Check	Description
Accuracy	Activity data source	Verify that the correct data source is being used for activity data.
Accuracy	Correct units	Ensure that the appropriate units are used.
Accuracy	Unit carry through	Confirm that units are consistently carried through calculations, including activity data and emission factors, to the summary table.
Accuracy	Method validity	Ensure that the methods used are valid and appropriate for the calculations.
Accuracy	Calculations check	All calculations should be verified by a second person for accuracy.
Accuracy	Uncertainties	Conduct an uncertainties analysis.
Accuracy	Double counting	Ensure there is no double counting in the data.
Accuracy	Correct GWP	Confirm that the correct Global Warming Potential (GWP) is being applied where applicable.

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QA/QC principle	Check	Description
Accuracy	Notation keys	Review the use of notation keys and associated assumptions for correctness.
Accuracy	Calorific values	Verify the correctness of calorific values.
Accuracy	Oxidation factors	Ensure oxidation factor values are accurate.
Accuracy	Carbon content	Confirm the accuracy of carbon content values.
Accuracy, Completeness, Consistency, Transparency	Trend check	Check that non-energy fuels are correctly reported between Energy and IPPU sectors.
Accuracy, Transparency	Emission factor applicability	Ensure proper allocation of CO_2 between Energy and IPPU sectors for Iron and Steel.
Accuracy, Transparency, Consistency, Completeness	Recalculations	Perform trend checks to identify errors and document any data outliers.
Completeness, Comparability	Sub-category completeness	Verify the accuracy of default emission factors and ensure source information is provided.
Consistency	Time series consistency	Compare values against previous submissions and explain any discrepancies.
Transparency	Documentation	Check that all sub-categories are fully reported; highlight any omissions.
Transparency, Completeness, Consistency, Accuracy	Colour coding	Ensure consistency across time series data for activity data and emission factors.
Accuracy, Comparability	Cross check data	Ensure there is sufficient documentation for the data.
Accuracy	Spot checks	Verify that colour coding is used consistently and accurately, and note any significant data gaps or weaknesses.
Transparency, Consistency	Data source referencing	Cross-check data against alternative sources, where possible.
Transparency	Links to source data	Perform random spot checks on the dataset.
Transparency	Raw primary data	Reference all source data used in submissions.
Accuracy	QA review	Provide links to source data, if available.
Transparency	Raw primary data	Ensure that all raw primary data is present in the workbook.
Accuracy	QA review	Data must be reviewed and checked by a second person for quality assurance.

4.1.6 Planned improvements

Planned improvements and recommendations are given in Table 4.6. These will be prioritised as required and are dependent on resources.

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Table 4.6: Planned improvements and recommendations

IPCC Code	Improvement/Recommendation
General	• Have sector specific engagements discussing the expectations regarding moving to the higher Tier methods. • Address time series consistency issues as data becomes available for specific categories that have been newly included in the inventory. • Ensure that facility intensity data is available (even though not publicly). • Expand reporting to have sector and technology specific intensities.
2A1	• Investigate historical data for the imports and exports of clinker
2A2	• Undertake a completeness assessment to determine if non-marketed lime is reported
2A3	• Disaggregate the cullet ratio by facility.
2B6	• Investigate the availability of the historical data.
2C5	• Investigate the air quality database for those data providers that trigger reporting under Lead Battery processing
2C6	• Investigate if secondary zinc production occurs in South Africa • Investigate the air quality database regarding pyrometallurgical process involving the use of an imperial smelting furnace is used for combined zinc and lead production.
2D1	• South Africa to undertake a desktop study regarding two-stroke engines and the use of blended lubricant.
2D	• Investigate the availability of more accurate data
2F	• Investigate the availability of more accurate data

4.2 Mineral industry (CRT 2.A)

Mineral production emissions are process related GHG emissions resulting from the use of carbonate raw materials. The *Mineral production* category is divided into five subcategories: *Cement production, Lime production, Glass production, Process uses of carbonates,* and *Other mineral products processes*. For this inventory report, emissions are reported for four subcategories: *Cement production (2A1), Lime production (2A2). Glass production (2A3)* and *Other process uses of carbonates (2A4)*. *Other mineral products processes (2A5)* are not included due to a lack of data.

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4.2.1 Cement production (CRT 2.A.1)

4.2.1.1 Category description

The South African cement industry's plants vary widely in age, ranging from five to over 70 years (DMR, 2009). The most common materials used for cement production are limestone, shells, and chalk or marl combined with shale, clay, slate or blast-furnace slag, silica sand, iron ore and gypsum. For certain cement plants, low-grade limestone appears to be the only raw material feedstock for clinker production (DMR, 2009). Portland cement, which has a clinker content of >95%, is described by the class CEM I, CEM II cements can be grouped depending on their clinker content into categories A (80 – 94%) and B (65 – 79%). Portland cement contains other pozzolanic components such as blast-furnace slag, micro silica, fly ash and ground limestone. CEM III cements have a lower clinker content and are also split into subgroups: A (35 – 64% clinker) and B (20 – 34% clinker). South Africa's cement production plants produce Portland cement and blended cement products, such as CEM I, and more recently CEM II and CEM III. Cement produced in South Africa is sold locally and to other countries in the Southern Africa region, such as Namibia, Botswana, Lesotho, and Swaziland.

The main GHG emission in *Cement production* is CO_2 emitted through the production of clinker, an intermediate stage in the cement production process. Non-carbonate materials may also be used in cement production, which reduce the amount of CO_2 emitted. However, the amounts of non-carbonate materials used are generally very small and not reported in cement production processes in South Africa. An example of non-carbonate materials would be impurities in primary limestone raw materials. It is estimated that 50% of the cement produced goes to the residential building market (DMR. 2009); therefore, any changes in the interest rates that affect the residential market will affect cement sales. COVID-19 effected the local market in the sense that lower strength cement was more in demand verses high strength cement during the 2020 period.

4.2.1.2 Methodological issues

From 2022, most cement producers used Tier 2 and 3 methodologies. Previously a Tier 1 approach was used to determine emissions from clinker produced in the *Cement production* category as per the IPCC 2006 Guidelines. From 2008 to 2015 imports of clinker were included in the calculations as the information was available for these years.

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4.2.1.2.1 *Activity data*

Data on cement production in South Africa was obtained from the SAMI Annual Reports produced by the DMRE for 2000 to 2017. Clinker production for the years 2018 and 2019 were provided by the cement industries via South Africa's GHG Reporting Programme. Clinker fraction for the years 2000 to 2012 were obtained from cement industries but was not available for the period between 2013 and 2017, therefore it was assumed to remain unchanged between 2012 and 2017. The clinker fraction for the years 2018 and 2019 were not provided by all cement industries, however the clinker produced was provided, from the 2020 -2024 reporting period through South Africa's GHG Reporting Programme.

4.2.1.2.2 *Emission factors*

For the calculation of GHG emissions in *Cement production*, CO_2 emission factors were sourced from the IPCC 2006 Guidelines. It was assumed that the Calcium Oxide (CaO) composition (one tonne of clinker) contains 0.65 tonnes of CaO from Calcium Carbonate ($CaCO_3$). This carbonate is 56.03% of CaO and 43.97% of CO_2 by weight (IPCC, 2006, p. 2.11). The emission factor for CO_2, provided by IPCC 2006 Guidelines, is 0.52 tonnes of CO_2 per tonne clinker. The country-specific clinker fraction for the period 2000 to 2021 ranged between 69% - 76%. From 2022 a Tier 2 calculation was done by production plants. The implied emission factor of 0.526 is very close that of the IPCC.

4.2.1.3 Uncertainties and time-series consistency

4.2.1.3.1 *Activity data uncertainty*

The largest uncertainty in this sub-category is the import/export data. According to IPCC 2006 Guidelines the uncertainties are: 1% for chemical analysis of clinker to determine CaO; 10% for country production data; 30% for the Cement Kiln Dust (CKD) correction factor default assumption; and 10% on the trade data. From 2022, these uncertainties will be much less due to the Tier 2 and Tier 3 reporting protocols but will only be updated once enough data is available to determine these.

4.2.1.3.2 *Emission factor uncertainty*

Since this submission moved back to a Tier 1 method uncertainty has increased. According to the IPCC 2006 Guidelines, uncertainty with a Tier 1 approach could be as much as 35% in terms of estimation of % of calcination of CKD (IPCC, 2006, Table 2.3).

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From 2022 Tier 2 and Tier 3 methods are used. Uncertainty should be much less but is not quantified yet.

4.2.1.3.3 Time-series consistency

The time-series for this sub-category is not consistent. A Tier 1 method has been used from 1990 to 2021 to estimate emissions from this category. Tier 2 and Tier 3 methodologies have been used for 2022-2024. Import data was available and used for estimations from 2008 to 2015. Emissions were estimated throughout the time-series by using clinker production, which was calculated by multiplying cement production, obtained from the SAMI Report, by clinker fraction from 2000 to 2017. Company specific clinker production was provided from 2018 onwards.

4.2.1.4 Category specific QA/QC and verification

External verification of 2022/23/ and 24 emissions were requested for most of the cement producers.

For verification of cement production data, the facility-level clinker production submitted by cement industries via the SAGERS for the inventory was compared with estimated clinker production from previous inventories. The clinker production however for 2020 showed a decrease compared to previous years. This decrease could be due to the COVID-19 pandemic which saw stringent lockdown measures being implemented in South Africa during 2020.

In previous years (2000 -2017) comparisons against the SAMI reports produced by DMR was also conducted although the information with the report is not clinker production but rather the total amount of lime and dolomite sold to the cement industry however using a clinker fraction of 69% - 76% indicates that clinker production follows the same trend as that from the facility level data from cement industries. It is important to note that the numbers in the SAMI Report may produce slightly overestimated values if not all lime is converted to cement in that year.

In addition, the estimates of clinker production from the DMR data do not include clinker exports due to a lack of data. It is not clear if the industry level clinker data within the report takes imports and exports into account. These differences lead to increased uncertainty and the reasons for the discrepancies need to be further investigated. Direct reporting and verification by data providers have limited these uncertainties.

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4.2.1.5 Category specific recalculations

Recalculations were not performed for this category.

4.2.1.6 Category specific planned improvements

It is evident that there are discrepancies between the cement production data from industry and the cement production data published by the DMR (2000 – 2017), however further data collected by SAGERS could assist in reducing this uncertainty and aid in more consistent reporting in future.

4.2.2 Lime production (CRT 2.A.2)

4.2.2.1 Category description

Lime is the most widely used chemical alkali in the world. Calcium oxide (CaO or quicklime or slaked lime) is sourced from $CaCO_3$ which occurs naturally as limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$). CaO is formed by heating limestone at high temperatures to decompose the carbonates (IPCC, 2006 pg 2.19) and produce CaO. This calcination reaction produces CO_2 emissions. Lime kilns are typically rotary-type kilns, which are long, cylindrical, slightly inclined and lined with refractory material. At some facilities, the lime may be subsequently reacted (slaked) with water to produce hydrated lime.

In South Africa the market for lime is divided into pyrometallurgical and chemical components. Hydrated lime is divided into three sectors: chemical, water purification and other sectors (DMR, 2019). Lime has wide applications, e.g., it is used as a neutralizing and coagulating agent in chemical, hydrometallurgical and water treatment processes and a fluxing agent in pyrometallurgical processes. Quicklime sales for both pyrometallurgical uses and chemical uses both increased in 2017 (DMR, 2019). Demand for hydrated lime for water purification purposes decreased from 2016 to 2017. while demand for sales for chemical applications increased during the same period (DMR, 2019).

4.2.2.2 Methodological issues

A Tier 1 and Tier 2 approach was used to estimate emissions from this category as per the IPCC 2006 Guidelines. The production of lime involves various steps, which include the quarrying of raw materials, crushing and sizing, calcining the raw materials to produce lime, and (if required) hydrating the lime to calcium hydroxide. The Tier 2

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approach was used for the calculation of GHG emissions from *Lime production* (Equation 2.6, IPCC 2006 Guidelines). This report estimated the total *Lime production* based on the quantity of quicklime, hydrated lime and dolomitic lime produced.

For 2024 a Tier 2 methodology is used for the calculation of emissions.

4.2.2.2.1 Activity data

The DMRE publishes data on lime products that is divided into quicklime which includes pyrometallurgical and chemical components; and hydrated lime that includes water purification, chemical and other uses (DMR, 2019). In the previous submissions only pyrometallurgical quicklime and water purification hydrated lime was incorporated from the SAMI Reports (DMR, 2019) were used (8). It was assumed that all quicklime is high calcium lime. From the 2020 inventory included activity data provided by the lime industries reported via South Africa's GHG Reporting Programme. The types of lime reported were quicklime, hydrated lime and dolomitic lime. Quicklime activity data for 2018 and 2019 were extrapolated due to lack of data received for these years. Activity data for hydrated lime during 2018 and 2019 was not provided by industry through South Africa's GHG Reporting Programme and the updated SAMI report was not available for use.

4.2.2.2.2 Emission factors

Quicklime is indicated to be high-calcium lime. The IPCC 2006 Guidelines default emission factor for high-calcium lime (0.75 tonnes CO_2 per tonne lime) was applied. The IPCC 2006 Guidelines default emission factor of 0.77 tonnes CO_2 per tonne lime was applied to dolomitic lime. The IPCC 2006 Guidelines default emission factor of 0.59 tonnes CO_2 per tonne lime was applied to hydrated lime.

From 2022, a Tier 3 methodology was used with implied emission factors of 0.78 and 0.57 tonnes CO_2 per ton lime for quicklime and hydrated lime respectively.

4.2.2.3 Uncertainties and time-series consistency

4.2.2.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines, uncertainty of the Lime Kiln Dust (LKD) correction factor for hydrated lime adds to the uncertainty of the activity data due to not knowing the amount of LKD produced and what percentage is calcined, as with the CKD

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correction factor used for estimating emissions from cement production. Therefore, it can be assumed that the uncertainty for LKD is equal to the uncertainty of CKD which is 30%.

For 2022 a Tier 3 methodology is used, but even though uncertainty would be much less, it has not been calculated.

4.2.2.3.2 Emission factor uncertainty

According to the IPCC 2006 Guidelines, the uncertainty on L*ime production* emissions is: 6% for assuming an average CaO in lime; 2% for high-calcium EF; 5% for correction for hydrated lime.

4.2.2.3.3 Time-series consistency

A Tier 1 and Tier 2 method was used to estimate emissions from 1990 to 2021. The time series was updated to include the IPCC 2006 Guidelines default emission factor of 0.59 for hydrated lime in 2017. Dolomitic lime was added to the time series in 2019. From 2022 a Tier 3 methodology is used.

4.2.2.4 Category specific QA/QC and verification

No category specific QC checks were completed for this sub-category.

The only available data for *Lime production* was sourced from the SAMI report for the 2000 to 2017 inventories, however, from the 2020 inventory, data was sourced from the lime production industry: therefore, there was no comparison of data across different plants previously. The numbers in the DMR report are the total amount of lime (quicklime and hydrated lime) sold locally so may produce slightly overestimated values if not all lime is produced in South Africa or during that year. Reporting is currently not consistent between plants, and verification will be undertaken as consistency is achieved in the future. The SAGERS which became active in 2020, will allow for consistency to be achieve going forward.

4.2.2.5 Category specific recalculations

Recalculations were not undertaken for this category.

4.2.2.6 Category specific planned improvements

The inclusion of Tier 3 emission estimates and external verification of emissions data is set to continue to the future.

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4.2.3 Glass production (CRT 2.A.3)

4.2.3.1 Category description

There are many types of glass and compositions used commercially, however the glass industry is divided into four categories: containers, flat (window) glass, fibre glass and speciality glass. When other materials (including metal) solidify, they become crystalline, whereas glass (a super cool liquid) is non-crystalline. The raw materials used in glass production are sand, limestone, soda ash, dolomite, feldspar and saltcake. The major glass raw materials which emit CO_2 during the melting process are limestone ($CaCO_3$), dolomite $CaMg(CO_3)_2$ and soda ash (Na_2CO_3). Glass makers do not produce glass only from raw materials, they also use a certain amount of recycled scrap glass (cullet). The chemical composition of most glass is silica (72%), iron oxide (0.075%), alumina (0.75%), magnesium oxide (2.5%), sodium oxide (14.5%), potassium oxide (0.5%), sulphur trioxide (0.25%) and calcium oxide (7.5%) (PFG glass, 2010).

4.2.3.2 Methodological issues

A Tier 3 approach was used to determine estimates of the GHG emissions from *Glass production* by the glass production industries for the 2024 inventory. Data providers used a mass balance approach to estimate emissions providing inputs and outputs of their process and carbon content factors specific to their materials. External verification is done on the 2024 data.

4.2.3.2.1 Activity data

Production data was provided by the glass production industries (PG Group, Consol Glass and Isanti Glass), via the manual reporting.

4.2.3.2.2 Emission factors

All glass production industries determined their own emissions using a Tier 3 approach and provided these emission estimates to DFFE. In most cases the activity data and emission factors used are not supplied due to confidentiality issues. External verification is however done on the 2024 data.

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4.2.3.3 Uncertainties and time-series consistency

4.2.3.3.1 Activity data uncertainty

As per the IPCC 2006 Guidelines. uncertainty related to activity data using a Tier 3 approach is between 1 – 3% (IPCC 2006 Guidelines, Chapter 2.4.2.2). Carbonates lost as dust is negligible under the Tier 3 method.

4.2.3.3.2 Emission factor uncertainty

As per the IPCC 2006 Guidelines, uncertainty related to emission factors developed using a Tier 3 approach is between 1 – 3% (IPCC 2006 Guidelines, p. 2.31). There is some uncertainty when assuming that all carbonates are calcined, but this is minimal.

4.2.3.3.3 Time-series consistency

A Tier 1 method was used to estimate emissions from 2000 to 2017, using the cullet ratio and the default emission factor of 0.2. From 2018 onwards after the promulgation of the NGER, glass production industries began using the Tier 2 and Tier 3 methods to estimate emissions, using a mass balance approach.

4.2.3.4 Category specific QA/QC and verification

External verification of emissions was done for the 2023 and 2024 data from individual companies.

4.2.3.5 Category specific recalculations

No recalculations were performed for this category.

4.2.3.6 Category specific planned improvements

There is an improvement project planned to investigate the inclusion separation of cullet ratio reported per facility.

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4.2.4 Other process uses of carbonates (CRT 2.A.4)

4.2.4.1 Category description

Limestone ($CaCO_3$), dolomite ($CaMg(CO_3)_2$) and other carbonates (e.g., $MgCO_3$ and $FeCO_3$) are basic raw materials having commercial applications in a number of industries. The calcination of carbonates at high temperatures yields CO_2. In addition to those industries already discussed individually above, carbonates are also consumed in metallurgy, agriculture, construction and environmental pollution control (IPCC, 2006). The use of lime in the following specific source categories are reported within the mineral category, such as ceramics, other soda ash usage and non-metallurgical magnesia production.

Ceramics include the production of bricks and roof tiles, vitrified clay pipes, refractory products, expanded clay products, wall and floor tiles, table and ornamental ware (household ceramics), sanitary ware, technical ceramics, and inorganic bonded abrasives. Emissions from the ceramic production industry are process related and are emitted when calcination of clay occurs and when additives are added to the process (IPCC, 2006). Within South Africa it has been shown that carbonates are very low in raw materials.

Soda ash is used in a variety of applications, including, glass production, soaps and detergents, flue gas desulphurisation, chemicals, pulp and paper and other common consumer products. Soda ash production and consumption results in the release of CO_2 emissions (IPCC, 2006).

Magnesite ($MgCO_3$) is one of the key inputs into the production of magnesia, and ultimately fused magnesia. There are three major categories of magnesia products: calcined magnesia, dead burned magnesia (periclase) and fused magnesia. Magnesia is produced by calcining $MgCO_3$ which results in the release of CO_2 (IPCC, 2006). Emissions may result from several other source categories that are not included above.

4.2.4.2 Methodological issues

A Tier 1 and 3 approach was adopted to estimate emissions from the *Ceramics* and *Soda ash usage* subcategories. The Tier 3 approach included data providers undertaking analysis of their raw materials used within the process to determine the carbon content and then applying this value to their production data. A Tier 1 approach was used to estimate emissions from other uses of carbonates. *Other uses of carbonates* included the use of dolomite and calcite within separate processes.

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4.2.4.2.1 Activity data

Activity data were obtained from industries operating under the relevant sector. Activity data was reported via South Africa's GHG Reporting Programme. This is a new category added to the inventory from 2018 and all activity data has been reported via the GHG reporting Programme in 2023/24.

4.2.4.2.2 Emission factors

The IPCC 2006 Guidelines default emission factors for calcite (0.43971 tonnes CO_2 per tonne carbonate), magnesite (0.52197 tonnes CO_2 per tonne carbonate) and for soda ash usage (0.41492 tonnes CO_2 per tonne carbonate) was applied where a Tier 1 approach was used. The IPCC 2006 Guidelines default emission factor for other usage of carbonates (0.47732 tonnes CO_2 per tonne lime) was applied to dolomite usage. Most industrial operators have however switched to a Tier 3 methodology.

4.2.4.3 Uncertainties and time-series consistency

4.2.4.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines. uncertainty arising from a Tier 3 approach is between 1-3%, and where a Tier 1 approach has been used uncertainty rises to between 15-85%. As both approaches were used to estimate emissions in 2020 activity data for subcategories *Ceramics* and *Soda Ash Usage* uncertainty will fall between the range of 1 - 85%.

4.2.4.3.2 Emission factor uncertainty

As per the IPCC 2006 Guidelines, emission factors used correctly to activity data that has been collected correctly uncertainty is negligible. However, should there be an error in the assumption of carbonates an uncertainty of between 1-5% should apply.

4.2.4.3.3 Time-series consistency

The *Other Process Uses of Carbonates* is a new category introduced to the inventory in 2018. This has resulted in an inconsistent time series as historical data is unavailable currently. The time series consistency will be updated as industry continues to report in future via the SAGERS Portal. More data providers are also switching to Tier 3 methodologies over time.

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4.2.4.4 Category specific QA/QC and verification

No category specific QC checks were completed for this sub-category.

4.2.4.5 Category specific recalculations

Recalculations were not undertaken for this category.

4.2.4.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS will be included.

4.3 Chemical industry (CRT 2.B)

This category estimates GHG emissions from the production of both organic and inorganic chemicals in South Africa. The chemical industry in South Africa is mainly developed through the gasification of coal because the country has no significant oil reserves. GHG emissions from the following chemical production processes were reported: *Ammonia production*, *Nitric acid production*, *Carbide production*, *Soda ash production*, *Titanium dioxide production*, *Carbon black*, *Hydrogen production* and *Other chemical processes*. The chemical industry in South Africa contributes approximately 3.0% to the GDP and 23% of its manufacturing. The chemical products in South Africa can be divided into four categories: base chemicals, intermediate chemicals, chemical end-products, and speciality end-products. Chemical products include ammonia, waxes, solvents, plastics, paints, explosives and fertilizers.

The chemical industries subsector contains confidential information, so, following the IPCC 2006 Guidelines for reporting confidential information, no disaggregated source-category level emission data are reported; only the emissions at the sector scale are discussed. Emission estimates are, however, based on bottom-up activity data and methodologies.

4.3.1 Ammonia production (CRT 2.B.1)

4.3.1.1 Category description

Ammonia production is the most important nitrogenous material produced and is a major industrial chemical. According to the IPCC 2006 Guidelines (p.3.11), ammonia gas can be

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used directly as a fertilizer, in heat treating, paper pulping, nitric acid and nitrates manufacture, nitric acid ester and nitro compound manufacture, in explosives of various types and as a refrigerant.

4.3.1.2 Methodological issues

Emission estimates from *Ammonia production* were obtained through the Tier 3 approach. Emissions were calculated based on actual process balance analysis. Total emission estimates were obtained from the ammonia production plants. 2022/23/ and 24 data was verified externally.

4.3.1.2.1 Activity data

Consumption data is not provided within this report due to confidentiality. It is however reported via the SAGERS system.

4.3.1.2.2 Emission factors

The emission factors are not provided within this report due to confidentiality reasons.

4.3.1.3 Uncertainties and time-series consistency

4.3.1.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines (p.3.16), the plant-level activity data required for the Tier 3 approach are the total fuel requirement classified by fuel type; CO_2 recovered for downstream use or other applications; and *Ammonia production*. Uncertainty of ±2% was applied to activity data as advised in the IPCC 2006 Guidelines (p.3.17) should activity data be obtained from producers. The uncertainty was assumed to be the same for both CO_2 and CH_4 emissions.

4.3.1.3.2 Emission factor uncertainty

The IPCC 2006 Guidelines default uncertainty for Tier 1 is 6% (IPCC 2006 Guidelines, Table 3.1) therefore it is expected that for a Tier 3 approach the uncertainty would be less, therefore an assumption of ±2% is made as per information provided in the IPCC 2006 Guidelines (p. 3.17) for activity data obtained from plants. The uncertainty was assumed to be the same for both CO_2 and CH_4 emission estimates as guidance was not provided per GHG.

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4.3.1.3.3 *Time-series consistency*

A Tier 3 method was used from the 2022 reporting onwards, emissions prior to 2022 were estimated using tier 1.

4.3.1.4 Category specific QA/QC and verification

Internal QA/QC for the inventory compilation was completed, and the 2024 reported emissions data was verified externally.

4.3.1.5 Category specific recalculations

No recalculations were performed for this category.

4.3.1.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS will be included.

4.3.2 Nitric acid production (CRT 2.B.2)

4.3.2.1 Category description

Nitric acid is a raw material used mainly in the production of nitrogenous-based fertilizer. According to the IPCC 2006 Guidelines (p.3.19), during the production of nitric acid, nitrous oxide is generated as an unintended by-product of high-temperature catalytic oxidation of ammonia.

4.3.2.2 Methodological issues

The emissions from *Nitric acid production* were calculated based on continuous monitoring (Tier 3 approach) and approved country specific emission factors.

4.3.2.2.1 *Activity data*

Consumption data is not provided within this report due to confidentiality. It is however reported via SAGERS.

4.3.2.2.2 *Emission factors*

The emission factors are not provided as the information is confidential.

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4.3.2.3 Uncertainties and time-series consistency

4.3.2.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines (p. 3.24) the plant-level activity data required for the Tier 3 approach includes production data disaggregated by technology and abatement system type. The IPCC 2006 Guidelines suggest that where uncertainty values are not available from other sources, as is the case for this inventory, this default value of ±2 percent should be applied to the activity data (IPCC 2006 Guidelines, p.3.25).

4.3.2.3.2 Emission factor uncertainty

According the IPCC 2006 Guidelines (p. 3.24), default emission factors have very high uncertainties for two reasons: a) N_2O may be generated in the gauze reactor section of nitric acid production as an unintended reaction by-product; and b) the exhaust gas may or may not be treated for NO_x control and the NO_x abatement system may or may not reduce the N_2O concentration of the treated gas. Since a Tier 3 approach was applied in this inventory it was assumed that the uncertainty value was ±2 as per Tier 3 approach (IPCC 2006 Guidelines, p.3.24).

4.3.2.3.3 Time-series consistency

A Tier 3 method was used throughout the time-series, with emission data being provided by industry.

4.3.2.4 Category specific QA/QC and verification

The 2024 data were verified externally.

4.3.2.5 Category specific recalculations

No recalculations were performed on this category.

4.3.2.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS will be included.

4.3.3 Adipic acid production (CRT 2.B.3)

There is no *Adipic acid production* occurring in South Africa.

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4.3.4 Caprolactuam, glyoxal and glyoxylic acid production (CRT 2.B.4)

There is no *Caprolactuam, glyoxal and glyoxylic acid production* occurring in South Africa.

4.3.5 Carbide production (CRT 2.B.5)

4.3.5.1 Category description

Carbide production can result in GHG emissions such as CO_2 and CH_4. According to the IPCC 2006 Guidelines (p.3.39), calcium carbide is manufactured by heating calcium carbonate (limestone) and subsequently reducing CaO with carbon (e.g., petroleum coke) while silicon carbide is produced from silica sand or quartz and petroleum coke.

4.3.5.2 Methodological issues

Emissions from *Carbide production* were calculated based on a Tier 1 approach as per the IPCC 2006 Guidelines. From 2022 emissions are reported based on Tier 3 methodologies.

4.3.5.2.1 Activity data

Calcium carbide and silicon carbide consumption values were sourced from the carbide production plants but are not shown due to confidentiality issues. Calcium carbide is not estimated for 2019 and the production plant is no longer operational. Silicon carbide emission estimates have been included since 2019 through South Africa's GHG Reporting Programme.

4.3.5.2.2 Emission factors

An IPCC 2006 Guidelines default emission factor was applied historically. Since 2022 Tier 3 methodologies are used.

4.3.5.3 Uncertainties and time-series consistency

4.3.5.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines (p. 3.45), the uncertainty of the activity data that accompanies the method used here is approximately ±5%. The uncertainty was assumed

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to be the same for both CO_2 and CH_4 emission estimates as guidance was not provided per GHG.

4.3.5.3.2 *Emission factor uncertainty*

The default emission factors are generally uncertain because industrial-scale carbide production processes differ from the stoichiometry of theoretical chemical reactions (IPCC 2006 Guidelines; p. 3.45). Emission factor uncertainty for Tier 1 is ±10%. The uncertainty was assumed to be the same for both CO_2 and CH_4 emission estimates as guidance was not provided per GHG. From 2022 Tier 3 methodologies are used with indicated uncertainty of ±2%.

4.3.5.3.3 *Time-series uncertainty*

The emissions from *Carbide production* were sourced from the specific carbide production plants therefore there was no comparison of data across different plants. A Tier 1 method was used across the time series, with the addition of silicon carbide in 2019. From 2022 a Tier 3 method is used.

4.3.5.4 Category specific QA/QC and verification

No category specific QC checks were carried out.

4.3.5.5 Category specific recalculations

No recalculations were performed on this category.

4.3.5.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS will be included.

4.3.6 Titanium dioxide production (CRT 2.B.6)

4.3.6.1 Category description

Titanium dioxide (TiO_2) is a white pigment used mainly in paint manufacture, paper, plastics, rubber, ceramics, fabrics, floor coverings, printing ink, among others. According IPCC 2006 Guidelines (p. 3.47), there are three processes in TiO_2 production that result in GHG emissions, namely, a) titanium slag production in electric furnaces; b) synthetic

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rutile production using the Becher Process and c) rutile TiO_2 production through the chloride route.

4.3.6.2 Methodological issues

A Tier 3 approach was used for calculating GHG emissions from titanium dioxide production. Data providers used a mass balance approach to estimate emissions.

4.3.6.2.1 Activity data

The *Titanium dioxide production* emissions data were sourced from the titanium dioxide production plants and activity data was not supplied in this report due to confidentiality issues.

4.3.6.2.2 Emission factors

The emission factors are not provided in this report as the information is confidential. Tier 3 calculations are done for this sector.

4.3.6.3 Uncertainties and time-series consistency

4.3.6.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines (p. 3.50), the uncertainty of the activity data when using a Tier 2 approach is ±2% for activity data collected at plant level. It is therefore assumed that the uncertainty is ±2 as data was provided at a plant level.

4.3.6.3.2 Emission factor uncertainty

The IPCC 2006 Guidelines state that uncertainty for titanium slag is unavailable due to confidentiality and lack of production plants. However, an assumption of ±2 was made as per the uncertainty of the activity data (IPCC 2006 Guidelines, p.3.50)

4.3.6.3.3 Time-series consistency

The total GHG emissions were sourced from the specific titanium dioxide production plants therefore, no comparison of data across different plants was made. A Tier 3 approach was used across the time series.

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4.3.6.4 Category specific QA/QC and verification

No category specific QC checks were completed for this sub-category.

4.3.6.5 Category specific recalculations

No recalculations were performed on this category.

4.3.6.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from South Africa's GHG Reporting Programme will be included.

4.3.7 Soda ash production (CRT 2.B.7)

4.3.7.1 Category description

Soda ash (sodium carbonate, Na_2CO_3) is a white crystalline solid that is used as a raw material in many industries including glass manufacture, soap and detergents, pulp and paper production and water treatment. CO_2 is emitted during production with the quantity emitted dependent on the industrial process used to manufacture soda ash (IPCC, 2006).

Emissions of CO_2 from the production of soda ash vary substantially with the manufacturing process. Four different processes may be used commercially to produce soda ash. Three of these processes, monohydrate, sodium sesquicarbonate (trona) and direct carbonation, are referred to as natural processes. The fourth, the Solvay process, is classified as a synthetic process. Calcium carbonate (limestone) is used as a source of CO_2 in the Solvay process.

4.3.7.2 Methodological issues

A Tier 3 approach was used for calculating GHG emissions from *soda production*. Data providers used a mass balance approach to estimate emissions from 2020 onwards.

4.3.7.2.1 Activity data

The *Soda ash production* emissions data were sourced from the production plants and activity data was not supplied in this report due to confidentiality issues.

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4.3.7.2.2 *Emission factors*

The emission factors are not provided in this report as the information is confidential. It is however reported via SAGERS and manually for the 2023/24 period.

4.3.7.3 Uncertainties and time-series consistency

4.3.7.3.1 *Activity data uncertainty*

According to the IPCC 2006 Guidelines (p. 3.54), the uncertainty of the activity data when uncertainty is unavailable is ±5% for activity data collected at plant level.

4.3.7.3.2 *Emission factor uncertainty*

The IPCC 2006 Guidelines state that the uncertainty of the default emission factor is negligible as an assumption of 100% purity of input and output materials is made (IPCC 2006 Guidelines, p.3.54).

4.3.7.3.3 *Time-series consistency*

The time series is not consistent as soda ash production is a new category added in 2019. Historical data is not available. The time series will be built on in future as more data becomes available.

4.3.7.4 Category specific QA/QC and verification

No category specific QC checks were completed for this sub-category.

4.3.7.5 Category specific recalculations

No recalculations were performed on this category.

4.3.7.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS and manually for the 2023/24 period.

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4.3.8 Petrochemical and carbon black production (CRT 2.B.8)

4.3.8.1 Category description

Carbon black is produced from petroleum-based or coal-based feed stocks using the furnace black process (IPCC, 2006). Primary fossil fuels in carbon black production include natural gas, petroleum and coal. The use of these fossil fuels may involve the combustion of hydrocarbon content for heat rising and the production of secondary fuels (IPCC 2006 Guidelines, p.3.56).

GHG emissions from the combustion of fuels obtained from feed stocks should be allocated to the source category in the IPPU sector, however, where the fuels are not used within the source category but are transferred out of the process for combustion elsewhere, these emissions should be reported in the appropriate energy sector source category (IPCC 2006 Guidelines, p. 3.56). Commonly, the largest percentage of carbon black is used in the tyre and rubber industry, and the rest is used as pigment in applications such as ink and carbon dry-cell batteries.

4.3.8.2 Methodological issues

Tier 1 was the main approach used in estimating emissions from *Carbon black production*, using production data and relevant emission factors.

4.3.8.2.1 Activity data

Carbon black activity data was sourced directly from industry but is not shown due to confidentiality issues.

4.3.8.2.2 Emission factors

For the calculation of emissions from *Carbon black production*, the IPCC 2006 Guidelines default CO_2 and CH_4 emission factors were applied (Table 4.7). Carbon black is mainly produced through the furnace black process; however, a small portion of carbon black production is known to be produced through the acetylene black process.

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Table 4.7: Emission factors applied for carbon black production emission estimates

Sub-category	CO_2 EF (tonnes CO_2/tonne product)	CH_4 EF (kg CH_4/tonne product)	Source
Carbon black production (Furnace Black Process)	2.62	0.06	IPCC 2006
Carbon black production (Acetylene Black Process)	0.12		IPCC 2006

4.3.8.3 Uncertainties and time-series consistency

4.3.8.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines, the uncertainty of the activity data that accompanies the method used here is in the range of ±15% for CO_2 and ±85% for CH_4 as per the IPCC 2006 Guidelines, Table 3.27.

4.3.8.3.2 Emission factor uncertainty

According to the IPCC 2006 Guidelines, the uncertainty of the emission factors that accompanies the method used here is in the range of ±15% for CO_2 and ±85% for CH_4 as per the IPCC 2006 Guidelines, Table 3.27.

4.3.8.3.3 Time-series consistency

A Tier 1 approach was used throughout the time series with activity data being collected from industry. Carbon black produced via the acetylene black process was reported for the years 2016 to 2018 when the company shut down.

4.3.8.4 Category specific QA/QC and verification

No category specific QC checks were completed for this sub-category.

4.3.8.5 Category specific recalculations

No recalculations were performed on this category.

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4.3.8.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS and manually for the 2023/24 period.

4.3.9 Hydrogen Production (2.B.8.g)

4.3.9.1 Category description

Hydrogen (H_2) is a gas with flammable properties like natural gas and gasoline. Currently hydrogen is used as raw material in refineries and in the production of ammonia, methanol and various chemicals (IPCC, 2019). Hydrogen can also be used as an energy carrier in the transport sector, as energy storage and buffer systems in renewable electricity production, as a main constituent in coal gas used for heating and cooking, as well as in semiconductor industry processing and welding (IPCC, 2019). Hydrogen can be produced through various processes, the most common being steam reforming (95%), which uses fossil fuels or renewable fuels as a feedstock. The use of fossil fuels results in GHGs being emitted (Zohuri, 2018).

4.3.9.2 Methodological issues

A Tier 3 approach was used for calculating GHG emissions from *hydrogen production*. Data Providers used a mass balance approach to estimate emissions from 2020 onwards.

4.3.9.2.1 Activity data

The *hydrogen production* emissions data were sourced from the production plants and activity data was not supplied in this report due to confidentiality issues.

4.3.9.2.2 Emission factors

The emission factors are not provided in this report as the information is confidential.

4.3.9.3 Uncertainties and time-series consistency

4.3.9.3.1 Activity data uncertainty

According to the IPCC 2019 Refinement (p. 3.50), the uncertainty of the activity data when plant level data is available is ±2%.

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4.3.9.3.2 *Emission factor uncertainty*

Uncertainty is not provided in the IPCC 2019 Refinement for emission factors; therefore, it was assumed to be the same as with activity data, ±2%.

4.3.9.3.3 *Time-series consistency*

The time series is not consistent as hydrogen production is a new category added in 2018. Historical data is not available. The time series will be built on in future as more data becomes available.

4.3.9.4 Category specific QA/QC and verification

No category specific QC checks were completed for this sub-category.

4.3.9.5 Category specific recalculations

No recalculations were performed on this category.

4.3.9.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS and manually for the 2023/24 period.

4.3.10 Other (CRT 2.B.10)

4.3.10.1 Category description

This category includes emissions from chemicals manufacturing industries that are not covered elsewhere in the IPCC 2006 Guidelines. Emissions of CO_2 and CH_4 are reported within this category. Process emission from the Phthalic Anhydride process and partial oxidation of Butane and Ortho-Xylene are included in this category.

4.3.10.2 Methodological issues

A Tier 3 approach was used for calculating GHG emissions from this subcategory. Data Providers used stack monitoring reports to estimate emissions from 2020 onwards.

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4.3.10.2.1 Activity data

The emissions data were sourced from the production plants and activity data was not supplied in this report due to confidentiality issues.

4.3.10.2.2 Emission factors

The emission factors are not provided in this report as the information is confidential. Tier 3 calculations are used for reporting in this sectors.

4.3.10.3 Uncertainties and time-series consistency

4.3.10.3.1 Activity data uncertainty

The IPCC 2006 Guidelines have not provided guidance on the uncertainty from activity data therefore an assumption of ±5% was made based on the default uncertainty from *Carbide production* for both CO_2 and CH_4.

4.3.10.3.2 Emission factor uncertainty

The IPCC 2006 Guidelines have not provided guidance on the uncertainty from emission factors therefore an assumption of ±5% was made based on the default uncertainty from *Carbide production* for both CO_2 and CH_4.

4.3.10.3.3 Time-series consistency

The time series is not consistent as this is a new category added in 2020. Historical data is not available. The time series will be built on in future as more data becomes available.

4.3.10.4 Category specific QA/QC and verification

No category specific QC checks were completed for this sub-category.

4.3.10.5 Category specific recalculations

No recalculations were performed on this category.

4.3.10.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS and manually for the 2023/24 period.

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4.4 Metal industry (CRT 2.C)

This subcategory relates to emissions resulting from the production of metals. Processes covered for this inventory report include the production of iron and steel, ferroalloys, aluminium, lead, and zinc. Estimates were made for emissions of CO_2 from the manufacture of all the metals and emissions of CH_4 were estimated from *Iron and steel production* and *Ferroalloy production*, and perfluorocarbons (CF_4 and C_2F_6) from *aluminium production*. Due to the moving towards Tier 3 calculations and estimation methodologies, CH_4 emissions are not estimated for all entities and uncertainties might be higher than stated.

4.4.1 Iron and steel production (CRT 2.C.1)

4.4.1.1 Category description

Iron and steel production results in the emission of CO_2, CH_4 and N_2O. According to the IPCC 2006 Guidelines (p. 4.9), the iron and steel industry broadly consists of primary facilities that produce both iron and steel; secondary steel-making facilities; iron production facilities; and offsite production of metallurgical coke. According to the World Steel Association (2010), South Africa is the 21st-largest crude steel producer in the world. The range of primary steel products and semi-finished products manufactured in South Africa includes billets; blooms; slabs; forgings; light-, medium- and heavy sections and bars; reinforcing bar; railway track material; wire rod; seamless tubes; plates; hot- and cold-rolled coils and sheets; electrolytic galvanised coils and sheets; tinplate; and pre-painted coils and sheets. The range of primary stainless-steel products and semi-finished products manufactured in South Africa include slabs, plates, and hot- and cold-rolled coils and sheets. COVID-19 had a negative effect on iron and steel production, but the market recovered to a large extend afterwards. The negative market effect was however used to shut down certain plants or areas for major maintenance.

4.4.1.2 Methodological issues

Historically a Tier 1 approach was applied to calculation emissions from *Iron and steel production*. A Tier 1 and 3 approach was applied for the different process types in 2020 and Tier 3 was used from 2022. Default IPCC emission factors were used for the calculation of GHG emissions from basic oxygen furnace, electric arc furnace, pig iron production, direct reduced iron production and sinter production. Industry also used a Tier 3 approach to estimate emissions from electric arc furnaces using raw material input and output.

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Energy-related emissions from *Iron and steel production* have been accounted for under the Energy Sector.

4.4.1.2.1 Activity data

Activity data was provided by the *Iron and steel production* plants via South Africa's GHG Reporting Programme.

4.4.1.2.2 Emission factors

Historically IPCC default emission factors were applied for the calculation of emissions from *Iron and steel production*. From 2022 all reporting was done using a Tier 3 approach based on mass balance.

4.4.1.3 Uncertainties and time-series consistency

4.4.1.3.1 Activity data uncertainty

As historically both a Tier 1 and Tier 3 approach was used to estimate emissions from this category it was assumed that the uncertainty ranged from ±5% to ±10% as per the IPCC 2006 Guidelines (Table 4.4). From 2022 a Tier 3 approach is used, and uncertainty is estimated as ±5%.

4.4.1.3.2 Emission factor uncertainty

The IPCC 2006 Guidelines indicate that applying Tier 1 to default emission factors for iron and steel production may have an uncertainty of ± 25% (IPCC 2006 Guidelines, Table 4.4). As both a Tier 1 and Tier 3 approach was used historically to estimate emissions an uncertainty range of ±5% and ±25% was used for the EF. From 2022 a Tier 3 approach is used, and uncertainty is estimated as ±5%.

4.4.1.3.3 Time-series consistency

Data was not consistent throughout the time series as the data was provided by different sources for the 2019 inventory. From 2020 the inventory included activity data directly from industry via the SAGERS through South Africa's GHG Reporting Programme. Prior to 2017 sinter production was not reported, however, since the promulgation of the NGER there has been disaggregation between direct reduced iron and sinter processes. Due to the effects of COVID-19, steel production values also differ with regards to production methodology for the past few years.

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4.4.1.4 Category specific QA/QC and verification

External verification of 2024 data was done.

4.4.1.5 Category specific recalculations

No recalculations were performed on the emissions from this subcategory.

4.4.1.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from South Africa's GHG Reporting Programme will be included. An improvement to consider in the future is the estimation of CH_4 emissions.

4.4.2 Ferroalloys production (CRT 2.C.2)

4.4.2.1 Category description

Ferroalloy refers to concentrated alloys of iron and one or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten. Ferroalloy plants manufacture concentrated compounds that are delivered to steel production plants to be incorporated in alloy steels. Ferroalloy production involves a metallurgical reduction process that results in significant CO_2 emissions (IPCC 2006 Guidelines, p. 4.32). South Africa is the world's largest producer of chromium and vanadium ores, and the leading supplier of these alloys (DMR, 2015). South Africa is also the largest producer of iron and manganese ores and an important supplier of ferromanganese, ferrosilicon and silicon metal (DMR, 2013). COVID-19 had a negative effect on ferroalloys production, but the market recovered to a large extend afterwards. The negative market effect was however used to shut down certain plants or areas for major maintenance.

4.4.2.2 Methodological issues

Historically a Tier 1 and 3 approach was applied across the different ferroalloy production plants for different types of ferroalloys. From 2022 only a Tier 3 approach is applied.

4.4.2.2.1 *Activity data*

Ferroalloy production data for 2000 to 2012 were obtained from ferroalloy production plants. Activity data from 2013 to 2017 were obtained from the SAMI Annual Reports (DMR. 2019), however, from 2018 activity data was again supplied by the ferroalloy

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production plants due to the implementation of the GHG Reporting Regulations. For ferromanganese production the 7% C values were taken to be the high and medium carbon ferro-manganese, and the 1% C values were the other manganese alloys (DMR, 2013, 2015). For 2014 and 2017 the split between 7% and 1% was not provided (only a total manganese value) therefore the split from 2013 was applied. A drop in silicon metal production was observed in 2017 due to the closure of most furnaces because of low demand and high electricity tariffs (DMR, 2019).

Most plants provided a split between ferromanganese 1% and 7%, however, where the split was not made, the split from 2013 was applied. This inconsistency was overcome form 2018 as South Africa's GHG Reporting Programme requires the split to be made.

4.4.2.2.2 *Emission factors*

Historically Tier 1 emission factors where used. Over the past 3 years it moved more towards a Tier 3 approach to the point that 2022 is purely Tier 3. Due to certain assumptions for the Tier 3 approach, there is still higher uncertainty with CH_4 emissions and Tier 1 is used in some instances.

4.4.2.3 Uncertainties and time-series consistency

4.4.2.3.1 *Activity data uncertainty*

An uncertainty of ±5% on activity data was assumed as per the IPCC 2006 Guidelines (IPCC, 2006, Table 4.9). The uncertainty was assumed to be the same for both CO_2 and CH_4.

4.4.2.3.2 *Emission factor uncertainty*

IPCC 2006 Guidelines indicates that for Tier 1, the default emission factors may have an uncertainty of ± 25% (IPCC, 2006). For this inventory, as both a Tier 1 and Tier 3 approach was used for CH_4 the uncertainty range was assumed to be between ±5% and ±25% for and CH_4. CO_2 uncertainty is assumed to be ±5%.

4.4.2.3.3 *Time-series consistency*

The time series is not consistent due to a change in data sources in 2018 and 2019. From 2020 industry reported via the brought better consistency.

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4.4.2.4 Category specific QA/QC and verification

The 2024 data was verified externally by the respective companies.

4.4.2.5 Category specific recalculations

No recalculations were performed for the category.

4.4.2.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from South Africa's GHG Reporting Programme will be included.

4.4.3 Aluminium production (CRT 2.C.3)

4.4.3.1 Category description

Aluminium production takes place via the Hall-Heroult electrolytic process. In this process, electrolytic reduction cells differ in the form and configuration of the carbon anode and alumina feed system.

The most significant process emissions are (IPCC, 2006, p. 4.43):

- CO_2 emissions from the consumption of carbon anodes in the reaction to convert aluminium oxide to aluminium metal;
- PFC emissions of CF_4 and C_2F_6 during anode effects. Also emitted are smaller amounts of process emissions, CO, Sulphur dioxide (SO_2), and NMVOCs.

4.4.3.2 Methodological issues

A Tier 1 approach was used for CO_2 emission estimation, while a Tier 3 methodology was applied to the PFCs between 2000 and 2012. In the Tier 3 approach the amount of CF_4 and C_2F_6 produced were tracked and used to determine emissions in this category. The Tier 3 method was then extrapolated for the 2013-15 period (using activity data and an implied emission factor). It is considered that the extrapolation of a Tier 3 method might overestimate or underestimate the emissions. Therefore, in the 2000-2017 inventory this was corrected so that actual plant-performance data is used to quantify emissions for the 2013-2017 period. A Tier 3 method was used to estimate emissions for both CO_2 and PFCs from 2018.

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4.4.3.2.1 Activity data

The source of activity data for *Aluminium production* were the aluminium production plants. Data is not shown in this report due to confidentiality.

4.4.3.2.2 Emission factors

The emission factors are not provided in this report as the information is confidential.

4.4.3.3 Uncertainties and time-series consistency

4.4.3.3.1 Activity data uncertainty

As per the IPCC 2006 Guidelines, uncertainty is minimal regarding aluminium production data. A default uncertainty of ±1% is used (IPCC, 2006, Page 4.57).

4.4.3.3.2 Emission factor uncertainty

The uncertainty on the Tier 3 CO_2 emission factors for aluminium production is ±5% (IPCC 2006 Guidelines, Page 4.56) for estimating CO_2 emissions. Even though a Tier 3 approach was used for *aluminium production* PFC emissions, no data was collected on uncertainty. The Tier 3 default uncertainty for CF_4 and C_2F_6 are indicated to be ±15% (IPCC 2006 Guidelines, page 4.56).

4.4.3.3.3 Time-series uncertainty

Emissions were estimated using a Tier 1 approach for Prebake and Soderberg processes from 2000 to 2013 and 2000 to 2008, respectively. A Tier 3 approach was used to estimate emissions from Centre-Worked Prebake (CWPB), Side Worked Prebake (SWPB), Vertical Stud Søderberg (VSS) and Horizontal Stud Søderberg (HSS) processes from 2000 to 2008.

The Soderberg, SWPB, VSS and HSS processes were stopped in 2008. A Tier 3 approach was used to estimate emissions for CWPB from 2012 onwards.

4.4.3.4 Category specific QA/QC and verification

The 2024 data has been externally verified.

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4.4.3.5 Category specific recalculations

No recalculations were performed for this category.

4.4.3.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from SAGERS will be included.

4.4.4 Magnesium production (CRT 2.C.4)

There is no *Magnesium production* occurring in South Africa.

4.4.5 Lead production (CRT 2.C.5)

4.4.5.1 Category description

According to the IPCC 2006 Guidelines, there are two primary processes to produce lead bullion from lead concentrates:

- Sintering/smelting, which consists of sequential sintering and smelting steps and constitutes approximately 7% of the primary production; and
- Direct smelting, which eliminates the sintering step and constitutes 22% of primary lead production.

Secondary lead processing, according to the IPCC 2006 Guidelines, involves the recycling of lead acid batteries. Recycling occurs through the following processes:

- crushed using a hammer mill and entered the smelting process with or without desulphurization; or
- smelted whole

4.4.5.2 Methodological issues

Emissions from *Lead production* were estimated using a Tier 1 approach.

4.4.5.2.1 Activity data

Lead production data for 2000 to 2017 were obtained from the SAMI Annual Reports (DMR, 2019), however from 2018 activity data was supplied by the lead production plants through South Africa's GHG Reporting Programme, via the SAGERS.

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4.4.5.2.2 *Emission factors*

IPCC 2006 default emission factor of 0.2 t CO_2 per tonne of lead produced was applied (IPCC, 2006, Table 4.21).

4.4.5.3 Uncertainties and time-series consistency

4.4.5.3.1 *Activity data uncertainty*

For *lead production* emissions using the Tier 1 method there is a ±10% uncertainty on the activity data (IPCC 2006 Guidelines, Table 4.23).

4.4.5.3.2 *Emission factor uncertainty*

Uncertainty for default lead production emission factors has an uncertainty of ±50% (IPCC 2006 Guidelines, Table 4.23).

4.4.5.3.3 *Time-series consistency*

The time series is not consistent as the source of activity data changed in 2018 from the SAMI Report (DMR, 2019) to industry reporting via the SAGERS Portal, and then manually reported in 2023/24.

4.4.5.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.4.5.5 Category specific recalculations

A recalculation was undertaken for the 1990 – 2019 where initially emissions were estimated using the emissions factor 0.52 tonnes CO_2/tonne product. In 2020 DFFE was made aware that the production was not primary but secondary and the emission factor was adjusted to 0.2 tonnes CO_2/tonne product.

4.4.5.6 Category specific planned improvements

There is currently no planned improvement projects.

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4.4.6 Zinc production (CRT 2.C.6)

4.4.6.1 Category description

According to the IPCC 2006 Guidelines, there are three primary processes to produce zinc:

- Electro-thermic distillation: this is a metallurgical process that combines roasted concentrate and secondary zinc products into sinter that is combusted to remove zinc. Halides, cadmium, and other impurities. The reduction results in the release of non-energy CO_2 emissions.
- The pyrometallurgical process: this involves the utilization of an Imperial Smelting Furnace. Which allows for the simultaneous treatment of zinc and zinc concentrates. The process results in the simultaneous production of lead and zinc and the release of non-energy CO_2 emissions.
- Electrolytic: this is a hydrometallurgical technique. During which zinc sulphide is calcinated. Resulting in the production of zinc oxide. The process does not result in non-energy CO_2 emissions.

4.4.6.2 Methodological issues

Emissions from *Zinc production* were estimated using a Tier 1 approach.

4.4.6.2.1 Activity data

In the previous submission the *Zinc production* data was supplied by industry, however this was not available for the period 2018 to 2021 and an extrapolation was applied. The 2022 to 2024 data was sourced from industry.

4.4.6.2.2 Emission factors

The IPCC 2006 Guidelines default emission factor of 1.72 t CO_2 per tonne zinc produced was applied. It was assumed that for *Zinc production* it was 60% imperial smelting and 40% Waelz Kiln (IPCC, 2006).

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4.4.6.3 Uncertainties and time-series consistency

4.4.6.3.1 Activity data uncertainty

For *Zinc production* emissions there is a ±10% uncertainty on the activity data (IPCC 2006 Guidelines, Table 4.25).

4.4.6.3.2 Emission factor uncertainty

Uncertainty for default *Zinc production* emission factors has an uncertainty of ±50% (IPCC 2006 Guidelines, Page 4.25).

Time-series consistency

The time series is inconsistent as activity data has not been available consistently since 2017 and an extrapolation was undertaken to obtain data values where necessary.

4.4.6.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.4.6.5 Category specific recalculations

No recalculations were performed for this category.

4.4.6.6 Category specific planned improvements

There is currently no planned improvement projects.

4.4.7 Other (CRT 2.C.7)

No activities were included under this sub-category.

4.5 Non-Energy Products from Fuels and Solvent Use (CRT 2.D)

Non-energy use of fuels and solvents includes lubricants. Paraffin wax and solvents. Lubricants are divided into two types, namely, motor and industrial oils, and greases that differ in physical characteristics. Paraffin wax is used in products such as petroleum jelly,

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paraffin waxes and other waxes (saturated hydrocarbons). Paraffin waxes are used in applications such as candles, corrugated boxes, paper coating, board sizing, food production, wax polishes, surfactants (as used in detergents) and many others (IPCC, 2006, p.5.11). The use of solvents can result in evaporative emissions of various NMVOCs. Which can be oxidized and released into the atmosphere. According to the IPCC 2006 Guidelines (p. 5.16). white spirit is used as an extraction solvent. Cleaning solvent. Degreasing solvent and as a solvent in aerosols, paints, wood preservatives, varnishes and asphalt products. Lubricants are used in industrial and transport applications. Emissions from solvents are not estimated due to a lack of data.

4.5.1 Lubricant use (CRT 2.D.1)

4.5.1.1 Category description

According to the IPCC 2006 Guidelines Lubricants are produced either at refineries through separation from crude oil or at petrochemical facilities.

4.5.1.2 Methodological issues

A Tier 1 method was applied to this subcategory.

4.5.1.2.1 Activity data

The source of activity data for solvents was the energy balance tables published annually by the DoE. Activity data was interpolated for 2007 to 2010 using 2006 and 2011 data as the data was unreliable for this period. An extrapolation was applied from 2020 activity data, as the updated energy balance tables are currently unavailable.

4.5.1.2.2 Emission factors

The IPCC 2006 Guidelines default carbon content (20 tC/TJ) and oxidised fraction factor (0.2) applied to this subsector.

4.5.1.3 Uncertainties and time-series consistency

4.5.1.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines much of the uncertainty in emission estimates is related to the difficulty in determining the quantity of non-energy products used in individual countries. For this a default of 5% may be used in countries with well-

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developed energy statistics and 10 to 20 % in other countries. Based on expert judgement of the accuracy of energy statistics (IPCC 2006 Guidelines, Page 5.10). Therefore, an uncertainty range of ±10% to ±20% was used.

4.5.1.3.2 Emission factor uncertainty

The default oxidised during use (ODU) factors available in the IPCC 2006 Guidelines are uncertain, as they are based on limited knowledge of typical lubricant oxidation rates. Expert judgment suggests using a default uncertainty of 50% (IPCC, 2006, Page 5.10).

4.5.1.3.3 Time-series consistency

The time series is inconsistent as activity data has not been available for 2020 to 2024 and an extrapolation was undertaken to obtain data values.

4.5.1.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.5.1.5 Category specific recalculations

No recalculations were performed for this category.

4.5.1.6 Category specific planned improvements

The is a planned improvement project to determine the use of blended lubricant in two-stroke engines.

4.5.2 Paraffin wax use (CRT 2.D.2)

4.5.2.1 Category description

According to the IPCC 2006 Guidelines this category includes petroleum jelly, paraffin waxes and other waxes, including ozokerite (mixtures of saturated hydrocarbons, solid at ambient temperature). Paraffin waxes are separated from crude oil during the production of light lubricating oils.

4.5.2.2 Methodological issues

A Tier 1 method was applied to this subcategory.

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4.5.2.2.1 Activity data

The source of activity data for solvents was the energy balance tables published annually by the DMRE. An extrapolation was applied to the activity data from 2020, as the updated energy balance tables are currently unavailable.

4.5.2.2.2 Emission factors

The IPCC 2006 Guidelines default carbon content (20 tC/TJ) and oxidised fraction factor (0.2) applied to this subsector.

4.5.2.3 Uncertainties and time-series consistency

4.5.2.3.1 Activity data uncertainty

According to the IPCC 2006 Guidelines much of the uncertainty in emission estimates is related to the difficulty in determining the quantity of non-energy products used in individual countries. For this a default of 5% may be used in countries with well-developed energy statistics and 10 to 20 % in other countries, based on expert judgement of the accuracy of energy statistics (IPCC, 2006, Page 5.13).

4.5.2.3.2 Emission factor uncertainty

The default ODU factors available in the IPCC 2006 Guidelines are very uncertain, as they are based on limited knowledge of typical lubricant oxidation rates. Expert judgment suggests using a default uncertainty of 50%. The carbon content coefficients are based on two studies of the carbon content and heating value of lubricants from which an uncertainty range of about ±3 % was estimated (IPCC, 2006, Page 5.13).

4.5.2.3.3 Time-series consistency

The time series is inconsistent as activity data has not been available from 2020 and an extrapolation was undertaken to obtain data values.

4.5.2.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.5.2.5 Category specific recalculations

No recalculations were performed for this category.

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4.5.2.6 Category specific planned improvements

There are no subcategory specific planned improvements, but any updated information from South Africa's GHG Reporting Programme.

4.5.3 Other (CRT 2.D.3)

No activities were included under this sub-category, due to the lack of data.

4.6 Electronics industry (CRT 2.E)

Emissions from the *Electronics industry* in South Africa are not estimated due to a lack of data. DFFE will undertake a survey to estimate GHG emissions for this category and assess the significance of this sector and report progress in its future GHG inventory submissions.

4.7 Product Uses as Substitutes for Ozone Depleting Substances (ODS) (CRT 2.F)

The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion. HFCs and, to a limited extent, PFCs are ODS being phased out under this protocol.

According to the IPCC 2006 Guidelines, current application areas of HFCs and PFCs include refrigeration and air conditioning; fire suppression and explosion protection; aerosols; solvent cleaning; foam blowing; and other applications (equipment sterilisation, tobacco expansion applications, and as solvents in the manufacture of adhesives, coatings, and inks).

Emissions were only estimated from 2005 onwards due to a lack of data prior to that. The 2012 inventory only estimated emissions from refrigeration, but due to recent studies, this inventory includes emissions from air conditioning, foam blowing agents, fire protection and aerosols. Emissions from solvents are not estimated due to a lack of data.

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4.7.1 Refrigeration and air conditioning (CRT 2.F.1)

4.7.1.1 Category description

According to the IPCC 2006 Guidelines, refrigeration, and air-conditioning (RAC) systems may be classified in up to six sub-application categories:

- Domestic refrigeration;
- Commercial refrigeration including different types of equipment, from vending machines to centralised refrigeration systems in supermarkets;
- Industrial processes including chillers, cold storage, and industrial heat pumps used in the food, petrochemical and other industries;
- Transport refrigeration including equipment and systems used in refrigerated trucks, containers, reefers, and wagons;
- Stationary air conditioning including air-to-air systems, heat pumps, and chillers for building and residential applications; and
- Mobile air-conditioning systems used in passenger cars, truck cabins, buses, and trains

4.7.1.2 Methodological issues

The IPCC 2006 Guidelines (IPCC, 2006) propose either an emissions factor approach at the sub-application level (Tier 2a) or a mass balance approach at the sub-application level (Tier 2b) to calculate emissions from RAC applications.

In the HFC Emissions Database the emissions factor approach (Tier 2a) is primarily applied, with the mass balance approach applied for uncertainty purposes/checking. There was insufficient data to follow this approach for Commercial Refrigeration and Industrial Processes. Thus, a hybrid approach is applied for these sub-applications, which were combined into one application. Table 4.8 summarises the approach used for each sub-application in the RAC sector.

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Table 4.8: Methodology and data sources used for each RAC sub-application

Sub-application	Method	Motivation
Domestic Refrigeration	Tier 2a (2b)	Estimated the yearly data on existing, new and retired domestic refrigerators in South Africa based on data from Stats SA. Emission factors based on IPCC (2006) and other international studies. Estimated yearly sales of R134a for servicing and/or new equipment into domestic refrigeration from survey for cross checking.
Commercial Refrigeration and Industrial Processes	Tier 2b	Estimated early sales of refrigerants into commercial refrigeration. Assumed share of refrigerant taken up into charging of new equipment. Emission factors based on IPCC (2006) and other international studies.
Stationary Air Conditioning	Tier 2a	Yearly data on stationary air conditioning units (BSRIA) Emission factors based on IPCC (2006) and other international studies. Estimated yearly sales of refrigerants into stationary air conditioning for servicing and/or new equipment from survey for cross checking.
Transport Refrigeration	Tier 2a (2b)	Yearly data on existing. new and retired refrigerated trucks based on previous studies (GIZ, 2014) and expert knowledge (SARDA). Emission factors based on IPCC (2006) and other international studies. Estimated yearly sales of R134a and R404a into transport refrigeration for servicing and/or new equipment from survey for cross checking.
Mobile Air Conditioning	Tier 2a (2b)	Yearly data on existing. new and retired vehicles from eNaTIS and NAAMSA. Emission factors based on IPCC (2006) and other international studies. Estimated yearly sales of R-134a into mobile air conditioning for servicing and/or new equipment from survey for cross checking.

4.7.1.2.1 Activity data

Stakeholders in the refrigeration and air conditioning sector in South Africa were identified by means of desktop research and the membership lists of the various industry associates in the refrigeration and air conditioning sector, such as the South African Institute of Refrigeration and Air Conditioning (SAIRAC), the South African Refrigeration & Air Conditioning Contractors' Association (SARACCA) and SARDA.

Other sources included the members of the DFFE's Chemical Management Hydrochlorofluorocarbons (HCFC) working group, and importers and exporters listed in the International Trade Centre (ITC) website (Market Analysis and Research). Other literature and statistical data sources provided the activity data for other sub-applications, e.g., eNaTIS for vehicle data for mobile air conditioning and transport refrigeration and Stats SA for data on the number of households with refrigerators.

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Printed by and obtainable from the Government Printer, Bosman Street, Private Bag X85, Pretoria, 0001
Contact Centre Tel: 012-748 6200. eMail: info.egazette@gpw.gov.za
Publications: Tel: (012) 748 6053, 748 6061, 748 6065

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Government Gazette
Staatskoerant

REPUBLIC OF SOUTH AFRICA
REPUBLIEK VAN SUID AFRIKA

Vol. 731 29 May Mei 2026 No. 54758

PART 3 OF 7

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ISSN 1682-5845

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Activity data from 2016 onwards was extrapolated due to inconsistent data availability.

4.7.1.2.2 Emission factors

It was assumed that the equipment lifespan was 15 years and the emission factor from the installed base was 15% (IPCC, 2006). The percentage of HFC destroyed at the end-of-life was assumed to be 25% (IPCC, 2006).

4.7.1.3 Uncertainties and time-series consistency

4.7.1.3.1 Activity data uncertainty

An uncertainty of ±25% was assumed for activity data (IPCC, 2006).

4.7.1.3.2 Emission factor uncertainty

An uncertainty of ±25% was assumed for emission factors (IPCC, 2006).

4.7.1.3.3 Time-series consistency

Time series is not consistent over the full 20-year period as emission data is only available from 2005, with an enhanced data set (including mobile air conditioning) from 2011. Activity data from 2016 onwards was extrapolated due to inconsistent data availability.

4.7.1.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.7.1.5 Category specific recalculations

No recalculations were performed for this category.

4.7.1.6 Category specific planned improvements

It is planned that the HFC survey will be updated and will focus mostly on the refrigeration and air conditioning sector to improve emissions estimates form this category.

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4.7.2 Foam blowing agents (CRT 2.F.2)

4.7.2.1 Category description

HFCs are being used as replacements for Chlorofluorocarbons (CFCs) and HCFCs in foams and particularly in insulation applications according to the IPCC 2006 Guidelines. Compounds that are being used include HFC-245fa, HFC-365mfc, HFC-227ea, HFC-134a, and HFC-152a. The division of foams into open-cell or closed-cell relates to the way in which blowing agent is lost from the products.

For open-cell foam. emissions of HFCs used as blowing agents are likely to occur during the manufacturing process and shortly thereafter. In closed-cell foam, only a minority of emissions occur during the manufacturing phase. Emissions therefore extend into the in-use phase, with often the majority of emissions not occurring until end-of-life (de-commissioning losses).

4.7.2.2 Methodological issues

HFC emissions from foam blowing applications are calculated in the HFC Emissions Database following the approach in the IPCC 2006 Guidelines (Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances), as given in Equation 3 (IPCC, 2006). This formula calculates the emissions based on the amount of HFC lost during manufacture and the first year of foam use, the annual amount lost from HFC-containing foams in use (banks), and the amount lost at the end of the foams' life when products are decommissioned, less the amount of HFC recovered or destroyed from decommissioned foam products.

4.7.2.2.1 Activity data

Where data is difficult to obtain in the country the IPCC 2006 Guidelines suggest obtaining historic regional usage to account for HFC banks and emissions factors from the UNEP Foams Technical Options Committee (FTOC). The latest United Nations Environmental Programme (UNEP) FTOC report suggests that in 2008 only 0.15% of the foam bank within developing nations contained HFCs and that sub-Saharan Africa had not utilised any HFC for foam manufacture at this time (UNEP, 2010). This suggests that the HFC-containing foam bank in South Africa is limited and the foam bank in the HFC Emissions are therefore estimated by simply extrapolating the annual net consumption data for 2010-2020 back to the date HFC blowing agent was introduced into South Africa (2005). Activity data was assumed to be stable from 2016.

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4.7.2.2.2 *Emission factors*

It was assumed that the equipment lifespan was 15 years and the emission factor from the installed base was 15% (IPCC, 2006). The percentage of HFC destroyed at the end-of-life was assumed to be 25% (IPCC, 2006). Other factors applied are shown in Table 4.9.

Table 4.9: Emission factors and defaults applied in the foam blowing agents emission estimates

Sub-category	Value	Units	Source
Product life	34	Years	(UNEP, 2005; IPCC. 2006)
First year loss	14	%	
Annual loss	0.66	%	
Landfilling loss	16	%	
Landfill annual loss	0.75	%	

4.7.2.3 Uncertainties and time-series consistency

4.7.2.3.1 *Activity data uncertainty*

An uncertainty of ±25% was assumed for activity data (IPCC, 2006).

4.7.2.3.2 *Emission factor uncertainty*

An uncertainty of ±25% was assumed for emission factors (IPCC, 2006).

4.7.2.3.3 *Time-series consistency*

Time series is not consistent over the full 20-year period as emission data for this sub-category is only available from 2011. Due to a lack of consistency in data availability, activity data was assumed to be the same from 2016.

4.7.2.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.7.2.5 Category specific recalculations

No recalculations were performed for this category.

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4.7.2.6 Category specific planned improvements

No improvements are planned currently.

4.7.3 Fire protection (CRT 2.F.3)

4.7.3.1 Category description

According to the IPCC 2006 Guidelines there are two general types of fire protection (fire suppression) equipment that use HFCs and/or PFCs as partial replacements for halons: portable (streaming) equipment, and fixed (flooding) equipment. While actual emissions from the fire protection sub-sector are expected to be quite small, the use is normally non-emissive in provision of stand-by fire protection and is growing.

4.7.3.2 Methodological issues

Emissions from fire protection applications are expected to be small because their use is non-emissive, that is, they are used in the provision of stand-by fire protection equipment. However, this does result in an accumulating bank of gas that has the potential to be released in the future when equipment is decommissioned (IPCC, 2006). The emissions from the fire protection sector are calculated in accordance with the approach suggested by the IPCC 2006 Guidelines, Equation 12 and Equation 13.

4.7.3.2.1 Activity data

Emissions from fire protection equipment are estimated using local sales data from eight importers/distributors of fire protection equipment and gases. This yielded very similar results to those calculated from net consumption (imports minus exports) of ten companies importing fire suppression agents. Activity data from 2016 onwards was extrapolated due to inconsistent data availability.

4.7.3.2.2 Emission factors

Emissions from Fire Protection were calculated in accordance with the IPCC 2006 Guidelines and an emission factor was calculated based on the fraction of agent in equipment emitted each year (excluding emissions from retired equipment or otherwise removed from service), dimensionless. However, none of the contractors or wholesalers of the agents interviewed could provide an estimation of the fraction of agent emitted each year the emissions of agent during recovery, recycling or disposal at the time of removal from service. However, experience gained with the emissions patterns of halon

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substances has yielded valuable lessons in terms of emissions factors for fire suppression agents. A proposed emissions factor of 4% of in-use quantities is assumed. as proposed by the IPCC (IPCC, 2006).

4.7.3.3 Uncertainties and time-series consistency

4.7.3.3.1 Activity data uncertainty

An uncertainty of ±25% was assumed for activity data (IPCC, 2006).

4.7.3.3.2 Emission factor uncertainty

An uncertainty of ±25% was assumed for emission factors (IPCC, 2006).

4.7.3.3.3 Time-series consistency

Time series is not consistent over the full 20-year period as emission data for this sub-category is only available from 2011. Activity data from 2016 onwards was extrapolated due to inconsistent data availability.

4.7.3.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.7.3.5 Category specific recalculations

No recalculations were undertaken for this category as they were not previously estimated.

4.7.3.6 Category specific planned improvements

No further improvements are planned for this sub-category.

4.7.4 Aerosols (CRT 2.F.4)

4.7.4.1 Category description

Most aerosol packages contain hydrocarbon (HC) as propellants but. in a small fraction of the total. HFCs and PFCs may be used as propellants or solvents. Emissions from

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aerosols usually occur shortly after production. on average six months after sale. During the use of aerosols, 100 percent of the chemical is emitted. The 5 main sub-applications are as follows:

- Metered dose inhalers (MDIs)
- Personal care products (e.g., hair care. deodorant. shaving cream)
- Household products (e.g., air-fresheners. oven and fabric cleaners)
- Industrial products (e.g., special cleaning sprays such as those for operating electrical contact. lubricants. pipe-freezers)
- Other general products (e.g., silly string. tyre inflators. klaxons)

4.7.4.2 Methodological issues

An emission factor approach on a sub-application level (Tier 2a) was applied to calculate emissions from aerosols. However, data from gas suppliers could not be disaggregated into sub-applications, resulting in a Tier 1a approach being applied in addition to the Tier 2a approach.

4.7.4.2.1 Activity data

Data on the number of aerosol products sold locally at the sub-application level (e.g. number of individual metered dose inhalers, hair care products, and tyre inflators. etc.), as well as the average charge of propellant per container, is required. In the HFC emissions database aerosols are grouped into the following sub-applications:

- MDIs;
- Personal care products;
- Household products;
- Industrial products; and
- Other general products.

Data on aerosol imports and exports had to be obtained directly from the companies/distributors, as trade data could not be used because official import statistics for aerosol products do not differentiate HFC-containing aerosols from other alternatives. Furthermore, import/export figures are typically reported in million units with no indication of the mass of the product or the type or loading of propellant, rendering them unusable for HFC emissions estimation. Due to a lack of consistency in data availability, activity data was assumed to be the same from 2016.

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4.7.4.2.2 *Emission factors*

The simplified default approach in Equation 2 assumes that all emissions associated with aerosols and metered dose inhalers occur during the use phase, that there are zero losses on the initial charge of the product during manufacture, zero leakages during the life of the product and zero emissions from the disposal of the product. A product life span of two years translates to a default EF of 50% of the initial charge per year (IPCC, 2006).

4.7.4.3 Uncertainties and time-series consistency

4.7.4.3.1 *Activity data uncertainty*

An uncertainty of ±25% was assumed for activity data (IPCC, 2006).

4.7.4.3.2 *Emission factor uncertainty*

An uncertainty of ±25% was assumed for emission factors (IPCC, 2006).

4.7.4.3.3 *Time-series consistency*

Time series is not consistent over the full 20-year period as emission data for this sub-category is only available from 2011. Due to a lack of consistency in data availability, activity data was assumed to be the same from 2016.

4.7.4.4 Category specific QA/QC and verification

No specific QC checks were completed for this sub-category.

4.7.4.5 Category specific recalculations

No recalculations were performed for this category as they were not previously estimated.

4.7.4.6 Category specific planned improvements

No improvements are currently planned.

4.7.5 Solvents (CRT 2.F.5)

No activities were included under this sub-category, due to the lack of data.

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4.8 Other product manufacture and use (CRT 2.G)

Emissions from this category were not estimated for South Africa due to a lack of data.

4.9 Other (CRT 2.H)

Emissions from this category were not estimated for South Africa due to a lack of data from the Pulp and Paper Industry and the Food and Beverages Industry.

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Chapter 5: Agriculture (CRT sector 3)

5.1 Sector overview

This chapter includes GHG emissions from Agriculture sector. Agriculture in South Africa is a vital sector of the economy, contributing significantly to employment and GDP. The country has diverse agricultural activities, including crop farming, livestock production, and horticulture. Major crops include maize, wheat, sugarcane, and citrus fruits, while livestock farming focuses on cattle, sheep, and poultry.

Table 5.1 presents the IPCC categories considered in estimating GHG emissions from the Agriculture sector. The inventory includes emissions from Enteric Fermentation (3A), Manure Management (3B), Direct and Indirect N_2O emissions from managed soils (3D1 and 3D2), Field Burning of Agricultural Residues (3F), Liming (3G), and Urea Application (3H). These categories represent the primary sources of emissions within the sector. Certain categories, such as Rice Cultivation (3C) and Other Carbon-Containing Fertilizers (3I), are classified as "Not Estimated (NE)" due to their negligible contribution or lack of activity data. Prescribed Burning of Savannahs (3E) is reported under a the LULUCF sector and therefore marked as "Included Elsewhere (IE)," while the category labelled "Other" (3J) is identified as "Not Occurring (NO)" within the national context. This classification ensures transparency in reporting and highlights the main emission sources considered under the Agriculture sector in line with IPCC 2006 Guidelines.

Table 5.1: Main IPCC categories included in the Agriculture sector emission estimates

IPCC Category	Category name	Included
3A	Enteric fermentation	√
3B	Manure management	√
3C	Rice cultivation	NE
3D1	Direct N_2O emissions from managed soils	√
3D2	Indirect N_2O from managed soils	√
3E	Prescribed burning of savannahs	IE
3F	Field burning of agricultural residues	√
3G	Liming	√

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3H	Urea application	√
3I	Other carbon containing fertilisers	NE
3J	Other	NO

Livestock included are dairy cattle, other cattle, sheep, goats, horses, mules and asses, swine and poultry. Emissions from ruminants in privately owned game parks were excluded due to comments made during the UNFCCC review.

Rice cultivation is not included, as it is regarded as insignificant. Prescribed burning of savannahs is included in the land sector. Other carbon containing fertilisers (3I) and Other (3J) are not estimated. More research needs to be done on other carbon containing fertilisers (3I).

Emissions from fuel combustion in this sector are not included here as these falls under Transport (category 1A4c *Agriculture/forestry/fisheries*) in the Energy sector subsector (see Section 3.2.8).

5.1.1 Shares and trends in emissions

Agricultural emissions have remained relatively stable between 1990 and 2024, fluctuating around 55 000–60 000 Gg CO_2e, with a slight overall decline. *Enteric fermentation* is the dominant source, consistently contributing about 70–75% of total emissions, while agricultural soils are the second-largest contributor, followed by manure management. Other sources such as field burning, liming, and urea application have minimal and nearly constant contributions. Emissions peaked slightly between 2010 and 2015 before gradually declining, with recent years (2020–2024) showing a downward trend compared to the peak.

In 2024, the Agriculture sector produced approximately 52 744 Gg CO_2e, accounting for 11% of South Africa's total emissions (excl. LULUCF). *Enteric fermentation* remained the dominant source category, contributing close to 36 048 Gg CO_2e in 2024, which is about 68% of the sector's emissions (Figure 5.1). The overall trend continues to show a gradual decline compared to earlier years, with total emissions in 2024 being roughly 12% lower than 2000 levels. This reduction is largely attributed to a sustained decrease in livestock population numbers and improved manure and soil management practices.

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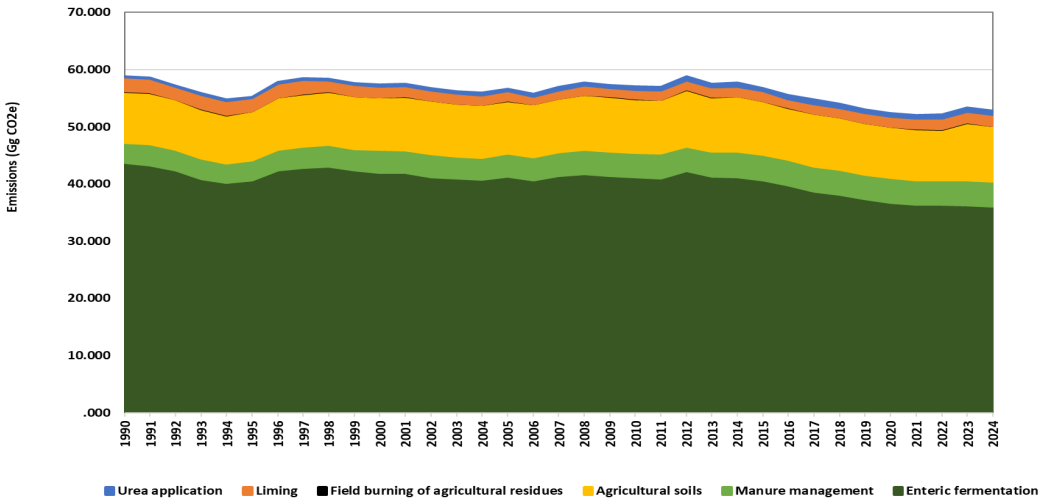


Figure 5.1: Trend in emissions from Agriculture sector, 1990-2024

5.1.1.1 Enteric fermentation

Figure 5.2 illustrates the trend in enteric fermentation emissions from 1990 to 2024, showing contributions from various livestock categories. Overall emissions declined from 43 687 Gg CO_2e in 1990 to 36 048 Gg CO_2e in 2024, indicating a gradual downward trend over the period. Non-dairy cattle consistently remained the dominant source, followed by sheep and dairy cattle, while minor contributors such as goats, horses, mules and asses, and swine exhibited negligible and stable emissions throughout the time series. A slight peak occurred between 2010 and 2013, after which emissions decreased significantly, particularly from 2015 onwards, largely due to reductions in livestock populations and improved management practices.

In 2022 the *Enteric Fermentation* category contributed 36 351 Gg CO_2e, with non-dairy cattle and sheep being the largest contributors (Table 5.2). By 2024, emissions further declined to 36 048 Gg CO_2e, representing a 5.1% decrease compared to 2022. Emissions from horses, which showed a slight increase between 2000 and 2022, stabilized in 2024, while emissions from all other livestock types continued to decline. This sustained reduction reflects ongoing structural changes in the agricultural sector, including herd size adjustments and improved feeding and manure management practices.

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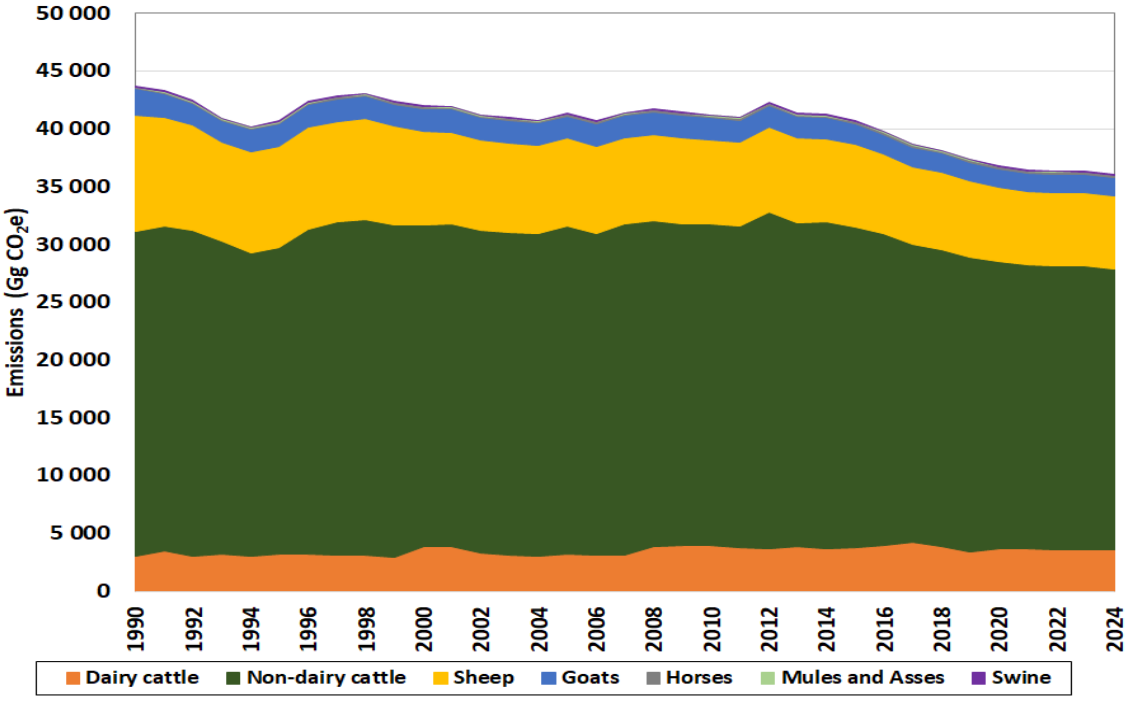


Figure 5.2: *Enteric fermentation* emission trends, 1990-2024

Table 5.2: *Enteric fermentation* emission trends, 1990-2024

	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Mules & asses	Total
	(Gg CO_2e)							
1990	3 021	28 133	10 020	49	2 285	116	63	43 687
1991	3 492	28 063	9 467	54	2 021	116	63	43 275
1992	3 021	28 199	9 117	53	1 883	116	63	42 451
1993	3 217	27 076	8 603	53	1 779	118	63	40 909
1994	3 021	26 263	8 744	51	1 925	121	63	40 188
1995	3 217	26 510	8 762	51	1 952	123	63	40 678
1996	3 217	28 098	8 825	55	1 982	126	63	42 365
1997	3 099	28 833	8 680	55	1 975	129	63	42 833
1998	3 099	29 050	8 725	56	1 948	131	63	43 072
1999	2 982	28 685	8 546	57	1 915	130	63	42 378

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	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Mules & asses	Total
	(Gg CO_2e)							
2000	3 884	27 776	8 121	53	1 990	136	46	42 006
2001	3 884	27 877	7 930	54	2 022	136	46	41 949
2002	3 335	27 888	7 772	55	1 982	136	46	41 214
2003	3 099	27 901	7 787	54	1 952	136	46	40 975
2004	3 021	27 919	7 620	54	1 956	136	46	40 752
2005	3 217	28 386	7 579	53	1 950	136	46	41 367
2006	3 139	27 848	7 508	52	1 965	141	46	40 699
2007	3 099	28 674	7 470	53	1 923	146	46	41 411
2008	3 845	28 172	7 450	52	1 997	150	46	41 713
2009	3 923	27 892	7 445	52	1 946	151	46	41 455
2010	3 923	27 823	7 282	51	1 920	151	47	41 197
2011	3 806	27 794	7 270	51	1 888	154	47	41 009
2012	3 649	29 198	7 317	51	1 881	155	47	42 297
2013	3 884	28 023	7 314	51	1 847	156	48	41 323
2014	3 727	28 269	7 149	50	1 830	157	48	41 230
2015	3 806	27 741	7 076	49	1 800	159	47	40 678
2016	3 963	26 948	6 892	49	1 731	161	47	39 789
2017	4 237	25 777	6 726	48	1 679	163	46	38 676
2018	3 884	25 634	6 703	47	1 658	164	46	38 135
2019	3 453	25 436	6 609	45	1 612	165	46	37 365
2020	3 727	24 814	6 395	44	1 586	164	46	36 776
2021	3 649	24 560	6 375	43	1 580	165	46	36 418
2022	3 640	24 499	6 378	43	1 578	168	46	36 351
2023	3 639	24 493	6 339	43	1 577	169	46	36 306
2024	3 609	24 291	6 313	43	1 577	170	45	36 048

Note: Numbers may not add exactly due to rounding off.

Figure 5.3 presents livestock population trends in South Africa from 1990 to 2024, based on DALRRD data. The population of other cattle remained relatively stable between 12 and 13 million until around 2015, after which it declined to approximately 11 million by 2024, representing a decrease of about 8% compared to 1990 levels. Sheep numbers exhibited a significant upward trend, increasing from about 100 million in 1990 to nearly 170 million in 2024, which is an approximate 70% increase over the period. Poultry populations also grew steadily, rising from around 120 million to 160 million, an increase of roughly 33%. In contrast, dairy cattle numbers remained relatively constant at around 1.2–1.6 million, with a slight decline after 2010, amounting to an overall reduction of about 10% since 1990. Goat populations decreased from roughly 3 million in 1990 to

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below 2 million by 2024, a decline of approximately 33%, while swine populations remained stable at around 1.5 million. Horses, mules, and asses maintained very small and nearly constant populations throughout the time series. These trends indicate structural changes in livestock production systems, with notable growth in sheep and poultry and gradual reductions in cattle and goats, which align with observed declines in enteric fermentation emissions.

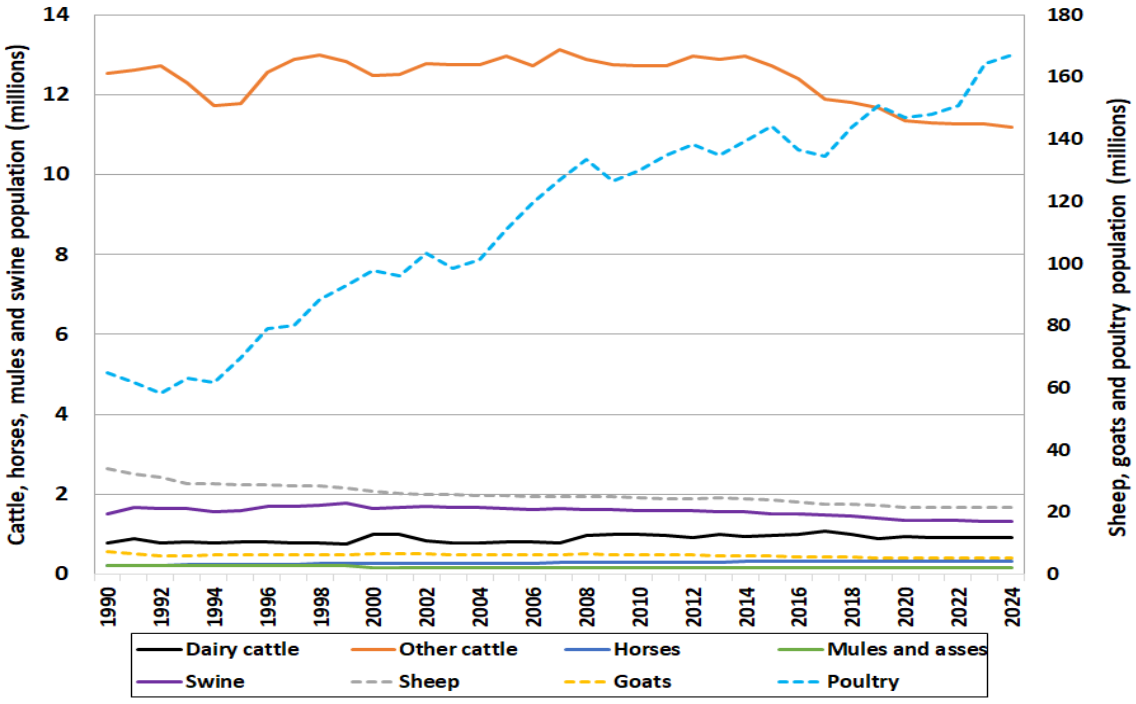


Figure 5.3: Livestock population trends, 1990-2024 (Data source: DALRRD, 2024)

Table 5.3 presents the changes in enteric fermentation emissions between 1990 and 2024, along with the relative contributions of different livestock categories. Overall, total emissions declined by 17.5%, from 43 687 Gg CO_2e in 1990 to 36 048 Gg CO_2e in 2024, indicating a downward trend over the long term. Despite this reduction, the distribution of emissions among species remained dominated by non-dairy cattle, which accounted for 67.4% of total enteric fermentation emissions in 2024, slightly higher than its 64.4% share in 1990.

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Sheep showed a significant decrease in emissions, dropping by 37%, and their share declined from 22.9% to 17.5%, reflecting changes in population or management practices. Dairy cattle, in contrast, experienced a 19.5% increase, raising their share from 6.9% to 10%, suggesting growth in dairy production systems. Other species such as goats, horses, and swine contributed marginally, with goats decreasing by 31% and horses increasing by 46.9%, though their overall shares remained below 1%.

Table 5.3: Change in *Enteric fermentation* emissions (1990-2024) and relative contribution of the various livestock categories to the total emissions

	Emissions		Change		Share of enteric fermentation (%)	
	(Gg CO_2e)		(1990-2024)			
	1990	2024	Diff	%	1990	2024
Dairy cattle	3 021	3 609	588.1	19.5	6.9	10.0
Non-dairy cattle	28 133	24 291	-3 842.0	-13.7	64.4	67.4
Buffalo	NO	NO				
Sheep	10 020	6 313	-3 706.8	-37.0	22.9	17.5
Goats	2 286	1 577	-708.4	-31.0	5.2	4.4
Camels	NO	NO				
Horses	116	170	54.4	46.9	0.3	0.5
Mules and asses	63	45	-17.6	-28.0	0.1	0.1
Swine	49	43	-6.5	-13.3	0.1	0.1
Other	NO	NO				
Total	**43 687**	**36 048**	**-7 638.8**	**-17.5**	**100**	**100**

Note: Numbers may not add exactly due to rounding off.

5.1.1.2 Manure management

As shown in Table 5.4, emissions from manure management increased from 3 573 Gg CO_2e in 1990 to 4 067 Gg CO_2e in 2024, representing a 13.8% rise over the period. This growth is primarily driven by nitrous oxide (N_2O) emissions, which increased by 406 Gg CO_2e (21.2%), while methane (CH_4) emissions grew modestly by 88 Gg CO_2e (5.3%).

The composition of emissions has shifted slightly. In 1990, methane contributed 46.4% of total manure management emissions, while nitrous oxide accounted for 53.6%. By

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2024, methane's share declined to 42.9%, whereas nitrous oxide increased to 57.1%, reinforcing its dominant role in this category.

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Table 5.4: Trends and changes in *Manure management* emissions, 1990-2024

	Emissions (Gg CO_2e)		Change (1990 – 2024)		Share of manure management	
	1990	2024	Diff	%	1990 %	2024 %
Methane	1 659	1 746	87.5	5.3	46.4	42.9
Nitrous oxide	1 914	2 321	406.2	21.2	53.6	57.1
Total manure management	**3 573**	**4 067**	493.7	13.8	100	100

Most of South Africa's livestock (cattle, sheep, goats, horses, mules and asses) are kept on pasture, range and paddock, therefore the *Manure management* category emissions were relatively small in 2022. Figure 5.4 shows that methane emissions from manure management remained relatively stable over the period 1990–2024, fluctuating between approximately 600 and 750 Gg CO_2e. Dairy cattle and non-dairy cattle are the dominant contributors, with dairy cattle accounting for the largest share, while swine provides a smaller but consistent contribution. Emissions from other species, including sheep, goats, horses, mules and asses, and poultry, are negligible. A slight increase in emissions occurred between 2010 and 2018, followed by a gradual decline toward 2024.

These emission trends closely reflect livestock population dynamics presented in Figure 5.4. The relatively stable manure management emissions correspond to the limited changes in dairy cattle and swine populations, which remained largely constant throughout the time series. The slight increase in emissions around 2010–2018 aligns with a period of marginal growth in cattle numbers, while the subsequent decline toward 2024 coincides with reductions in other cattle populations after 2015. In contrast, significant increases in sheep and poultry populations did not substantially affect manure management emissions, as these species contribute minimally to methane generation from manure. Overall, the stability of manure management emissions underscores the influence of cattle and swine populations and suggests that mitigation efforts should focus on improving manure handling practices for these species.

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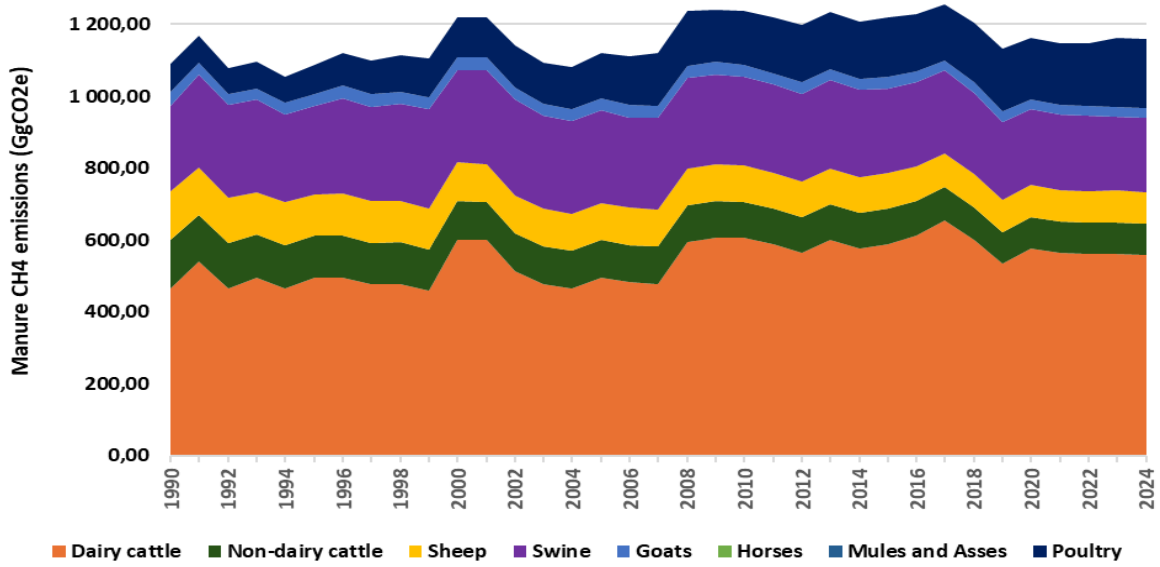


Figure 5.4: Trend in manure management CH_4 emissions from livestock, 1990-2024

Figure 5.5 illustrates the trend in nitrous oxide (N_2O) emissions from manure management in the livestock sector between 1990 and 2024. Overall emissions show a steady upward trajectory, increasing from 1 914 Gg CO_2e in 1990 to 2 654 Gg CO_2e in 2024, representing an increase of 38.6% over the period. Non-dairy cattle and dairy cattle are the dominant contributors, with non-dairy cattle accounting for the largest share, followed by dairy cattle. Sheep and swine contribute smaller but noticeable portions, while emissions from goats, horses, mules and asses, and poultry remain minimal. The growth in N_2O emissions correlates with the expansion of sheep and poultry populations observed in Figure 5.3, as well as changes in manure management practices. This upward trend contrasts with the relatively stable methane emissions from manure management (Figure 5.4), highlighting the increasing significance of N_2O emissions within the agricultural sector.

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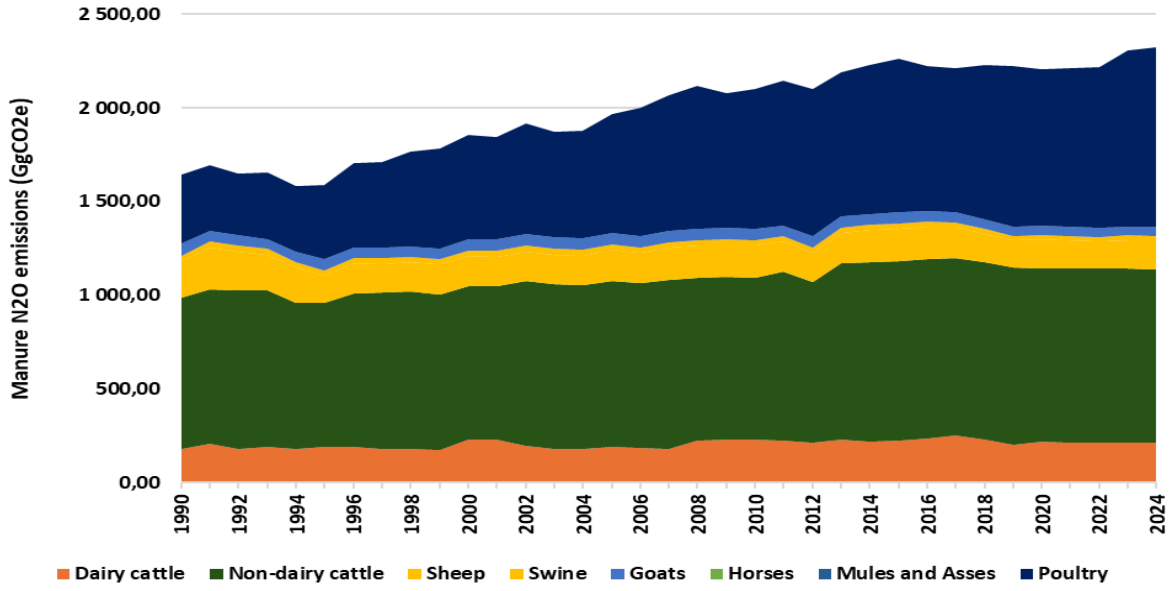


Figure 5.5: Trend in manure management N_2O emissions from livestock, 1990-2024

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Table 5.5 presents the time series of indirect N_2O emissions from manure management (IPCC category 3B5) for 1990–2024, expressed in Gg CO_2e. These emissions occur through two pathways: volatilization and leaching/runoff. Overall, emissions increased from 268 Gg CO_2e in 1990 to 333 Gg CO_2e in 2024, an approximate 24% rise. Between 2000 and 2024, emissions grew by 14.1%, with volatilization remaining the dominant pathway. Poultry manure shows the most significant growth across both pathways, increasing by 71% for volatilization and leaching, while other cattle manure rose moderately, contrasting with declines in dairy, swine, and goat manure. Recent changes between 2022 and 2024 indicate that poultry manure continues to drive increases, rising by 10.5% for volatilization and 10.9% for leaching, while emissions from cattle remain stable or slightly declining. These trends highlight the growing influence of poultry production and shifts in livestock management practices.

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Table 5.5: Indirect N_2O emissions from manure management (3B5), 1990-2024

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	Gg CO_2e														
Emissions due to volatilization															
Dairy cattle	41.80	44.52	53.75	44.52	54.29	52.66	54.83	58.63	53.75	47.78	51.58	50.49	50.37	50.35	49.94
Other cattle	127.97	122.28	129.79	140.27	136.23	152.44	153.72	152.43	151.94	151.69	148.16	149.32	149.11	149.09	148.41
Sheep	30.34	22.29	24.28	24.80	26.16	26.89	25.89	24.79	23.30	21.68	23.89	22.65	21.90	23.37	24.15
Swine	22.55	23.45	24.37	24.43	23.59	22.54	22.37	21.92	21.52	20.57	20.08	19.89	19.87	19.55	19.55
Goat	0.91	0.77	0.79	0.78	0.77	0.72	0.69	0.67	0.66	0.64	0.63	0.63	0.63	0.63	0.63
Poultry	23.36	24.86	34.55	39.04	45.94	50.85	48.38	47.46	50.82	53.58	52.17	52.53	53.51	58.33	59.11
Horses	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Mules and asses	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions due to leaching/runoff															
Dairy cattle	2.26	2.41	2.91	2.41	2.93	2.85	2.96	3.17	2.91	2.58	2.79	2.73	2.72	2.72	2.70
Other cattle	10.61	10.11	10.77	11.69	11.36	12.59	12.66	12.51	12.47	12.44	12.13	12.23	12.21	12.21	12.15
Sheep	2.61	1.92	2.09	2.13	2.25	2.31	2.23	2.13	2.00	1.87	2.05	1.95	1.88	2.01	2.08
Swine	0.35	0.37	0.38	0.38	0.37	0.35	0.35	0.34	0.33	0.32	0.31	0.31	0.31	0.30	0.30
Goat	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Poultry	5.43	5.83	8.16	9.25	10.85	12.03	11.41	11.22	11.99	12.59	12.26	12.37	12.58	13.72	13.95
Horses	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Mules and asses	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total Indirect N_2O emissions	268.28	258.88	291.89	299.77	314.81	336.28	335.55	335.34	331.75	325.80	326.10	325.14	325.16	332.34	333.03

Note: Numbers may not sum exactly due to rounding off.

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5.1.1.3 Agricultural soils

Table 5.6 summarizes changes in emissions related to agricultural soils between 1990 and 2024. Overall emissions in this category increased by 6.5%, from 11 544 Gg CO_2e in 1990 to 12 296 Gg CO_2e in 2024, indicating a relatively stable trend with moderate growth over the long term.

The largest contributor remains Direct N_2O emissions from managed soils (3D1), which rose slightly by 3.2% to 8 167 Gg CO_2e in 2024. Indirect N_2O emissions (3D2) increased significantly by 50%, reaching 1 514 Gg CO_2e, while urea application (3H) recorded the most dramatic growth of 637.1%, reflecting change of activity data source in the year 2024.

Conversely, liming (3G) declined by 23.5%, and field burning of agricultural residue (3F) decreased by 7.4%, suggesting progress in reducing emissions from these sources. These trends indicate that while some mitigation measures have been effective, increased nitrogen inputs through fertilizers remain a key driver of emissions growth.

Table 5.6: Changes in emissions related to agricultural soils between 1990 and 2024

Category	Emissions (Gg CO_2e)		Change (1990 – 2024)	
	1990	2024	Diff	%
3D1 Direct N_2O from managed soils	7 914	8 167	252.3	3.2
3D2 Indirect N_2O from managed soils	1 009	1 514	504.7	50.0
3F Field burning of agricultural residue	59	55	-4.4	-7.4
3G Liming	2 471	1 891	-579.9	-23.5
3H Urea application	91	671	579.8	637.1
Total	**11 544**	**12 296**	**752.6**	**6.5**

Note: Numbers may not sum exactly due to rounding off.

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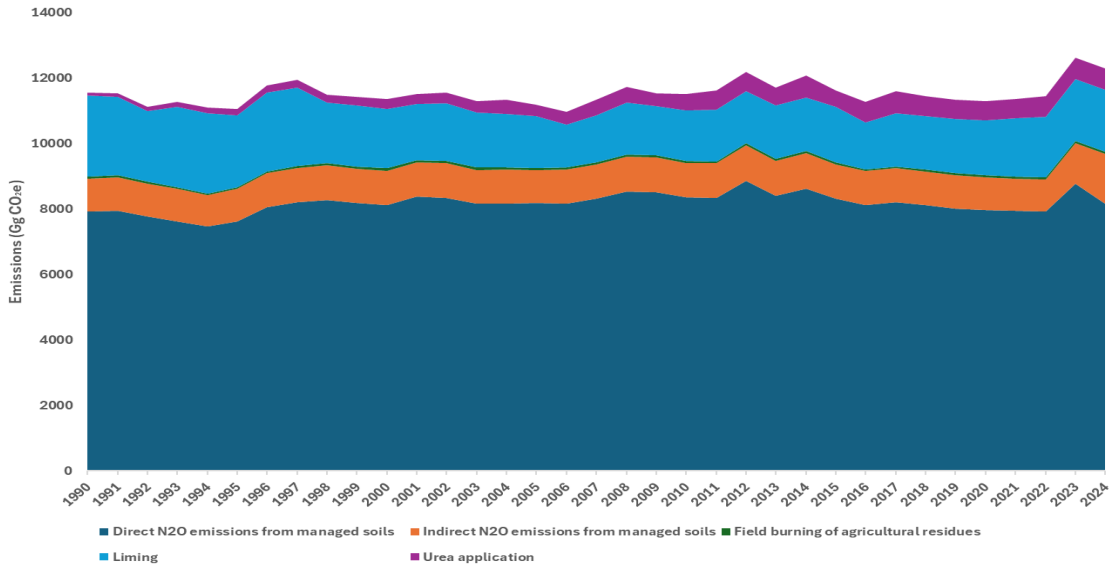


Figure 5.6: Trends in emissions related to agricultural soils, 1990-2024

Figure 5.6 illustrates trends in emissions related to agricultural soils from 1990 to 2024. Overall emissions fluctuated between 8 424 Gg CO_2e and 10 012 Gg CO_2e, with a slight increase toward 2024. *Direct N_2O emissions from managed soils* (Figure 5.6) consistently represent the largest share, increasing by about 15% over the period. Indirect N_2O emissions show a moderate rise of approximately 20%, while emissions from *Liming* grew by roughly 10%. *Urea application* increased significantly, by nearly 30%, reflecting greater use of nitrogen-based fertilizers. *Field burning of agricultural residues* remained negligible throughout the time series. A modest peak occurred around 2013–2015, followed by stabilization and a slight rise in recent years. These trends underscore the dominance of nitrogen-related processes in agricultural soils as a key driver of emissions, with notable growth in fertilizer-related sources.

5.1.2 Overview of methodology and completeness

The IPCC 2006 Guidelines (IPCC, 2006) is applied in this sector, with a few updated methodologies being taken from the IPCC 2019 Refinement (IPCC, 2019). Default constants and emission factors are also sourced from these two guideline documents, with details being provided in the methodology sections within each category section. Table 5.6 shows the methods and types of EF used in the Agriculture inventory.

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Table 5.6: Summary of methods, emission factors and completeness of the Agriculture sector emissions.

GHG Source and sink category		CO_2		CH_4		N_2O		NO_x	CO	NMVOC	NH_3
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
3A LIVESTOCK	***3.A Enteric fermentation***										
	3.A.1- Cattle										
	3.A.1.a - Dairy cows	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.1.b - Other cattle	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.2 - Sheep	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.3 - Swine	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.4 - Other										
	3.A.4.a - Buffalo	NA	NA	NO	NO	NA	NA	NA	NA	NA	NA
	3.A.4.b - Camels	NA	NA	NO	NO	NA	NA	NA	NA	NA	NA
	3.A.4.d - Goats	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.4.e - Horses	NA	NA	T1	DF	NA	NA	NA	NA	NA	NA
	3.A.4.f – Mules and Asses	NA	NA	T1	DF	NA	NA	NA	NA	NA	NA
	3.B Manure management										
	3.B.1- Cattle										
	3.B.1.a - Dairy cows	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
	3.B.1.b - Other cattle	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
	3.B.2 - Sheep	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE
	3.B.3 - Swine	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
	3.B.4 - Other										
	3.B.4.a - Buffalo	NA	NA	NO	NO	NO	NO	NE	NA	NA	NE
	3.B.4.b - Camels	NA	NA	NO	NO	NO	NO	NE	NA	NA	NE
	3.B.4.d - Goats	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE
	3.B.4.e - Horses	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE
	3.B.4.f – Mules and Asses	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE

GHG Source and sink category	CO_2		CH_4		N_2O		NO_x	CO	NMVOC	NH_3
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
3.B.4.g - Poultry	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
3.B.5-Indirect N_2O emissions										
3.C – Rice cultivation	NE		NE		NE					
3.D –Agricultural soils										
3.D.1 – Direct N_2O Emissions from managed soils										
Synthetic fertilizers	NA		NA		T1	DF		NA	NA	
Animal waste added to soils	NA		NA		T2	CS		NA	NA	
Other organic fertilizers	NA		NA		T1	DF		NA	NA	
Urine and dung deposited by grazing livestock	NA		NA		T2	CS		NA	NA	
Crop residues	NA		NA		T1	DF		NA	NA	
3.D.2 – Indirect N_2O Emissions from managed soils										
Atmospheric deposition	NA		NA		T1	DF				
Nitrogen leaching and runoff	NA		NA		T1	DF				
3.E – Prescribed burning of savannas										
Prescribed burning of savannas	NE		NE		NE					
3.F – Field burning of Agricultural residues										
Field burning of Agricultural residues	T2	DF, CS	T2	DF, CS	T2	DF, CS				
3.G - Liming										
Liming	T1	DF	NA		NA		NA	NA	NA	NA

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GHG Source and sink category		CO_2		CH_4		N_2O		NO_x	CO	NMVOC	NH_3
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
	3. H - Urea application										
	Urea application	T1	DF	NA		NA		NA	NA	NA	NA
	3.I – Other carbon containing fertilisers										
	Other carbon containing fertilisers	NE		NE		NE					
	3.J - Other										
	Other	NO		NO		NO					

NA = Not applicable; NO = Not occurring; NE = Not estimated; IE = Included elsewhere; T1 = Tier 1; T2 = Tier 2; DF = IPCC default factor; CS = Country specific factor.

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5.1.3 Improvements and recalculations

The agriculture sector is under continual improvement which leads to recalculations. The main inventory improvements that were carried out and which led to recalculations were:

- Included Organic soils for cropland and Grassland under agriculture sector
- Area of drained organic soils for cropland is 4 173 and 4 173 ha for 2023 and 2024 respectively.
- Area of drained organic soils for Grassland is 15 678 and 15 678 ha for 2023 and 2024 respectively.
- Included the IPCC 2019 Refinement EFs for soil management categories since it is disaggregated into wet and dry climate.
- Time-series (historical) data were included for the early years (1990–1999), and the dataset has now been extended to cover the period from 1990 to 2024.

The specific details of these improvements are discussed in the relevant category or sub-category sections within this report. The recalculations indicated a consistent trend; however, they also indicated a shift in the trend across the entire time series (Figure 5.7). After the recalculations, emissions are higher than those recorded in the previous inventory (Figure 5.7).

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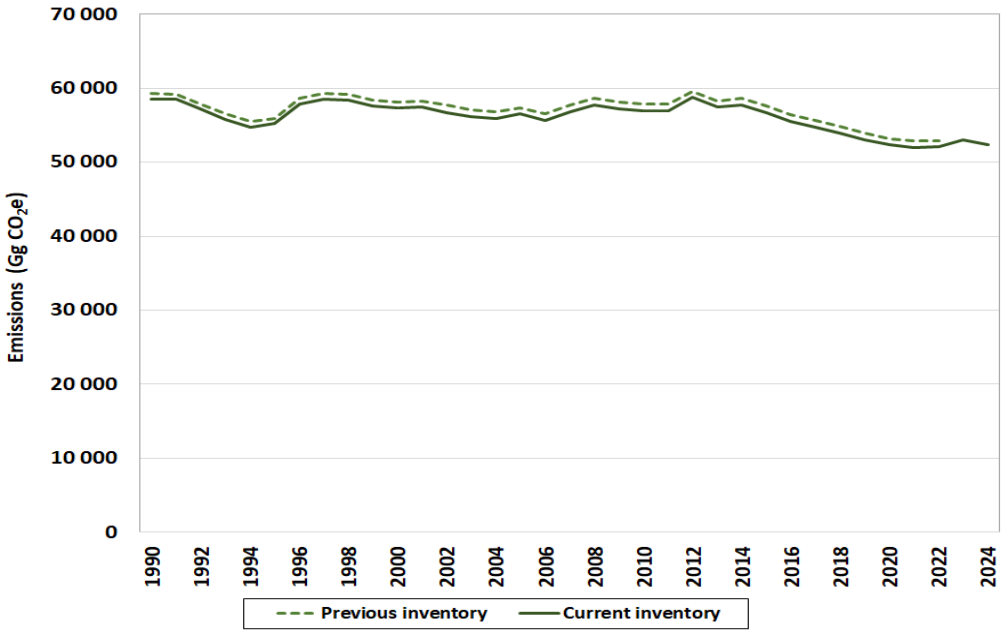


Figure 5.7: Change in Agriculture emission estimates due to recalculations since 2022 submission

5.1.4 Key categories in the Agriculture sector

The key categories for the Agriculture sector as determined by the level (L) and trend (T) assessment are shown in Table 5.7 The key categories identified for the Agriculture sector in 2024 are *Enteric fermentation* (CH_4) from non-dairy cattle, dairy cattle, sheep and goats. These were followed by poultry manure management (N_2O), and emissions from *Liming* and *Urea application* (CO_2).

Table 5.7: Key categories in the Agriculture sector in 2024

Key category rank	IPCC code	IPCC Category	GHG	Criteria
15	3.A.1.a.ii	Non-dairy Cattle	CH_4	L, T
16	3.A.2	Sheep	CH_4	L, T
37	3.A.4	Goats	CH_4	L, T

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Key category rank	IPCC code	IPCC Category	GHG	Criteria
39	3.A.1.a.i	Dairy Cattle	CH_4	L, T
40	3.B.4	Poultry	N_2O	T
41	3.G	Liming	CO_2	L, T
42	3.H	Urea Application	CO_2	T

#L = Level Assessment; T = Trend Assessment

5.1.5 QA/QC process and verification

The QA/QC processes implemented are described in detail in the sections for each category below. Furthermore, the QA/QC measures outlined in Table 5.8 were used for the agriculture sector calculation files.

Table 5.8: General QA/QC checks completed for the agriculture sector

QA/QC principle	Check
Accuracy	Activity data source
Accuracy	Correct units
Accuracy	Unit carry through
Accuracy	Method validity
Accuracy	Calculations check
Accuracy	Uncertainties
Accuracy	Double counting
Accuracy	Correct GWP
Accuracy	Notation keys
Accuracy, Completeness, Consistency, Transparency	Trend check
Accuracy, Transparency	Emission factor applicability
Accuracy, Transparency, Consistency, Completeness	Recalculations
Completeness, Comparability	Sub-category completeness
Consistency	Time series consistency
Transparency	Documentation
Transparency, Completeness, Consistency, Accuracy	Colour coding
Accuracy, Comparability	Cross check data
Accuracy	Spot checks
Transparency, Consistency	Data source referencing
Transparency	Links to source data

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QA/QC principle	Check
Transparency	Raw primary data
Accuracy	QA review

5.1.6 Planned improvements and recommendations

The following are planned improvements and recommendations for agriculture sector to improve estimates in the future:

a) Improving livestock population data has become increasingly important, as recent studies have refined emission factors, leaving population figures as the largest source of uncertainty. Establishing a Livestock Estimates Committee could help address this gap. The DFFE has begun discussions with the Department of Agriculture and the Agricultural Research Council, which hosts a dedicated livestock division, to explore potential collaboration on this matter.

b) National data set on manure management systems: This data seems to be highly variable depending on where the information comes from. In addition, data on the amount of manure being diverted to biogas needs to be included as this is a mitigation option and has been highlighted in previous inventory reviews. It is recommended to find a mechanism to track manure management practices or systems used in South Africa, as this could allow for incorporation of dynamics driven by changes in management regimes, and thus improve the accuracy of manure related emissions.

c) A detailed study on the herd composition of the various livestock and the number of days each livestock sub-category is alive in a year would contribute to a reduction in uncertainty.

d) Use appropriate MCFs depending on the average temperature for each year of the time series. Stratify the estimates depending on the average temperature in different regions in South Africa.

e) Collect data for Tier 2 approach on soil management category since as a key category.

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5.2 Enteric Fermentation (CRT 3.A)

5.2.1 Category description

Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which plant material consumed by an animal is broken down by bacteria in the gut under anaerobic conditions. A portion of the plant material is fermented in the rumen to simple fatty acids, CO_2 and CH_4. The fatty acids are absorbed into the bloodstream, and the gases vented by eructation and exhalation by the animal. Unfermented feed and microbial cells pass to the intestines.

According to IPCC 2006 Guidelines the method for estimating CH_4 emissions from enteric fermentation requires three basic steps:

- Divide livestock population into animal subgroups based on sex, age, and production level.
- Estimate the emission factors for each subgroup in terms of kilograms of CH_4 per animal per year.
- Multiply the subgroup emission factors by the subgroup populations to estimate subgroup emissions and sum across the subgroups to estimate total emission.

Enteric fermentation emissions decreased by 14.2% in the period 2000–2024. Enteric fermentation contributed 36 048 Gg CO_2e in 2024, which is 68.8% of the agriculture sector emissions. South Africa identified, through Tier 1 level and trend assessments, *Enteric fermentation* as a key source category. In accordance with IPCC good practice requirements Tier 2 methods are therefore used, to estimate *Enteric fermentation* emissions from the major livestock sub-categories.

5.2.2 Methodological issues

A Tier 1 methodology is used to calculate CH_4 emissions from enteric fermentation in horses, mules and asses by multiplying the population data by IPCC 2019 Refinement default emissions factors (IPCC Equation 10.19, IPCC 2019 Refinement).

For all other livestock a Tier 2 methodology was applied by following the basic IPCC equations:

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$$CH_4 \text{ emissions} = EF * Population$$

and

$$EF = (GE * (Ym/100) * 365 \text{ days}) / 55.65 \text{ MJ (kg } CH_4)^{-1}$$

Where:

EF = emission factor (kg CH_4 head^{-1} yr^{-1})

GE = gross energy intake (MJ head^{-1} day^{-1})

Ym = methane conversion factor (percentage gross energy in feed converted to methane) (Table 5.9)

These equations assume that the emission factors are for an entire year. Since the population data is census data it is assumed that the population data is representative of a typical population on any one day of the year.

Table 5.9: Methane conversion factors and their sources.

Livestock category	Sub-category	Breed	Methane conversion factor (Ym)
Dairy cattle	Mature female cows	Holstein	6[1]
		Jersey	6.3[1]
	Heifers (6 - 24 months)		7[1]
Other cattle	Commercial	All breeds	7[1]
	Subsistence		6.5[2]
	Feedlot		3[1]
Sheep	Commercial	All breeds	6.7[1]
	Subsistence		6.7[1]
	Feedlot		6.7[1]
Goats	Commercial	All breeds	5.5[1]
	Subsistence		5.5[1]
Swine	Commercial		0.7[3]
	Subsistence		0.7[3]

[1]IPCC 2019 Refinement, [2]IPCC 2006 Guidelines, [3]Du Toit et al. (2013c).

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5.2.2.1 Activity data: Livestock population

The data sources for the livestock population estimates are shown in Table 5.10. The main data source is the Abstracts of Agricultural Statistics (DALRRD, 2024a) which is a sustainable data source released every year. The livestock population data is collected 4 times in a year (every 3 months). For the year 2022, the data was initially collected in February, the second datasets were collected in May, the 3rd in August and the 4th in November. In addition, the total livestock numbers for cattle, sheep, goats and pigs are obtained from data provided by the DALRRD (2024b). The same data for number of animals of the various animal groups is used in all the different calculations of emissions.

Table 5.10: Livestock population data sources.

Livestock category		Data source
Cattle	Total cattle	DALRRD (2024b)
	Commercial dairy cows (>2yrs)	DALRRD (2024a)
	Commercial dairy heifers (1-2 yrs)	DALRRD (2024a)
	Feedlot cattle	Feedlot SA (2024)
	Commercial other cattle total	DALRRD (2024a)
	Subsistence cattle	Calculated (see text)
Sheep	Total sheep	DALRRD (2024b)
	Commercial sheep total	DALRRD (2024a)
	Feedlot sheep	Calculated from DALRRD (2024a) slaughter data (see text)
	Subsistence sheep	Calculated (see text)
Goats	Total goats	DALRRD (2024b)
	Commercial goats total	DALRRD (2024a)
	Subsistence goats	Calculated (see text)
Horses, mules and asses		FAOSTAT (2024)
Swine	Total swine	DALRRD (2024b)
	Commercial swine	Calculated (see text)
	Subsistence swine	Calculated (see text)
Poultry	Commercial broilers	Extrapolated based on the data from Leading edge Poultry Software CC (2024)
	Commercial broiler parents	Extrapolated based on the data from Leadingedge Poultry Software CC (2024)
	Commercial layers	Extrapolated based on the data from Leadingedge Poultry Software CC (2024)
	Commercial pullets	Extrapolated based on the data from Leadingedge Poultry Software CC (2024)

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Livestock category		Data source
	Subsistence broilers	Calculated (see text)
	Subsistence layers	Calculated (see text)

5.2.2.1.1 *Other cattle calves and subsistence cattle*

The total number of calves is obtained from the Abstracts of Agricultural Statistics (DALRRD, 2024a), but the feedlot cattle are all assumed to be calves, so these are subtracted from the total calves to obtain the estimate of commercial calves in the other cattle category.

The total number of cattle is provided by DALRRD (2024b). The number of dairy heifers and cows is subtracted from the total number of cattle to obtain the total number of other cattle. The Abstracts of Agricultural Statistics (2024a) provides the total commercial other cattle; therefore, this is subtracted from the total other cattle to obtain an estimate of the subsistence cattle population.

5.2.2.1.2 *Subsistence and feedlot sheep*

There is limited data on feedlot sheep, so several assumptions were applied. The number of sheep slaughtered is obtained from the Abstracts of Agricultural Statistics (DALRRD, 2024a). It was assumed that 70% of the slaughtered animals come from feedlots. Feedlot sheep are estimated to be in the feedlots on average for 35 days (pers. comm. Mokhele Moeletsi, 2021) and are weaned or sold at about 120 days which means the feedlot sheep are alive for 155 days. This data was applied to equation 10.1 of the IPCC 2006 Guidelines to determine the annual average population. The feedlot total is assumed to be included in the total commercial sheep numbers provided by Abstracts of Agricultural Statistics (DALRRD, 2024a).

The subsistence sheep population is estimated by subtracting the total commercial sheep (DALLRD, 2024a) from the total sheep (DALRRD, 2024b).

5.2.2.1.3 *Subsistence goats*

The subsistence goat population is estimated by subtracting the total commercial goats (DALLRD, 2024a) from the total goats (DALRRD, 2024b).

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5.2.2.1.4 *Commercial and subsistence swine*

The total swine population provided by DALRRD (2024b) is almost the same as that provided in the Abstracts of Agricultural Statistics (DALRRD, 2024a), suggesting that there are no subsistence swine. Du Toit et al (2013c) noted that there was a large discrepancy between DALRRD (2024a) data and data from industry with industry suggesting a much lower population. Du Toit et al. (2013c) indicated that 26% of the population was subsistence, so based on this it is assumed that the total swine population is as given in the DALRRD (2024b) data, but that this data is split into commercial and subsistence using the 0.26 ratio provided by Du Toit et al. (2013c).

5.2.2.1.5 *Poultry*

Commercial – Broilers and Commercial – Layers data was obtained from SAPA-Board-Report- 2023[18] and 2024.[19] South African Poultry Association (SAPA) is provided data by Leadingedge Poultry Software CC (2024). The data is modelled data. In this inventory the total broiler parents and pullets are also included. Data for parents and pullets are only available for 2018 onwards for these categories. A ratio between the parents and the broilers, as well as the pullets and the layers, is determined and this ratio is extrapolated (linear) backwards to 1990 to complete the time-series for the parent population.

Leading Poultry Software CC (2021) reports that in 2015, subsistence populations accounted for 4-5% of commercial poultry populations. The percentage (4%) is assumed to be constant between 2000 and 20015. In 2024, the projected number of subsistence poultry is 4-5% of commercial poultry, therefore, 5% was applied in 2024 and linear extrapolation was used to estimate the percentage of poultry subsistence poultry in other years.

5.2.2.2 *Activity data: Population characterisation and herd composition*

The previous inventory included more detailed characterization of livestock. This is based on a study conducted in 2010 (Du Toit et al., 2013a, b, c) which provided country-specific emission factors for all livestock types. The population data for the detailed livestock characterisation in the previous inventory utilised the same national data as provided in this inventory but applied the population and herd composition data provided in Du Toit et al. (2013a, b, c) to split the population into the more detailed categories. Subsequent to this there have been further studies on livestock emissions

[18] *https://www.sapoultry.co.za/wp-content/uploads/2024/07/SAPA-AR-2023.pdf*
[19] *https://www.sapoultry.co.za/wp-content/uploads/2025/06/SAPA-Board-Report-2024.pdf*

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which made use of fewer herd composition categories but added more detailed breed classes. To accommodate new data and improve consistency, the list of categories has been revised (Table 5.11) and some of the herd classes were aggregated. In addition, instead of incorporating the detailed category information into the population break down, the detail is incorporated into the emission factors. Thus, the national statistics population data categories are kept, and the detailed breed and herd composition data is used to calculate a weighted average emission factor (based on the composition and assumptions provided in Table 5.11) for each class. This way the national population data categories can be kept constant for reporting purposes, and any detailed data gathered in the future can be incorporated into the emission factors.

Table 5.11: Livestock characterization and herd composition data sources and assumptions

Main category	Production category	Subcategory	Herd composition data and assumptions
Dairy cattle	• High production (Holstein) • Medium production (Jersey)	• Mature female cows • Heifers (12-18 months) • Heifers (6-12 months) • Heifers (3-6 months)	Herd composition based on DALRRD (2021a) data; 57% Holstein and 43% Jersey; even distribution of heifer categories
Other cattle	• Commercial (Afrikaner; Angus; Beefmaster; Bonsmara; Boran; Brahams; Brangus; Braunvich; Charolais; Drakensburger; Hereford; Hugenoot; Limousin; Bradford; Santa Gertrudis; Simbra; Simmentaler; Susses; Wagyu; Tuli)	• Mature cows • Bulls • Young bulls • Heifers (12-18 months) • Heifers (6-12 months) • Heifers (3-6 months) • Ox • Young ox • Calves	Commercial herd composition based on ARC Report (2021) data; even distribution of heifer categories; herd composition assumed to be the same for all breeds; even distribution of breeds
	• Subsistence	• Mature cows • Bulls • Heifers (12-18 months) • Heifers (6-12 months) • Heifers (3-6 months) • Ox • Young ox • Calves	Subsistence herd composition based on ARC Report (2021) data; even distribution of heifer categories
	• Feedlot		All calves
Sheep	• Commercial wool (Merino) • Commercial meat (Dorper)	• Mature ewe • Replacement ewe • Mature ram • Young ram	Commercial sheep herd composition based on ARC Report (2021) data; even distribution of mature and replacement ewes;

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Main category	Production category	Subcategory	Herd composition data and assumptions
	• Commercial dual-purpose (Mutton Merino, Dohne merino)	• Female lamb • Male lamb	even distribution of mature and young rams; even distribution of male and female lambs; species distribution taken from ARC Report (2021a)
	• Subsistence	• Mature ewe • Replacement ewe • Mature ram • Young ram • Female lamb • Male lamb	Subsistence sheep herd composition based on ARC Report (2021) data; even distribution of mature and replacement ewes; even distribution of mature and young rams; even distribution of male and female lambs; all species assumed to be dual purpose
	• Feedlot		All weaned sheep
Goats	• Commercial (Angora; Boer) • Commercial dairy goat (Saanen; Toggenburg; British Alpine)	• Mature doe • Replacement doe • Mature buck • Young buck • Female kid • Male kid	Commercial goat herd composition based on ARC Report (2021) data; even distribution of mature and replacement does; even distribution of mature and replacement buck; even distribution of male and female kids; distribution of commercial and dairy goats taken from ARC Report (2021a); even distribution of dairy goats and also commercial goats
	• Subsistence	• Mature doe • Replacement doe • Mature buck • Young buck • Female kid • Male kid	Subsistence goat herd composition based on ARC Report (2021) data; even distribution of mature and replacement does; even distribution of mature and replacement buck; even distribution of male and female kids)
Horses, mules, asses	• All breeds		
Swine	• Commercial	• Boars • Cull boars • Replacement boars • Cull sows • Replacement sows • Dry gestating sows • Lactating sows • Pre-wean-piglets	Commercial swine herd composition based on Du Toit et al. (2013c) data
	• Subsistence	• Boars • Cull boars • Replacement boars • Cull sows • Replacement sows • Dry gestating sows	Commercial swine herd composition based on Du Toit et al. (2013c) data

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Main category	Production category	Subcategory	Herd composition data and assumptions
		• Lactating sows • Pre-wean-piglets	
Poultry	• Commercial • Subsistence	• Broilers • Broiler parents • Layers • Pullets	Composition determined from population data

5.2.2.3 *Emission factors*

Tier 1 IPCC 2019 Refinement default emission factors of 18 kg CH_4 head^{-1} yr^{-1} and 10 kg CH_4 head^{-1} yr^{-1} are applied to horses, and mules/asses, respectively (IPCC Table 10.10, IPCC 2019 Refinement). Emission factors for all other livestock are determined using the IPCC Tier 2 methodology. The emission factors for the detailed livestock categories are used to determine weighted averages (Table 5) for the livestock categories with population data. The weighting is based on the herd and breed composition assumptions provided in Table 5.

Table 5.12: Enteric fermentation emission factors and their sources per livestock category

Livestock category	Sub-category	Enteric EF (kg CH_4 head^{-1} yr^{-1})	Reference
Dairy cattle	Mature cows	141.07	Calculated (see text)
	Heifers	70.91	Calculated (see text)
Other cattle	Commercial bulls	113.00	Du Toit et al. (2013a)
	Commercial young bulls	51.6	Assumed the same as young ox
	Commercial cows	118.41	Calculated (see text)
	Commercial heifers	65.23	Calculated (see text)
	Commercial ox	89.40	Du Toit et al. (2013a)
	Commercial young ox	51.60	Du Toit et al. (2013a)
	Commercial calves	51.60	Du Toit et al. (2013a)
	Feedlot	41.61	Calculated (see text)
	Subsistence cattle	61.47	Calculated (see text)
Sheep	Commercial wool	9.95	Calculated (see text)
	Commercial dual-purpose	10.89	Calculated (see text)
	Commercial meat	13.80	Calculated (see text)
	Feedlot	7.22	Calculated (see text)
	Subsistence sheep	5.61	Calculated (see text)
	Commercial mohair	6.64	Calculated (see text)

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Livestock category	Sub-category	Enteric EF (kg CH_4 $head^{-1}$ yr^{-1})	Reference
Goats	Commercial meat	14.38	Calculated (see text)
	Commercial dairy	19.99	Calculated (see text)
	Subsistence goats	9.33	Calculated (see text)
Swine	Commercial swine	1.09	Calculated (see text)
	Subsistence swine	1.33	Calculated (see text)
Horses		18	IPCC 2019 Refinement, Table 10.10
Mules/asses		10	IPCC 2019 Refinement, Table 10.10

5.2.2.3.1 *Cattle (3.A.1)*

Emission factors for commercial and subsistence bulls, young bulls, ox, young ox and calves are taken directly from Du Toit et al. (2013a) where the methods are described in detail. For the other, more dominant livestock categories, all the background data is included in the calculation files to enable the direct calculation of the emission factors using the IPCC Tier 2 equations (Table 5.13).

5.2.2.3.2 *Sheep (3.A.2) and goats (3.A.4.d)*

Emission factors for sheep and goats are calculated using a Tier 2 methodology (Table 5.14). The net energy for growth and lactation for goats is determined in the same way as for sheep as the IPCC 2019 Refinement indicates that this is the updated approach for goats and Swine (3.A.3).

Gross energy intake data for swine is taken from Du Toit et al. (2013c) and applied in the IPCC Equation 10.21 to determine the emission factors.

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Table 5.13: Equations for the calculation of emissions factors for cattle using the Tier 2 approach

IPCC Equation	IPCC 2006 equations	Variables/constants/assumptions
10.3	$\mathrm{NE_m} = \mathrm{Cf}_i \times (weight)^{0.75}$	$\mathrm{NE_m}$ = net energy for maintenance (MJ day^{-1}) Cf_i = maintenance coefficient (MJ day^{-1} kg^{-1}) [IPCC 2019 Refinement, Table 10.4: Lactating dairy cows = 0.386, Non-lactating cattle = 0.322, Bulls = 0.37] *Weight* = live weight of animal (kg)
10.4	$\mathrm{NE_a} = \mathrm{C}_a \times \mathrm{NEm}$	$\mathrm{NE_a}$ = net energy for activity (MJ day^{-1}) $\mathrm{C_a}$ = coefficient corresponding to animal's feeding situation [Dairy cattle assumed to feed in pastures[1], other cattle assume to graze on large grazing areas[1]; IPCC 2019 Refinement, Table 10.5: Dairy cattle = 0.17, Other cattle = 0.36]
10.6	$\mathrm{NE_g} = 22.02 \times (\frac{BW}{C \times MW})^{0.75} \times (WG)^{1.097}$	$\mathrm{NE_g}$ = net energy for growth (MJ day^{-1}) BW = average live body weight of animals in the population (kg) C = growth coefficient [IPCC 2019 Refinement, Equation 10.6: Females = 0.8, Castrates = 1.0, Bulls = 1.2] MW = mature live body weight of an adult animal in moderate condition (kg) WG = average daily weight gain of animals in the population (kg day^{-1})
10.8	$\mathrm{NE_l} = Milk \times (1.47 + 0.40 \times Fat)$	$\mathrm{NE_l}$ = net energy for lactation (MJ day^{-1}) *Milk* = amount of milk produced (kg milk day^{-1}) *Fat* = milk fat content (% by weight)
10.11	$\mathrm{NE_{work}} = 0.10 \times \mathrm{NE_m} \times Hours$	$\mathrm{NE_{work}}$ = net energy for work (MJ day^{-1})

IPCC Equation	IPCC 2006 equations	Variables/constants/assumptions
		Hours = number of hours of work daily
10.13	$\mathrm{NE_p} = C_{preg} \times \mathrm{NE_m}$	$\mathrm{NE_m}$ = net energy for pregnancy (MJ day^{-1}) C_{preg} = pregnancy coefficient [IPCC 2019 Refinement, Table 10.7: Cattle = 0.1]
10.14	$REM = \left[1.123 - (4.092 \times 10^{-3} \times DE\%) + [1.126 \times 10^{-5} \times (DE\%)^2] - \left(\frac{25.4}{DE\%}\right)\right]$	REM = ratio of net energy available in a diet for maintenance to digestible energy consumed DE% = digestible energy as a percentage of gross energy [ARC (2021): Mature dairy cows = 70%, Dairy heifers = 60%, Other commercial cattle in grazing land = 60%, Cattle feedlot = 75%, Other subsistence cattle in grazing land = 50%]
10.15	$REG = \left[1.164 - (5.160 \times 10^{-3} \times DE\%) + [1.308 \times 10^{-5} \times (DE\%)^2] - \left(\frac{37.4}{DE\%}\right)\right]$	REG = ratio of net energy available for growth in a diet to digestible energy consumed DE% = digestible energy as a percentage of gross energy [see above]
10.16	$GE = \left[\frac{\left(\frac{\mathrm{NE_m} + \mathrm{NE_a} + \mathrm{NE_l} + \mathrm{NE_{work}} + \mathrm{NE_p}}{REM}\right) + \left(\frac{\mathrm{NE_g}}{REG}\right)}{\frac{DE\%}{100}}\right]$	GE = gross energy intake (MJ $head^{-1}$ day^{-1}) DE% = digestible energy as a percentage of gross energy [see above]
10.21	$EF = \left[\frac{GE \times \left(\frac{Y_m}{100}\right) \times 365}{55.65}\right]$	EF = emissions factor (kg CH_4 $head^{-1}$ yr^{-1}) Y_m = methane conversion factor (percent of gross energy in feed converted to methane) [IPCC 2019 Refinement, Table 10.12: Holstein high milk producing dairy cows = 6%, Jersey medium milk producing dairy cows = 6.3%, Dairy heifers = 7%, Non-dairy commercial cattle = 7%, Non-dairy subsistence cattle = 6.5, Feedlot cattle = 3%] 55.65 (MJ kg^{-1} CH_4) is the energy content of CH_4 constant

[1]ARC (2021)

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Table 5.14: Equations for the calculation of emissions factors for sheep and goats using the Tier 2 approach

IPCC Equation	IPCC 2006 equation	Variables/constants/assumptions
10.3	$\mathrm{NE_m} = \mathrm{Cf}_i \times (weight)^{0.75}$	$\mathrm{NE_m}$ = net energy for maintenance (MJ day^{-1}) $\mathrm{Cf_i}$ = maintenance coefficient (MJ day^{-1} kg^{-1}) [IPCC 2019 Refinement, Table 10.4: Mature and replacement ewes = 0.217, Mature ram = 0.250, Young ram and male lamb = 0.271, Female lamb = 0.236] Weight = live weight of animal (kg)
10.5	$\mathrm{NE_a} = \mathrm{C}_a \times (weight)$	$\mathrm{NE_a}$ = net energy for activity (MJ day^{-1}) $\mathrm{C_a}$ = coefficient corresponding to animal's feeding situation (MJ day^{-1}) [Sheep grazing assumed to occur on flat pastures[1]; IPCC 2019 Refinement, Table 10.5: all sheep = 0.0107] *Weight* = live weight of animal (kg)
10.7	$\mathrm{NE_g} = \frac{WG_{lamb/kid} \times (a + 0.5b(BW_i + BW_f))}{365}$	$\mathrm{NE_g}$ = net energy for growth (MJ day^{-1}) $WG_{lamb/kid}$ = weight gain (BW_f – BW_i) (kg yr^{-1}) BW_i = the live bodyweight at weaning (kg) BW_f = the live bodyweight at 1-year old or at slaughter (kg) a = constant (MJ kg^{-1}) [IPCC 2019 Refinement, Table 10.6: Female sheep = 2..1; Male sheep = 2.5 as it is assumed all male sheep are intact[1]] b = constant (MJ kg^{-1}) [IPCC 2019 Refinement, Table 10.6: Female sheep = 0.45; Male sheep = 0.35 as it is assumed all male sheep are intact[1]]
10.10	$\mathrm{NE_l} = \left[\frac{5 \times WG_{wean}}{365}\right] \times EV_{milk}$	$\mathrm{NE_l}$ = net energy for lactation (MJ day^{-1}) $\mathrm{WG_{wean}}$ = the weight gain of the lamb/kid between birth and weaning (kg)

IPCC Equation	IPCC 2006 equation	Variables/constants/assumptions
		EVmilk = the energy required to produce 1 kg of milk (MJ kg^{-1}) [IPCC 2019 Refinement, Equation 10.10: sheep = 4.6, goats = 3]
10.12	$\mathrm{NE}_{\mathrm{wool}} = \frac{EV_{wool} \times Production_{wool}}{365}$	NEwool = net energy required to produce wool (MJ day^{-1}) EV_{wool} = the energy value of each kg of wool produced (weighed after drying but before scouring) (MJ kg^{-1}) [IPCC 2019 Refinement, Equation 10.12: sheep = 24, for goats this energy value is not considered] $Production_{wool}$ = annual wool production per sheep (kg yr^{-1})
10.13	$\mathrm{NE}_{\mathrm{p}} = C_{preg} \times \mathrm{NE}_{\mathrm{m}}$	NE_m = net energy for pregnancy (MJ day^{-1}) C_{preg} = pregnancy coefficient [The number of lambs/kids born in a year divided by the number of ewes that are pregnant in a year yields a value less than 1[1], therefore single birth coefficient is applied[2]; IPCC 2019 Refinement, Table 10.7: single births for sheep and goats = 0.077]
10.14	$REM = \left[1.123 - (4.092 \times 10^{-3} \times DE\%) + [1.126 \times 10^{-5} \times (DE\%)^2] - \left(\frac{25.4}{DE\%}\right)\right]$	REM = ratio of net energy available in a diet for maintenance to digestible energy consumed DE% = digestible energy as a percentage of gross energy [ARC (2021): Sheep in grazing land = 60%, Sheep in feedlots = 75%, Subsistence sheep = 50%, Goats in grazing land = 60%, Dairy goats = 70%, Subsistence goats = 50%]
10.15	$REG = \left[1.164 - (5.160 \times 10^{-3} \times DE\%) + [1.308 \times 10^{-5} \times (DE\%)^2] - \left(\frac{37.4}{DE\%}\right)\right]$	REG = ratio of net energy available for growth in a diet to digestible energy consumed DE% = digestible energy as a percentage of gross energy [see above]

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IPCC Equation	IPCC 2006 equation	Variables/constants/assumptions
10.16	$GE = \left[\frac{\left(\frac{NE_m + NE_a + NE_l + NE_{work} + NE_p}{REM}\right) + \left(\frac{NE_g}{REG}\right)}{\frac{DE\%}{100}}\right]$	GE = gross energy intake (MJ head^{-1} day^{-1}) DE% = digestible energy as a percentage of gross energy [see above]
10.21	$EF = \left[\frac{GE \times \left(\frac{Y_m}{100}\right) \times 365}{55.65}\right]$	EF = emissions factor (kg CH_4 head^{-1} yr^{-1}) Y_m = methane conversion factor (percent of gross energy in feed converted to methane) [IPCC 2019 Refinement, Table 10.13: Sheep = 6.7%, Goats = 5.5%] 55.65 (MJ kg^{-1} CH_4) is the energy content of CH_4 constant

[1]ARC (2021); [2]IPCC 2019 Refinement

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5.2.3 Uncertainty and time-series consistency

5.2.3.1 Activity data uncertainty

5.2.3.1.1 Population data

Uncertainty data is provided in Moeletsi et al. (2015a), although it is not clear how the uncertainty was derived. In this report dairy population data is indicated to have an uncertainty of ±10%. Considering the comparisons above this uncertainty value appears reasonable. A ±10% uncertainty is also assigned to commercial beef cattle categories, except calves which has an uncertainty of ±5%. The comparisons with Du Toit et al. (2013a) suggest that the uncertainty could be around ±20%. The comparison is only for one year, therefore an uncertainty of ±20% is applied to all commercial beef cattle categories except calves (which remains at ±5%). Moeletsi et al. (2015a) indicate a ±10% uncertainty on commercial sheep and goat population data. The comparisons with Du Toit et al. (2013b) suggest that this uncertainty is reasonable for sheep but may be too low for goats. The goat uncertainty is therefore increased to ±20%. The ±10-20% uncertainty provided in Moeletsi et al. (2015a) for swine appears to be low with Du Toit et al. (2013c) reporting values 60% lower. The uncertainty for swine population is therefore increased to ±50%. Moeletsi et al. (2015a) does not provide uncertainty data for poultry but considering the comparisons with FAO and Du Toit et al. (2013c) an uncertainty of ±20% is assigned to poultry population data.

5.2.3.2 Emission factor uncertainty

The uncertainties on the emission factors are provided by ARC (2021) for mature cows, heifers, feedlot cattle, all sheep and all goat sub-categories (Table 5.15). No uncertainty data is provided by Du Toit et al. (2013c) for bulls, oxen, young oxen, calves, or swine emission factors. For the bulls, young bulls, oxen, young oxen, and calf sub-categories the uncertainty was assumed to be an average of those for mature cows and heifers in each sub-category. For swine IPCC 2006 Guidelines indicates that a Tier 2 approach is likely to have an uncertainty of around ± 20%. Tier 1 default factors for horses, and mules/asses have an uncertainty of between ± 30% - 50%, hence an average of ± 40% is applied.

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Table 5.15: Enteric fermentation emission factor uncertainties

Animal categories	Animal subcategories	Emission Factor uncertainty	Reference
3.A.1.a - Dairy cattle	Mature cows	± 23	ARC (2021)
	Heifer (12 – 18 months)	± 21	ARC (2021)
	Heifer (6 – 12 months)	± 17	ARC (2021)
	Heifer (3 – 6 months)	± 13	ARC (2021)
3.A.1.b - Commercial beef cattle	Bulls	± 10	Average of uncertainty estimates for cows and heifers
	Young bulls	± 10	
	Mature cows	± 7	ARC (2021)
	Heifer (12 – 18 months)	± 9	ARC (2021)
	Heifer (6 – 12 months)	± 9	ARC (2021)
	Heifer (3 – 6 months)	± 13	ARC (2021)
	Oxen	± 10	Average of uncertainty estimates for cows and heifers
	Young oxen	± 10	
	Calves	± 10	
	Feedlot cattle	± 15	ARC (2021)
3.A.1.b - Subsistence cattle	Bulls	± 26	Average of uncertainty estimates for cows and heifers
	Young bulls	± 26	
	Mature cows	± 24	ARC (2021)
	Heifer (12 – 18 months)	± 28	ARC (2021)
	Heifer (6 – 12 months)	± 27	ARC (2021)
	Heifer (3 – 6 months)	± 27	ARC (2021)
	Oxen	± 26	Average of uncertainty estimates for cows and heifers
	Young oxen	± 26	
	Calves	± 26	
3.B.2 - Sheep	Mature ewes	± 30	ARC (2021)
	Replacement ewes	± 22	ARC (2021)
	Female lambs	± 36	ARC (2021)
	Male lambs	± 27	ARC (2021)
	Young rams	± 33	ARC (2021)
	Rams	± 24	ARC (2021)
	Feedlot sheep	± 29	ARC (2021)
3.A.4.d - Goats	Mature does	± 35	ARC (2021)
	Replacement does	± 31	ARC (2021)
	Female kids	± 34	ARC (2021)
	Male kids	± 34	ARC (2021)
	Young buck	± 39	ARC (2021)
	Buck	± 40	ARC (2021)
3.A.4.e - Horses		± 40	IPCC 2006

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Animal categories	Animal subcategories	Emission Factor uncertainty	Reference
3.A.4.f - Mules & asses		± 40	IPCC 2006
3.A.3 - Swine		± 20	IPCC 2006

5.2.3.3 Time-series consistency

The time-series for enteric fermentation is consistent.

5.2.4 Category specific QA/QC and verification

5.2.4.1 Livestock population data

Livestock data were compared with FAO data and other studies. For all livestock except poultry, the national statistics data (DALRRD, 2022a) used in this inventory correspond to those in the FAO database. There were small differences in the early years (1990 – 2002), but the data were then adjusted accordingly. Regarding poultry data, the data applied in this inventory are on average 33% lower than the FAO data. However, it should be noted that the majority of FAO poultry data are estimates and do not come from official data sources. In 2005 and 2006 official data is indicated to be reported and, in these years, the current data is 9% and 5% lower, respectively. Official data is also indicated to be used between 2013 and 2015, and in these years the data is 12% to 19% lower than the reported data in the FAO database.

In another study by Moeletsi and Tongwane (2015) the same national statistics data was applied for all livestock except poultry. Moeletsi and Tongwane (2015) reported broiler data that is 4% higher and layer data that is 24% lower for the year 2004.

A study by Du Toit et al. (2013a, b, c) made use of population data from the livestock industry associations for the year 2010. This study provides a total dairy population that is 7% higher than the DALRRD (2024a) data. The commercial and subsistence other cattle numbers provided by Du Toit et al. (2013a) are 22% and 4% higher than the DALRRD (2024a) data, respectively.

For sheep Du Toit et al. (2013b) utilized national statistics from Statistics SA and these numbers are within 0.5% of the data from DALRRD (2024a). Goat population data from Du Toit et al. (2013b) were obtained from the industry associations and are 34% higher for commercial goats, while subsistence numbers are only 1% higher.

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Swine population data from industry (Du Toit et al., 2013c) are 60% lower than that provided in DALRRD (2024a). Broiler and layer commercial population data is 19% and 15% lower than the Du Toit et al. (2013c) data for 2010.

All of this data shows that there is still a gap between the national statistics and data from livestock associations. As has been mentioned in previous inventories, it would be beneficial to set up a Livestock Estimates Committee which brings together government and livestock association representatives on an annual basis to discuss livestock population data to obtain consensus. The committee could also be used for discussions on ways to improve livestock population estimates and the reporting thereof.

5.2.4.2 Emission factors

For the emission factor data, a literature search was conducted, and the results are shown in the calculation files.

Data was also compared to the IPCC default data. The *Dairy cattle* Implied Emission Factor (IEF) is higher than the Africa default and is slightly higher than the default values for Oceania and Western Europe. The weight and milk production of SA dairy cattle are closer to those in Oceania and Western Europe than those in Africa, hence the closer alignment of the emission factors with these regions. This is the same for *Non-dairy cattle*. The sheep, goat and swine IEFs are generally consistent with the IPCC defaults.

5.2.5 Category-specific recalculations

No recalculations are performed for this category.

5.2.6 Category-specific planned improvements

In this inventory all the background calculations to complete the Tier 2 calculations has been included, however average activity data (i.e., livestock weights, milk production, fat content) are applied in many cases. However, it is recommended that in future inventories annual activity data be collected and incorporated. This means that the emission factor will vary annually and may better reflect any emission changes due to implemented changes (or mitigation actions) in livestock population management, feeding situations and pasture management. South Africa would then be able to track the impacts of possible mitigation actions through the inventory. This issue was noted in the previous inventory, and there has been no progress on the planned improvements.

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Improving livestock population data has become increasingly important, as recent studies have refined emission factors, leaving population figures as the largest source of uncertainty. Establishing a Livestock Estimates Committee could help address this gap. The DFFE has begun discussions with the Department of Agriculture and the Agricultural Research Council, which hosts a dedicated livestock division, to explore potential collaboration on this matter.

A detailed study on the herd composition of the various livestock and the number of days each livestock sub-category is alive in a year would contribute to a reduction in uncertainty. Use appropriate MCFs depending on the average temperature for each year of the time series. Stratify the estimates depending on the average temperature in different regions in South Africa.

5.3 Manure Management (CRT 3.B)

5.3.1 CH4 emissions from manure management (CRT 3.B(a))

5.3.1.1 Category description

Livestock manure is composed principally of organic material. When the manure decomposes in the absence of oxygen, methanogenic bacteria produce CH_4. The amount of CH_4 emissions is related to the amount of manure produced and the amount that decomposes anaerobically.

According to IPCC 2006 Guidelines the method for estimating CH_4 emissions from manure management requires the following steps:

- Divide livestock population into animal subgroups based on sex, age, and production level.
- For CH_4 emissions:
    i. Estimate the emission factors for each subgroup in terms of kilograms of CH_4 per animal per year.
    ii. Multiply the subgroup emission factors by the subgroup populations to estimate subgroup emissions and sum across the subgroups to estimate total emission.

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Manure management emissions increased by 11.2 % in the period 2000–2024. Manure management contributed 4 399.8 Gg CO_2e in 2024, which is 8.3% of the agriculture sector emissions. Methane emissions from manure management contributed 40% to the total manure emissions. N_2O emissions from manure management contributed 60% to the total manure emissions.

5.3.1.2 Methodological issues

5.3.1.2.1 Activity data

Livestock population data is described in section 5.2.2.1.

The manure management data for cattle, sheep and goats was sourced from the ARC Report (2021) and there were various sources for this data as indicated in Table 5.16 Data for horses, swine and poultry is sourced from Moeletsi and Tongwane (2015) and Du Toit et al. (2013c).

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Table 5.16: Manure management systems for the various livestock types and their data sources

Livestock	Lagoon	Liquid/ slurry	Dry lot/ Kraals	Solid storage	Daily spread	Compost	Manure with litter	Manure without litter	Pasture, range, paddock (PRP)
Dairy cattle									
Mature female cows	5[1]	5[1]	20[1]	5	5				60[3]
Heifers (6 - 24 months)			2						98[4]
Other cattle									
Commercial			3						97[4]
Subsistence			35						65[4]
Feedlot	5		85[2]	10					
Sheep									
Commercial[4]			2						98
Subsistence			35[6]						65[4]
Feedlot[6]	2		98						
Goats									
Commercial			2[2]						98[4]
Subsistence[4]			35						65
Dairy goats[4]			10						90
Horses, mules, asses[2]									100
Swine									
Commercial[2,5]	71	11	13		3	2			
Subsistence[5]	25	10	35						30
Poultry									
Commercial[2]			80			5	15		
Subsistence[2]		5	70		5	10		10	

[1] *DEA (2014);* [2] *Moeletsi and Tongwane (2015);* [3]*Malaka (2017) ;* [4,6]*Expert opinion,* [5]*Du Toit et al. (2013c);*

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Table 5.17: Verification of livestock manure management systems

Livestock	DAFF (2010)	Du Toit et al. (2013a, b, c)	Moeletsi et al. (2015)	Moeletsi and Tongwane (2015)	ARC Report (2021)	IPCC 2019 Refinement (Sub-Saharan Africa (SSA)default)
Dairy cattle	Cows and heifers: 45% lagoon, 10% liquid slurry, 15% dry lot, 10% compost, 20% PRP	TMR: 10% lagoon, 0.5% liquid slurry, 1% daily spread, 88.5% PRP; Pasture: 3% lagoon, 7% daily spread, 90% PRP	TMR: 95% lagoon, 5% manure with bedding; Pasture: 11% lagoon, 8% dry lot, 10% solid storage, 3% daily spread, 60% PRP	Cows: 20% lagoon, 5% liquid slurry, 25% dry lot, 45% PRP, 5% manure with bedding; Heifers: 5% dry lot, 2% compost, 93% PRP	Cows: 5% lagoon, 5% liquid slurry, 20% dry lot, 5% solid storage, 5% daily spread, 60% PRP; Heifers: 2% dry lot, 98% PRP	20% solid storage, 29% dry lot, 45% PRP, 6% burned for fuel
Other cattle	Commercial: 25% dry lot, 5% compost, 70% PRP; Feedlot: 1.5% lagoon, 1.5% liquid slurry, 20% dry lot, 2% daily spread, 10% compost, 65% PRP Subsistence: 10% dry lot, 90% PRP	Commercial: 100% PRP; Feedlot: 80% dry lot, 20% solid storage; Subsistence: 100% PRP	Commercial: 2% solid storage, 1% daily spread, 95% PRP, 2% manure with bedding; Feedlot: 20% solid storage, 80% manure with bedding; Subsistence: 10% dry lot, 30% PRP, 60% manure with bedding	Commercial: 5% dry lot, 5% compost, 90% PRP Feedlot: 5% lagoon, 5% liquid slurry, 75% dry lot, 5% daily spread, 10% compost; Subsistence: 10% dry lot, 80% PRP, 10% manure with bedding	Commercial: 3% dry lot, 97% PRP; Feedlot: 5% lagoon, 85% dry lot, 10% solid storage; Subsistence: 35% dry lot, 65% PRP	15% solid storage, 30% dry lot, 50% PRP, 5% burned for fuel
Sheep	Commercial: 2% dry lot, 98% PRP; Subsistence: 5% dry lot, 95% PRP	Commercial and subsistence: 100% PRP	Commercial and subsistence: 100% PRP	Commercial: 2% dry lot, 98% PRP; Subsistence: 5% dry lot, 95% PRP	Commercial: 2% dry lot, 98% PRP; Subsistence: 35% dry lot, 65% PRP; Feedlot: 2% lagoon, 98% dry lot	17% solid storage, 3% dry lot, 80% PRP

Livestock	DAFF (2010)	Du Toit et al. (2013a, b, c)	Moeletsi et al. (2015)	Moeletsi and Tongwane (2015)	ARC Report (2021)	IPCC 2019 Refinement (Sub-Saharan Africa (SSA)default)
Goats	Commercial: 2% dry lot, 98% PRP; Subsistence: 5% dry lot, 95% PRP	Commercial and subsistence: 100% PRP	Commercial and subsistence: 100% PRP	Commercial: 2% dry lot, 98% PRP; Subsistence: 5% dry lot, 95%PRP	Commercial: 2% dry lot, 98% PRP; Subsistence: 35% dry lot, 65% PRP	17% solid storage, 3% dry lot, 80% PRP
Horses	100% PRP	40% dry lot, 60% PRP	100% PRP	100% PRP		
Mules/asses	100% PRP	100% PRP	100% PRP	100% PRP		
Swine	Commercial: 50% lagoon, 20% liquid slurry, 20% dry lot, 5% daily spread, 5% compost	Commercial: 92% lagoon, 1.5% liquid slurry, 5% dry lot, 1.5% daily spread; Subsistence: 50% dry lot, 50% daily spread	Commercial: 50% lagoon, 20% liquid slurry, 20% dry lot, 10% solid storage	Commercial: 50% lagoon, 20% liquid slurry, 20% dry lot, 5% daily spread, 5% compost		High productivity: 7% liquid slurry, 6% solid storage, 86% dry lot, 1% pit<1; Low productivity: 5% lagoon, 30% liquid slurry, 15% solid storage, 15% dry lot, 15% pit<1, 5% pit>1, 5% daily spread, 5% digester, 5% PRP
Poultry	Layers and broilers: 80% dry lot, 20% compost	Layers: 100% poultry manure without litter; Broilers: 100% poultry manure with litter	Layers and broilers: 10% dry lot, 5% daily spread, 2% compost, 5% poultry manure without litter, 78% poultry manure with litter	Layers: 5% liquid slurry, 70% dry lot, 5% daily spread, 10% compost, 10% poultry manure without litter; Broilers: 80% dry lot, 5% compost, 15% poultry manure with litter		Layers: 90% pit>1 month, 10% poultry manure with litter; Broilers: 100% poultry manure with litter

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5.3.1.2.2 Emission factors

Annual volatile solid (VS) excretion from horses and mules/asses is determined with a Tier 1 methodology (IPCC 2006 Guidelines, Equation 10.22) by using a default VS excretion rate of 7.2 kg VS (1000 kg animal mass)$^{-1}$ day^{-1} (IPCC 2019 Refinement, Table 10.13A).

The annual VS excretion for all other livestock is determined with the IPCC 2006 Guidelines Equation

10.24. IPCC 2006 suggests a value of 0.04 for the fraction of urinary energy (UE) for all livestock except swine where a value of 0.02 is applied (IPCC 2006 Guidelines, Equation 10.24). Thefraction of ash content of feed (ASH) is set at 0.08 for all livestock (IPCC 2006 Guidelines, Equation 10.24), except for swine where a value of 0.17 is applied (Du Toit et al., 2013c).

5.3.1.3 Uncertainty

5.3.1.3.1 Activity data uncertainty

The population data uncertainties are discussed in section 5.2.3.1

For manure management data Moeletsi et al. (2015) reported a ±20% uncertainty on mixed diet dairy cattle manure management, and a ±25% and ±10% uncertainty on pasture and Total Mixed Ratio (TMR) manure management systems, respectively. Considering the variation in the reported data (Table 5.17) the uncertainty seems to be much higher, therefore an uncertainty of ±50% is assigned to dairy cattle manure management. For non-dairy cattle an uncertainty of ±15% is provided, and considering the variation shown in this is not unreasonable, although it might be slightly on the low side. The uncertainty is therefore adjusted to ±20%. The ±5% uncertainty assigned by Moeletsi et al. (2015) to goats and horses, and the ±2% assigned to horses, mules/asses and sheep appears to be reasonable, but it is unclear why the uncertainty for sheep is lower than goats when the manure management data is the same in all studies for these two livestock categories. Based on this, and the data in Table 5.17, the uncertainty for goats is adjusted to ±2%. Poultry and swine manure management data has an uncertainty of ±15% (Moeletsi et al., 2015). The variation in the data reported in Table 5.17 is low for swine but is high for poultry, therefore the uncertainty is adjusted to ±10% and ±25% for swine and poultry, respectively.

The IPCC 2006 Guidelines default uncertainty for N excretion is ± 50%, but this is for a Tier 1 method. It is therefore assumed that the Tier 2 method reduces uncertainty to ± 30%.

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5.3.1.3.2 Emission factor uncertainty

The data on uncertainty for CH_4 emission factors from livestock manure is presented in Table 5.18. Uncertainty on the CH_4 manure emission factors is provided by ARC (2021) for mature cows, heifers, feedlot cattle, all sheep and all goat sub-categories. No uncertainty data is provided by Du Toit et al. (2013c) for bulls, oxen, young oxen, calves, or swine emission factors. For the bulls, young bulls, oxen, young oxen, and calf sub-categories the uncertainty was assumed to be an average of those for mature cows and heifers in each sub-category. For swine IPCC 2006 Guidelines indicate that a Tier 2 approach is likely to have an uncertainty of around ± 20%. The same applies to poultry. Tier 1 default factors for horses, and mules/asses have an uncertainty of between ± 30% - 50%, that an average of ± 40% is applied.

Table 5.18: Uncertainty data for livestock manure CH_4 emission factors

Animal categories	Animal subcategories	Emission Factor uncertainty	Reference
3.B.1.a - Dairy cattle	Mature female	±24	ARC (2021)
	Heifer (12 – 18 months)	±21	ARC (2021)
	Heifer (6 – 12 months)	±18	ARC (2021)
	Heifer (3 – 6 months)	±13	ARC (2021)
3.B.1.b - Commercial beef cattle	Bulls	± 10	Average of uncertainty estimates for cows and heifers
	Young bulls	± 10	
	Mature female	±7	ARC (2021)
	Heifer (12 – 18 months)	±11	ARC (2021)
	Heifer (6 – 12 months)	±9	ARC (2021)
	Heifer (3 – 6 months)	±9	ARC (2021)
	Oxen	± 10	Average of uncertainty estimates for cows and heifers
	Young oxen	± 10	
	Calves	± 9	
	Feedlot cattle	± 6	ARC (2021)
3.B.1.b - Subsistence cattle	Bulls	± 17	Average of uncertainty estimates for cows and heifers
	Young bulls	± 17	
	Mature female	±16	ARC (2021)
	Heifer (12 – 18 months)	±19	ARC (2021)
	Heifer (6 – 12 months)	±18	ARC (2021)
	Heifer (3 – 6 months)	±19	ARC (2021)
	Oxen	± 17	Average of uncertainty estimates for cows and heifers
	Young oxen	± 17	
	Calves	± 17	
3.B.2 - Sheep	Mature ewes	±15	ARC (2021)
	Replacement ewes	±8	ARC (2021)

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Animal categories	Animal subcategories	Emission Factor uncertainty	Reference
	Female lambs	±15	ARC (2021)
	Male lambs	±16	ARC (2021)
	Young rams	±11	ARC (2021)
	Rams	±9	ARC (2021)
	Feedlot sheep	±15	ARC (2021)
3.B.4.d - Goats	Mature does	±46	ARC (2021)
	Replacement does	±42	ARC (2021)
	Female kids	±46	ARC (2021)
	Male kids	±46	ARC (2021)
	Young buck	±50	ARC (2021)
	Buck	±50	ARC (2021)
3.B.4.e - Horses		± 30	IPCC 2006
Mules & asses		± 30	IPCC 2006
3.B.3 - Swine		± 20	IPCC 2006
3.B.4.g - Poultry		± 20	IPCC 2006

5.3.1.4 Time-series consistency

The time-series is consistent throughout the period 2000 – 2024.

5.3.1.5 Category specific QA/QC and verification

Livestock data verification is provided in section 5.2.4.1.

Manure management data is compared to data from various studies and Table 5.17 shows that there is high variation in the results for cattle and poultry. The data variability is much less for sheep, goats, horses, mules/asses and swine. The percentage allocation differs significantly from the IPCC 2019 Refinement Sub-Saharan Africa (SSA) default value, but this is not unexpected as the default is for the whole SSA region while the numbers from the other studies are more specific to SA which has some high productivity systems. There is some agreement on the types of manure management systems utilised, except that SA does not mention pit storage systems. In addition, no manure is allocated to burning or digesters since there is no data and it is not significant. There are some cattle feedlots and piggeries which make use of digesters, but the data is limited, and it is thought to be minimal. This should, however, be monitored in future, particularly because of the energy production benefits of the digesters.

For the emission factor data, a literature search was conducted, and the results are shown in the calculation files.

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Data was also compared to the IPCC default data. The dairy cattle emission factor is higher than the default for Africa. The differences are due to the different manure management systems in these regions which impacts the MCF. The situation is similar for the emission factor for swine. The Other cattle emission factor is much lower than that in other countries and is even lower than the default value for Africa. Sheep and goat emission factors are lower than IPCC default values.

5.3.1.6 Category-specific recalculations

There have been no recalculations performed for this source category this year.

5.3.1.7 Category-specific planned improvements

There are no planned improvements for this category in the next year.

5.3.2 N2O emissions from manure management (CRT 3.B(b))

5.3.2.1 Category description

The *Manure management* category also includes N_2O emissions related to manure handling before it is added to agricultural soil. The amount of N_2O emissions depends on the system of waste management and the duration of storage. N_2O emissions from manure management occur both directly and indirectly. Direct emissions occur during the handling, storage, and application of manure. When manure is stored in anaerobic conditions (without oxygen), microbes break down nitrogen compounds, leading to the release of N_2O. Indirect emissions of N_2O-N can take place in two ways: i) volatilization of N as NH_3 and oxides of N, and ii) through runoff and leaching from land where N was applied (IPCC, 2006).

Ammonia (NH_3) and NO_x volatilise from manure storage; however, these emissions are not estimated due to a lack of data.

According to IPCC 2006 Guidelines the method for estimating direct N_2O emissions from manuremanagement requires the following steps:

- Divide livestock population into animal subgroups based on sex, age, and production level.
- For N_2O emissions:
    i. Determine average annual nitrogen excretion rate per head for each livestock subcategory.

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ii. Determine the fraction of total annual nitrogen excretion for each livestockcategory that is managed in each manure management system.
iii. Determine N_2O emission factors for each manure management system.
iv. Multiply the emission factor by the total nitrogen managed in the systemand sum over all manure management systems.

Direct N_2O emissions from manure management contributed 53% of the total Manure management emissions in 2024. Indirect N_2O emissions from manure management contributed 8% of the total Manure management emissions in 2024.

5.3.2.2 Methodological issues

Direct manure N_2O emissions are calculated following the IPCC 2006 Guidelines equation 10.25 (IPCC, 2006, volume 4, chapter 10).

A Tier 1 method is used to determine N_2O emissions from deposition of volatilized N. Indirect N_2O losses due to volatilization are calculated using the Tier 1 method as described by equation 10.26 in the IPCC 2019 Refinement. This is followed by equation 10.28. Data on biogas plants and co-digestion is limited, therefore this term was excluded from the calculation and can be updated in future when more data becomes available.

Indirect N_2O losses due to leaching and runoff are calculated using the Tier 1 method as described by equation 10.27 in the IPCC 2019 Refinement, which is followed by equation 10.29. As with the emissions due to volatilisation the amount of N from co-digestates added to biogas plants was excluded from the calculation and can be updated in future when more data becomes available.

5.3.2.2.1 Activity data

Direct N_2O emissions require information on livestock population (section 5.2.2.1), manure management (section 5.3.1.2) and annual average nitrogen (N) excretion per head of livestock ($N_{ex(T)}$).

Annual N excretion for horses and mules/asses is calculated with a Tier 1 methodology, based on the IPCC default N excretion rate of 0.46 kg N (1000 kg animal mass)$^{-1}$ day^{-1}, and typical animal mass. ARC (2021) provides a typical animal mass of 595 kg for horses and 250 kg for mules and asses.

A Tier 2 methodology (following IPCC 2006 Guidelines Equation 10.31 and 10.32) is utilised to calculate annual N excretion rates for cattle, sheep, and goats (Table 5.19). The updated IPCC 2019 Refinement Tier 2 methodology (Equation 10.32A) is applied to swine and poultry to determine N intake rates. The dry matter intake (DMI) data for

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swine and poultry is taken from Du Toit et al. (2013c). In all cases the N retention values are sourced from IPCC 2006 Guidelines, Table 10.2.

Both indirect N_2O emission equations require data on livestock population, N excretion, and manure management which are described in section 5.2.2.1, section 5.3.2.2 and section 5.3.1.2, respectively. The fraction of managed manure that volatilises and that is leached are taken from the IPCC 2019 Refinement (volume 4, chapter 11, Table 10.22).

Table 5.19: Nitrogen excretion rate for different livestock categories

Livestock category	Subcategories	Nitrogen excretion rate (kgN/animal/year)
3.A.1.a - Dairy cattle	Mature female cows	113.71
	Heifer 12 - 18 months	27.06
	Heifer 6 - 12 months	21.87
	Calves 0 - 6 months	12.09
3.A.1.b - Commercial beef cattle	Mature female cows	44.60
	Heifers 12 - 18 months	25.74
	Heifers 6 - 12 months	19.86
	Calves 3 - 6 months	13.34
	Feedlot cattle	59.00
3.A.1.b - Subsistence cattle	Mature female cows	46.05
	Heifers 12 - 18 months	26.09
	Heifers 6 - 12 months	24.00
	Calves 0 - 6 months	16.46
3.A.2 - Commercial sheep	Mature ewes	4.00
	Replacement ewes	2.93
	Female lambs	3.28
	Male lambs	4.06
	Replacement rams	3.82
	Mature rams	5.11
	Feedlot sheep	4.33
3.A.2 - Subsistence sheep	Mature ewes	4.47
	Replacement ewes	3.27
	Female lambs	2.42
	Male lambs	2.63
	Replacement rams	2.84
	Mature rams	5.77
3.A.4.d - Goats	Mature does	6.33
	Replacement does	2.99
	Female kids	2.51

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Livestock category	Subcategories	Nitrogen excretion rate (kgN/animal/year)
	Male kids	3.31
	Replacement bucks	3.51
	Bucks	5.59
	Dairy goats	-

5.3.2.2.2 Emission factors

Emission factors for all livestock are obtained from IPCC 2019 Refinement (Table 10.21).

IPCC default emission factors for N_2O from atmospheric deposition of N on soils and water surfaces, and from leaching and runoff are taken from the IPCC 2019 Refinement (volume 4, chapter 11, Table 11.3). The dry climate factors are applied.

5.3.2.3 Uncertainty

5.3.2.3.1 Activity data uncertainty

The population data uncertainties are discussed in section 5.2.3.1. Uncertainty on manure management systems is provided in section 5.3.1.3. The IPCC 2006 Guidelines default uncertainty for N excretion is ± 50%, but this is for a Tier 1 method. It is therefore assumed that the Tier 2 method reduces uncertainty to ± 30%.

Uncertainty on activity data for livestock population and N excretion are discussed in sections 5.2.3.1 and 5.3.2.2. $Frac_{GASMS}$ and $Frac_{LeachMS}$ uncertainties are provided in IPCC 2019 Refinement (volume 4, chapter 10, Table 10.22).

5.3.2.3.2 Emission factor uncertainty

Uncertainty on the IPCC 2019 Refinement default N_2O manure emission factors is -50% to +100%. The uncertainty on EF_4 is -100% and +120%, and for EF_5 it is -100% and +82% (IPCC 2019 Refinement, Table 11.3).

5.3.2.4 Time-series consistency

The time-series is consistent throughout the period 1990 – 2024.

5.3.2.5 Category specific QA/QC and verification

Category specific QA/QC and verification is provided in section 5.3.1.5. Additionally, general QA/QC measures in Table 5.8 were used for this category.

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5.3.2.6 Category-specific recalculations

No recalculations are performed for this category.

5.3.2.7 Category-specific planned improvements

Improvements include collecting the national data set on manure management systems. This data seems to be highly variable depending on where the information comes from. In addition, data on the amount of manure being diverted to biogas needs to be included as this is a mitigation option and has been highlighted in previous inventory reviews. It is recommended to find a mechanism to track manure management practices or systems used in South Africa, as this could allow for incorporation of dynamics driven by changes in management regimes, and thus improve the accuracy of manure related emissions. it is recommended that data be collected on manure inputs to biogas plants so the data can be incorporated into the equation in future. Investigate if there are studies available about the burning of manure in South Africa. This issue was noted in the previous inventory, and there has been no progress on the planned improvements.

5.4 Rice cultivation (CRT 3.C)

Rice cultivation is excluded from this inventory because, in accordance with IPCC 2006 Guidelines, it is not identified as a key category and its contribution to total GHG emissions is considered insignificant. The previous inventory included estimations for rice cultivation, which demonstrated and confirmed that its emissions were negligible. Therefore, its exclusion does not materially affect the completeness or accuracy of the inventory results.

5.5 Agricultural soils (CRT 3.D)

5.5.1 Direct N_2O emissions from managed soils (CRT 3.D.1)

5.5.1.1 Category description

Agricultural soils contribute to GHGs in three ways:

- CO_2 through the loss of soil organic matter. This is a result of land-use change, and is, therefore, dealt with in the land sector, not in this section. CH_4 from anaerobic soils. Anaerobic cultivation, such as rice paddies, is not practised in

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South Africa, and therefore CH_4 emissions from agricultural soils are not included in this inventory; and

- N_2O from fertilizer use and intensive cultivation. This is a significant fraction of non-carbon emissions from agriculture and is the focus of this section of the inventory.

The IPCC 2006 Guidelines identifies several pathways of nitrogen inputs to agricultural soils that can result in direct N_2O emissions:

- Nitrogen inputs:
    - Synthetic nitrogen fertilizers.
    - Organic fertilizers (including animal manure, compost, and sewage sludge); and
    - Crop residue (including nitrogen fixing crops).
- Soil organic matter lost from mineral soils through land-use change.
- Organic soil that is drained or managed for agricultural purposes; and
- Animal manure deposited on pastures, rangelands, and paddocks.

In this inventory, sewage sludge emissions are included under waste (IE). In South Africa, sewage sludge is often not applied to agricultural crops due to concerns about contamination. Sewage sludge can contain pathogens, heavy metals, and other pollutants that could pose risks to human health and the environment if not properly treated. Regulations and guidelines are in place to manage its use, but many farmers and regulatory bodies remain cautious. Some areas may use treated sludge for non-food crops or in controlled applications, but the widespread use of untreated or inadequately treated sludge on food crops is typically avoided.

In 2024, direct N_2O emissions from managed soils were estimated at 8167 Gg CO_2e, accounting for 84% of total emissions from agricultural soils. Indirect N_2O emissions from managed soils were estimated at 1514 Gg CO_2e, representing the remaining 16% of agricultural soil emissions. The emission contribution of the various types of N inputs is shown in Table 5.**20**. Total direct N_2O emissions increased between 1990 and 2000, followed by a period of relative stabilisation, with emissions in 2024 remaining close to 2000 levels despite shifts among individual source categories (Table 5.**20**).

Between 1990 and 2024, emissions from inorganic and organic nitrogen fertilisers increased, with organic fertilisers showing the larger relative growth. Emissions from urine and dung of grazing animals declined over the period but remained the largest

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source of direct N_2O emissions. In contrast, emissions from crop residues increased substantially, becoming a more significant contributor by 2024. Emissions associated with soil organic matter mineralisation and immobilisation remained negligible throughout, while emissions from the cultivation of organic soils increased modestly, with their share of total agricultural emissions remaining constant.

Direct N_2O emissions from managed soils is a key category based on the level and trend assessments.

Table 5.20: Emission trends for the various sub-categories of direct N_2O emissions from managed soils

		1990	2000	2024	Change (%)	
					1990-2024	2000-2024
Inorganic N fertiliser	Emissions (Gg CO_2e)	715.6	866.0	864.0	20.7	-0.2
	% Agriculture	1.2	1.5	1.6		
Organic N fertiliser	Emissions (Gg CO_2e)	544.2	645.7	783.2	43.9	21.3
	% Agriculture	0.9	1.1	1.5		
Urine and dung from grazing animals	Emissions (Gg CO_2e)	6 302.6	6 179.8	5 256.5	-16.6	-14.9
	% Agriculture	10.7	10.8	10.0		
Crop residues	Emissions (Gg CO_2e)	350.7	426.9	1 261.7	259.7	195.5
	% Agriculture	0.6	0.7	2.4		
Mineralization/ immobilization associated with loss/gain of soil organic matter	Emissions (Gg CO_2e)	0.9	0.9	1.1	19.1	18.4
	% Agriculture	0.0	0.0	0.0		
Cultivation of organic soils	Emissions (Gg CO_2e)	42.0	46.5	50.7	20.7	9.0
	% Agriculture	0.1	0.1	0.1		

5.5.1.2 Methodological issues

Tier 1 and Tier 2 approaches were used to calculate Direct N_2O emission from managed soils. Some of the sub-categories under managed soils utilized Tier 1 method, while

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others employed Tier 2 method. Tier 1 followed the IPCC 2006 Guidelines Equation 11.1 (IPCC, 2006, Volume 4, Chapter 11).

5.5.1.2.1 *Inorganic fertiliser N inputs (F_N) (CRT 3.D.1.a)*

IPCC Tier 1 methodologies and default emission factors (IPCC 2006) are used for estimating direct N_2O emissions from managed soils. The amount of inorganic N applied to soils is multiplied with the IPCC 2006 Guidelines default emission factor (IPCC 2006).

5.5.1.2.2 *Organic fertiliser N inputs (F_{ON}) (CRT 3.D.1.b)*

The amount of N (kg N yr-1) from organic N additions applied to soil is calculated using IPCC 2006 Guidelines Equation 11.3 (IPCC, 2006; Volume 4, chapter 11).

A Tier 2 approach was used to calculate N from animal manure applied to soils (IPCC 2006 Guidelines, Equation 11.4, vol 4, chapt 11). The amount of animal manure applied is equal to the amount of managed manure N available for soil application minus that used for feed and construction. The amount of managed manure N available for soil application is calculated from IPCC 2006 Guidelines Equation 10.34 (IPCC, 2006, volume 4, chapter 10).

N_2O emissions from sludge are included in the Waste sector and are therefore excluded here to avoid double counting.

The amount of compost N applied on managed soils each year is estimated from the synthetic fertilizer consumption data. The synthetic fertilizer input changed each year, while the rest of the factors were assumed to remain unchanged over the 20-year period. It is estimated that a total of 5% of all farmers use compost (DAFF, 2010). Compost is seldom, if ever, used as the only nutrient source for crops or vegetables. It is used as a supplement for synthetic fertilizers, and it is estimated that farmers would supply about 33% of nutrient needs through compost. All of this is considered when estimating N inputs from compost (details provided in DAFF (2010) and Otter (2011)).

5.5.1.2.3 *Urine and dung N deposited by grazing animals (F_{PRP}) (CRT 3.D.1.c)*

Manure N deposited in pastures, rangelands and paddocks include all the open areas where animal excretions are not removed or managed. It also includes emissions from daily spread. This manure remains on the land, where it is returned to the soil, and contributes to GHG emissions. In South Africa, the majority of animals spend most of their lives on pastures and rangelands. The annual amount of urine and dung N deposited on pastures, ranges, or paddocks by grazing animals (FPRP; kg N yr-1) is calculated using Equation 11.5 in the IPCC 2006 Guidelines (Chapter 11, Volume 4).

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5.5.1.2.4 *Crop residues N inputs (F_{CR}) (CRT 3.D.1.d)*

The amount of N in crop residues is estimated using the updated IPCC Tier 1 approach for the IPCC 2019 Refinement (Equation 11.6) but with some national factors. Some country specific factors are given for fraction of dry matter, fraction of residue burnt, fraction of residue removed, and ratio of above-ground and below ground residues to harvested yield (Tongwane et al., 2016). IPCC default factors are applied for combustion factors. IPCC 2019 Refinement default values for N content of above-ground residue, N content of below ground residue, and ratio of below-ground biomass to above-ground biomass (IPCC 2019 Refinement, Table 11.1A) are applied.

5.5.1.2.5 *Mineralisation/immobilisation associated with loss/gain of soil organic matter (F_{SOM}) (CRT 3.D.1.e)*

The mineralised N resulting from loss of soil organic carbon stocks in mineral soils through land-use change (FSOM) was estimated following the equation 11.8 from the IPCC 2006 Guidelines. IPCC recommended defaults for C:N ratio (IPCC 2006, Equation 11.8) are used in the calculation.

5.5.1.2.6 Activity data

Inorganic fertiliser N inputs

For nitrogen emissions the Fertilizer Association of South Africa (Fertasa) reports total N consumption.[20] This value is the total nitrogen consumed in all fertilizer types and it accounts for the different N content of urea, ammonia, etc. It should be noted that the N consumption data between 2000 and 2009 was based on actual data, but thereafter the numbers are estimates.

Organic fertiliser N inputs

Animal manure inputs

IPCC 2006 Guidelines Equation 10.34 (IPCC, 2006; volume 4, chapter 10) requires the following data:

- Livestock population data (section5.2.2.1)
- N excretion data (section5.3.2.2)
- Manure management system usage data (Table 5. 30)
- Amount of managed manure nitrogen that is lost in each manure

[20] http://www.fertasa.co.za/fertilizer-information/historic-sales-data/ and http://www.fertasa.co.za/wp-content/uploads/2021/03/Fertilizer-Usage-2020-and- 2021-RSA.pdf

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management system ($Frac_{LossMS}$). IPCC 2006 Guidelines default values were used here (Table 10.23, Chapter 10, Volume 4, IPCC 2006).

- Amount of nitrogen from bedding. There were no data available for this, so the values provided by IPCC (IPCC, 2006; pg. 10.66) are utilized and
- The fraction of managed manure used for feed, fuel, or construction. Again, there were insufficient data and thus F_{AM} was not adjusted for these fractions (IPCC 2006 Guidelines, p. 11.13).

Compost inputs

The activity data to calculate compost is inorganic N fertiliser data which is described above.

Urine and dung deposited by grazing animals

Activity data for this sub-category are livestock population (section 5.2.2.1) and manure management (section 5.3.1.2) data.

Crop residue N inputs

Planted area and production data is obtained from Abstracts of Agricultural Statistics (DALRRD, 2022) and FAO (FAOStat). Production data is used to calculate yield and this is usually dry mass (as indicated in FAOSTAT) so these values are not multiplied by the dry matter content to get dry yield.

Mineralised N due to land use change

The average annual loss of soil carbon from the various land types is the activity data for this subcategory and this data comes from the land conversions data discussed in the Land sector.

5.5.1.2.7 Emission factors

Inorganic and organic N fertiliser, crop residues and F_{SOM}

The IPCC default emission factor of 0.005 kg N_2O-N/kg N applied (IPCC 2019 Refinement, Table 11.1, dry climate).

Urine and dung deposited by grazing animals

The IPCC default emission factor of 0.002 kg N_2O-N (kg N)$^{-1}$ for cattle, poultry and pigs and 0.003 kg N_2O-N (kg N)$^{-1}$ for sheep and other animals is applied (IPCC 2019 Refinement, Table 11.1, dry climate).

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5.5.1.3 Uncertainty

5.5.1.3.1 Activity data uncertainty

For *Inorganic N fertiliser,* Expert opinion (Corne Louw, corne@grainsa.co.za) suggests that the N consumption would likely be within 15% of the number.

For animal manure inputs the uncertainty is estimated at ±41% based on the uncertainty on livestock population, manure management and N excretion data. No uncertainty data was provided for compost, so a ±25% uncertainty is assumed. This is based on the 15% uncertainty on N consumption, with additional uncertainty on the percentage nitrogen, percentage of compost in total fertiliser application and amount of animal manure in compost.

For *Urine and dung deposited by grazing animals,* the uncertainty estimate for this activity data is 53.6% based on the uncertainty on livestock population data, manure management data and the 50% uncertainty on the $Frac_{LossMS}$ factor (IPCC 2006 Guidelines, Table 10.23).

For *Crop residues,* the uncertainty on crop residue input data is high (average of 91.2%) which is estimated from a ±10% uncertainty on crop production data, a ±75% uncertainty on N content, a ±50 uncertainty on above and below ground ratios (IPCC 2019 Refinement, Table 11.1A) and a ±10% uncertainty on residue management data.

For *FSOM,* Uncertainty is estimated at ±33% due to a ±13% uncertainty on land area data, ±30% uncertainty on SOC data and ±5% uncertainty on the C:N ratio.

5.5.1.3.2 Emission factor uncertainty

Inorganic and organic N fertiliser, crop residues and F_{SOM}

Uncertainty on the default emission factor applied to these sub-categories is -100% and +200% (IPCC 2019 Refinement, Table 11.1).

Urine and dung deposited by grazing animals

Uncertainty on the default emission factor for cattle, poultry and pigs is -100% to +200% and for the sheep and other animals it is -100% to +230% (IPCC 2019 Refinement, Table 11.1).

5.5.1.4 Time-series consistency

The time-series for direct N_2O emissions is complete and consistent.

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5.5.1.5 Category specific QA/QC and verification

Synthetic N fertiliser consumption data was compared to the FAO data (FAOSTAT) and there was no difference in the data between 2000 and 2014, but after that data varied by up to 23%. It was noted in the FAO data that the last few years were indicated to be unofficial data so this could account for the discrepancy. Additionally, the general QA/QC measures in Table 5.8 were used for this category.

5.5.1.6 Category-specific recalculations

Recalculations were performed for the entire time-series and the updated data is lower than provided in the previous inventory. The difference seen is because of the updated emission factors in this category. The emission factors provided in the IPCC 2019 Refinement are half of what was used in the previous inventory. This is because the 2019 Refinement disaggregates the data into wet and dry climates and the dry climate data, (which is applied in this inventory) are much lower.

5.5.1.7 Category-specific planned improvements

No category-specific improvements are currently planned. However, data collection is required to support a Tier 2 approach for the soil management category, as it is a key category. This need was identified in the previous inventory, but no progress has been made.

5.5.2 Indirect nitrous oxide emissions from managed soils (CRT 3.D.2)

5.5.2.1 Category description

Indirect emissions of N_2O-N from managed soils can take place in two ways: i) volatilization of N as NH_3 and oxides of N, and the deposition of these gases onto water surfaces, and ii) through runoff and leaching from land where N was applied (IPCC, 2006). Indirect emissions due to atmospheric deposition/volatilisation occur from inorganic and organic N application and urine and dung N inputs, while indirect runoff/leaching emissions can also occur from crop residue application and N losses due to changes in land management practices and land use (see Figure 11.1 of the IPCC 2006 Guidelines).

Indirect N_2O emissions from managed soils contributed 1 514 Gg CO_2e in 2024, accounting for 16% of total emissions from agricultural soils.

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5.5.2.2 Methodological issues

Due to limited data a Tier 1 approach was used to calculate the indirect N_2O emissions in this category.

5.5.2.2.1 *Indirect N_2O from atmospheric deposition of volatilized N*

The annual amount of N_2O-N produced from atmospheric deposition of N volatilized from managed soils ($N_2O_{(ATD)-N}$) was calculated with IPCC 2006 Guidelines Equation 11.9.

5.5.2.2.2 *Indirect N_2O from leaching/runoff*

The annual amount of N_2O-N produced from leaching and runoff of N additions to managed soils ($N_2O_{(L)-N}$) is determined by IPCC 2006 Guidelines Equation 11.10. IPCC 2019 Refinement (Chapter 11, Vol. 4, Table 11.3) indicates that the term $Frac_{LEACH-(H)}$ only applies to wet climates, while for dry climates $Frac_{LEACH-(H)}$ is taken as zero. South Africa has a dry climate, therefore zero was applied to urine and dung deposits. The fraction of all N added to/mineralised in cultivated lands that is lost through leaching and runoff ($Frac_{LEACH-(H)}$) was determined by using a weighted average as leaching was assumed to occur on irrigated lands. WRI (2018) indicated that 10% of cultivated land is irrigated, therefore a $Frac_{LEACH-(H)}$ value of 0.02 kg N (kg N additions)-1 was applied to cultivated lands.

5.5.2.2.3 *Activity data*

The calculations of F_{SN}, F_{ON}, and F_{PRP} are described above.

5.5.2.2.4 *Emission factors*

Indirect N_2O from atmospheric deposition of volatilized N

The emission factor (EF_4), and the volatilization fractions ($Frac_{GASF}$ and $Frac_{GASM}$) were all taken from the IPCC 2019 Refinement default table (Table 11.3, Chapter 11, Volume 4).

Indirect N_2O from leaching/runoff

The emission factor (EF_5) was taken from the IPCC 2019 Refinement (Table 11.3, Chapter 11, Volume 4).

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5.5.2.3 Uncertainty

5.5.2.3.1 Activity data uncertainty

Uncertainty on activity data for F_{SN}, F_{ON}, and F_{PRP} are provided in section 5.5.1.3. $Frac_{GASF}$ has an uncertainty of -82% and +200%, while $Frac_{GASM}$ has an uncertainty of -100% + 48% (IPCC 2019 Refinement, Table 11.3).

5.5.2.3.2 Emission factor uncertainty

The uncertainty on EF_4 is -100% and +120%, and for EF_5 it is -100% and +82% (IPCC 2019 Refinement, Table 11.3).

5.5.2.4 Time-series consistency

The time-series is consistent throughout the inventory time period.

5.5.2.5 Category specific QA/QC and verification

There were no category specific quality control checks. The general QA/QC measures in Table 5.8 were used for this category.

5.5.2.6 Category-specific recalculations

Recalculations across the entire time-series produced slightly lower emissions. The reduction in emissions is due mostly to the updated emission factors from the IPCC 2019 Refinement, but also due to the Inclusion of Organic soils for cropland and Grassland.

5.5.2.7 Category-specific planned improvements

There are no planned improvements for this category.

5.6 Prescribed burning of savannahs (CRT 3.E)

In this inventory, the prescribed burning of savannahs is included within the land sector. This technique is commonly employed for land management, enhancing ecological health and biodiversity.

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5.7 Field burning of agricultural residues (CRT 3.F)

5.7.1 Category description

Agricultural burning is the intentional use of fire for residue management in agricultural fields. Agricultural burning helps farmers remove crop residues left in the field after harvesting grains. This section reports emissions of non-CO_2 gases (CH_4, CO, N_2O and NO_x) from cropland while other Land use categories are discussed in the LULUCF section.

In this inventory this category includes biomass burning of sugarcane residues only since the burning of other crop residues is not significant in South Africa. Sugarcane is the only crop which utilises pre-harvest burning to expose the cane stalks removing the outer leaves, driving away insects, snakes and other wild animals making easy not only manual, but also mechanical harvesting additionally, after harvesting, sugarcane residues are burned releasing to the atmosphere GHGs. In addition to CO_2, the burning of biomass results in the release of other GHGs or precursors of GHGs that originate from incomplete combustion of the fuel. The key GHGs are CO_2, CH_4, and N_2O; however, NO_x, NH_3, NMVOC and CO are also produced, and these are precursors for the formation of GHG in the atmosphere (IPCC, 2006).

The CO_2 emissions from burning are not included in this category as they are accounted under the disturbance losses in the Land (3B) category. All non-CO_2 emissions, on the other hand, are included in this category.

Field burning of sugarcane residues before harvesting, a common agricultural practice, contributed 54.5 Gg CO_2e in 2024, which is 0.10% of the agriculture sector emissions. Emissions decreased by 21.08% in the period 2000–2024. This pre-harvesting burning is primarily employed to clear the fields of dry leaves and debris, making it easier to harvest the cane itself. However, while it offers immediate benefits in terms of labour efficiency and reduced harvesting challenges, the environmental consequences can be significant. South Africa has 14 cane-producing areas, extending from Northern Pondoland in the Eastern Cape Province through the coastal belt and KwaZulu-Natal midlands to the Mpumalanga Lowveld.

5.7.2 Methodological issues

The Tier 1 methodology was applied, with the emissions from biomass burning being calculated using the following equation (Equation 2.27 from IPCC 2006 Guidelines):

$$L_{fire} = A * M_B * Cf * G_{ef} * 10^{-3}$$

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Where:

L_{fire} = mass of GHG emissions from the fire (t GHG)

A = area burnt (ha)

M_B = mass of fuel available for combustion (t dm ha^{-1})

Cf = combustion factor (dimensionless)

G_{ef} = emission factor (g kg^{-1} dm burnt)

This equation calculates the mass of emissions (L_{fireL}) produced by a fire based on several key factors. The area burned (A) in hectares is multiplied by the mass of fuel available for combustion (MB), expressed in tons per dry matter per hectare. Additionally, the combustion factor (Cf), which is dimensionless, accounts for the efficiency of combustion, while the emission factor (G_{ef}), measured in grams per kilogram of dry matter burned, quantifies the specific emissions produced during the burning process. By combining these variables, the equation provides a comprehensive estimate of the GHG emissions resulting from the burning of biomass.

5.7.2.1 Activity data

5.7.2.1.1 Burnt area data

The report utilized crop data on sugarcane planted areas from the Abstracts of Agricultural Statistics (DALRRD, 2022), which is a reliable and sustainable data source published annually.

The research conducted by Shikwambana et al. (2021) indicates that the sugarcane industry in South Africa burns 90% of its crop at harvest while 10% is harvested green; therefore, this assumption was applied for this inventory. A 90% assumption was applied to estimate the burned area for sugarcane.

5.7.2.1.2 Mass of fuel available for combustion (MB) and the combustion factor (Cf)

The country specific parameters such as Fuel density of 7 t/ha was used for cropland and it was sourced from DAFF (2010), and the combustion factor of 1 was used and sourced from DAFF (2010). The IPCC value of fuel combustion (t/ha) of 4-10 was used for cropland (IPCC, 2006).

5.7.2.2 Emission factors

IPCC 2006 Guidelines default emission factors (IPCC, 2006, vol 4, chapter 2, Table 2.5, page 2.47) are applied.

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5.7.3 Uncertainty

5.7.3.1 Activity data uncertainty

Based on uncertainties in IPCC 2006 Guidelines (IPCC, 2006; Table 2.4) and van Leeuwen et al. (2014) fuel consumption uncertainty was determined to be 20% for croplands.

5.7.3.2 Emission factor uncertainty

IPCC 2006 Guidelines default uncertainties for emission factors are provided in the guidelines (IPCC, 2006; Table 2.5).

5.7.4 Time-series consistency

Time series is consistent.

5.7.5 Category specific QA/QC and verification

Burnt area data that was estimated from the crop data on sugarcane planted areas from the Abstracts of Agricultural Statistics was compared to those from MODIS collection 6 data. Additionally, the general QA/QC measures in Table 5.8 were used for this category.

5.7.6 Category-specific recalculations

No recalculations are performed for this category.

5.7.7 Category-specific planned improvements

There are no specific planned improvements for this category.

5.8 Liming (CRT 3.G)

5.8.1 Category description

Liming is used to reduce soil acidity and improve plant growth in managed systems. Adding carbonates to soils in the form of lime (limestone or dolomite) leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate. Lime is commonly applied to agricultural lands where nitrogenous fertilisers are continuously used and where precipitation exceeds evapotranspiration.

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Liming emissions increased by 3.9% in the period 2000–2024. Liming contributed 1 891 Gg CO_2e in 2024, which is 3.6% of the agriculture sector emissions.

5.8.2 Methodological issues

A Tier 1 approach of the IPCC 2006 Guidelines was used to calculate annual CO_2 emissions from lime application (Equation 11.12, IPCC 2006). Tier 2 approach is not available for this category.

5.8.2.1 Activity data

The crop area data was sourced from the Abstracts of Agricultural Statistics (DALRRD, 2022), which is a reliable and sustainable data source published annually. Emissions from lime application was estimated per crop type using crop area data and application rates. The calculation was derived from crop areas and application rates, employing estimates from Tongwane et al. (2016). However, this resulted in a figure exceeding 3 million tons of lime in 2008, contrasting with the 1.5 million tons reported by the Fertiliser Association of South Africa.

5.8.2.2 Emission factors

The IPCC 2006 Guidelines default emission factors of 0.12 t C (t limestone)-1 and 0.13 t C (t dolomite)-1 were used to calculate the CO_2 emissions from *Liming*.

5.8.3 Uncertainty

5.8.3.1 Activity data uncertainty

Uncertainty is determined from the difference between the SAMI (DMR, 2018) report data and the Fertilizer Association data. For limestone it is -90% to 25% and for dolomite it was determined to be -75% to 15%.

5.8.3.2 Emission factor uncertainty

The dolomite and limestone default emission factors have an uncertainty of -50% (IPCC 2006 Guidelines, p. 11.27).

5.8.4 Time-series consistency

The time-series is consistent and complete.

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5.8.5 Category specific QA/QC and verification

Previous inventories reviews highlighted the need to enhance this information and explore alternative methods for calculating potential lime use. In 2020 inventory, this was attempted by using crop area estimates along with application rates from Tongwane et al. (2016), which resulted in a figure exceeding 3 million tons of lime in 2008, in contrast to the 1.5 million tons reported by the Fertiliser Association of SA. This highlighted a discrepancy between the two data sources. As a result, this data was excluded from the 2020 inventory, but it has now been included in this report. Additionally, there is a need to seek alternative data sources for future analyses. Additionally, the general QA/QC measures in Table 5.8 were used for this category.

5.8.6 Category-specific recalculations

No recalculations are performed for this category.

5.8.7 Category-specific planned improvements

There is a need for alternate data sources for lime data.

5.9 Urea application (CRT 3.H)

5.9.1 Category description

Adding urea to soils during fertilization leads to a loss of CO_2 that was fixed in the industrial production process.

Urea application emissions increased by 126% in the period 2000–2024. Urea application contributed 671 Gg CO_2e in 2024, which is 1.3% of the agriculture sector emissions.

Urea application emissions increased from 297.3 Gg CO_2e in 2000 to 670.8 Gg CO_2e in 2024, representing more than a twofold rise. The increase in urea application emissions from 2000 to 2024 does not represent a real rise in fertilizer use or associated emissions. Instead, it results from a change in the data source used for the inventory, which has produced higher reported values. The increase is interpreted as an improvement in data quality rather than a true emissions surge.

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5.9.2 Methodological issues

A Tier 1 approach of the IPCC 2006 Guidelines is used to calculate CO_2 emissions from urea fertilization (Equation 11.13, IPCC 2006).

5.9.2.1 Activity data

Import and export data for urea was obtained from South African Revenue Service (SARS) (downloaded from http://www.sagis.org.za/sars.html on 13/07/2022).

5.9.2.2 Emission factors

The IPCC 2006 Guidelines default emission factor of 0.2 t C (t urea)-1 is applied in the equation to calculate the CO_2 emissions.

5.9.3 Uncertainty

5.9.3.1 Activity data uncertainty

In terms of urea application, it is assumed that all urea imported is applied to agricultural soils and this approach may lead to an over- or under-estimate if the total imported urea is not applied in that particular year. However, over the long-term this bias should be negligible (IPCC, 2006). Urea data is based on import data, which is well controlled, so a nominal 5% uncertainty was assumed. There is also some uncertainty with regards to the use and distribution of this urea. Again, there are no uncertainty estimates provided for this so an additional 5% was assumed.

5.9.3.2 Emission factor uncertainty

As for the liming emission factors, the urea emission factor also has an uncertainty of -50% (IPCC 2006 Guidelines, p. 11.32).

5.9.4 Time-series consistency

The time-series is consistent.

5.9.5 Category specific QA/QC and verification

Urea data is checked against the FAOStat dataset and found to be very similar. Additionally, the general QA/QC measures in Table 5.8 were used for this category.

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5.9.6 Category-specific recalculations

No recalculations are performed for this category.

5.9.7 Category-specific planned improvements

No improvements are planned for this category in the next year.

5.10 Other carbon-containing fertilizers (CRT 3.I)

Other carbon-containing fertilizers are not included in the inventory, as there has been no progress since the previous inventory in terms of data availability or research regarding their presence and use in South Africa. Relevant activity data and parameters required to define and quantify this category remain unavailable. In the absence of sufficient evidence on application rates, associated carbon emissions, and overall environmental impacts, it is not possible to reliably estimate their contribution to GHG emissions. Consequently, the inventory continues to focus on well-documented fertilizer categories to ensure methodological robustness and transparency. Further research and data development would be required before these fertilizers can be considered for inclusion in future inventories.

5.11 Other (CRT 3.J)

The "Other" category is excluded from the inventory because it is not applicable.

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Chapter 6: Land use, Land Use Change and Forestry (LULUCF) (CRT sector 4)

6.1 Sector overview

In the LULUCF sector South Africa reports on the emissions (positive) and removals (negative) of CO_2, CH_4 and N_2O from the entire land area (122 008 kha) of South Africa as all lands are considered managed. The national territory of South Africa includes two subantarctic islands, namely Marion Island (46° 54′ S, 37° 45′ E; 29 300 ha) and Prince Edward Island (46° 38′ S, 37° 57′ E; 4 500 ha) and together they are known as The Prince Edward Islands (Nel, et al., 2020; Smith & Mucina, 2006). These overseas territories are included in the total land area.

The following land categories are included in this inventory:

- *Forest land* (4.A.)
- *Cropland* (4.B.)
- *Grassland* (4.C.)
- *Wetlands* (4.D.)
- *Settlements* (4.E.)
- *Other land* (4.F.)

In all these land categories a distinction is made between areas which, during the reporting period:

- undergo no land-use changes, and thus remain, in unchanged form, in the land-use category they are in ("land remaining" categories 4.A.1. – 4.F.1.)
- undergo land-use changes:
    - From the time of conversion onward, these areas are reported in the category to which they were converted. Within those land-use categories, the converted areas are then reported in conversion categories ("land conversion" categories 4.A.2. – 4.F.2.) for a total of 20 years. After 20 years in a conversion category, the areas are reported under the relevant remaining categories.

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The following pools are included under each of the land categories:

- Above-ground biomass:
  - Includes all living biomass above the soil including stem, stump, branches, bark, seeds, and foliage.
  - Included for all land categories.
- Below-ground biomass:
  - Includes all biomass of live roots.
  - Included for all land categories.
- Litter:
  - Included all non-living biomass, lying dead, in various states of decomposition above the mineral or organic soil.
  - Included for all land categories.
- Dead wood:
  - Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil.
  - Only separated out from litter in the *Forest land* category.
- Mineral soils:
  - Includes organic carbon in mineral soils to a depth of 30cm.
  - Included for all land categories.
- Organic soils:
  - Drainage and rewetting (see below).
- Harvested wood products (4.G.).

Within each land categories the following non-CO_2 emissions are also included:

- Direct and indirect N_2O emissions from nitrogen inputs into managed lands (4(I)):
  - There is insufficient data to include all these emissions under each land category, but a start is made by including N input to forest plantations (*Forest land*) and golf courses (*Settlements*).
  - N inputs to Croplands are included under Agriculture (3.D. Agricultural soils) and not in the LULUCF sector.
- Emissions and removals from drainage, rewetting and other management of soils (4(II)):
  - N_2O emissions from drained organic soils only included for *Grasslands remaining grasslands*. Estimates for *Croplands remaining croplands* are reported under Agriculture (CRT 3.D.1).

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- CH_4 emissions from rewetting of mineral and organic soils are included for *Wetlands*.

- Direct and indirect N_2O emissions from N mineralisation/mobilisation associated with loss/gain soil organic matter resulting from change of land use or management (4(III)):
  - These emissions are included in all land categories except Cropland remaining croplands which are included under Agriculture (CRT 3.D.1).
- Biomass burning (4(IV)):
  - Included for all land categories except *Other land* as it is assumed there is no burning on *Other lands* due to the lack of vegetation.
  - Emission estimates of the precursor gases CO, NO_x and NMVOC are reported here, but the indirect emissions of CO_2 and N_2O associated with these are reported in Chapter 8 of this NID and Table 6 of the CRT. These emissions are not included in the LULUCF sector total.

6.1.1 Shares and trends in emissions 1990-2024

The LULUCF sector is a sink in 2024 (Table 6.1) with *Forest lands* being the largest contributor to the sink. All other land categories, except for a small sequestration from *Settlements*, are a source of emissions in 2024, with *Other lands* being the largest.

Table 6.1: Summary of emissions from the LULUCF sector in 2024

GHG source and sink categories	CO_2	CH_4		N_2O		Total
	Gg CO_2	Gg	Gg CO_2e	Gg	Gg CO_2e	Gg CO_2e
4. LULUCF	**-37 584**	**105**	**2 941**	**5**	**1 231**	**-33 412**
4.A. Forest land	-55 744	14	399	1	309	-55 037
4.B. Cropland	8 084	3	71	1	156	8 311
4.C. Grassland	3 048	19	519	1	351	3 918
4.D. Wetlands	107	69	1 932	0	67	2 105
4.E. Settlements	-1 453	1	21	0	106	-1 326
4.F. Other land	10 093	0	0	1	241	10 334
4.G. Harvested wood products	-1 718	NA	NA	NA	NA	-1 718

Figure 6.1 provides an overview of the LULUCF emission trends for South Africa over the time-series 1990-2024. The time-series reflects the trends in land-use changes (Figure 6.2). The land-use changes have been determined based on South African National Land Cover (SANLC) data sets for the reference years 1990, 2014, 2018, 2020 and 2022.

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Between the reference years, the land-use changes have been linearly interpolated, hence the larger changes after each refence year and the stable emissions and removals between reference periods. A map is being developed for 2024 but it was not finalised before the preparation of this inventory and so the data could not be included. Data for the period 2022-2024 was extrapolated as per the methodology described in section 6.3.6.

Forest lands are the largest contributor to the sink across the time-series. The dominant *Forest land* sinks are thickets and woodlands. Between 1990 and 2000 the *Forest land* sink is smaller than the later years and this is attributed to the burnt area data that was extrapolated over this period. The data is very uncertain and appears to be much higher than for the years from 2001 onwards (see further details in section 6.4.7). The increased annual variability, particularly in *Forest lands*, from 2001 onwards is due to changes in burnt area and the associated losses, as well as fuelwood and harvest losses. The increasing *Forest land* sink between 2018 and 2024 is attributed to an increasing conversion of *Grasslands* to *Forest land* (Figure 6.2).

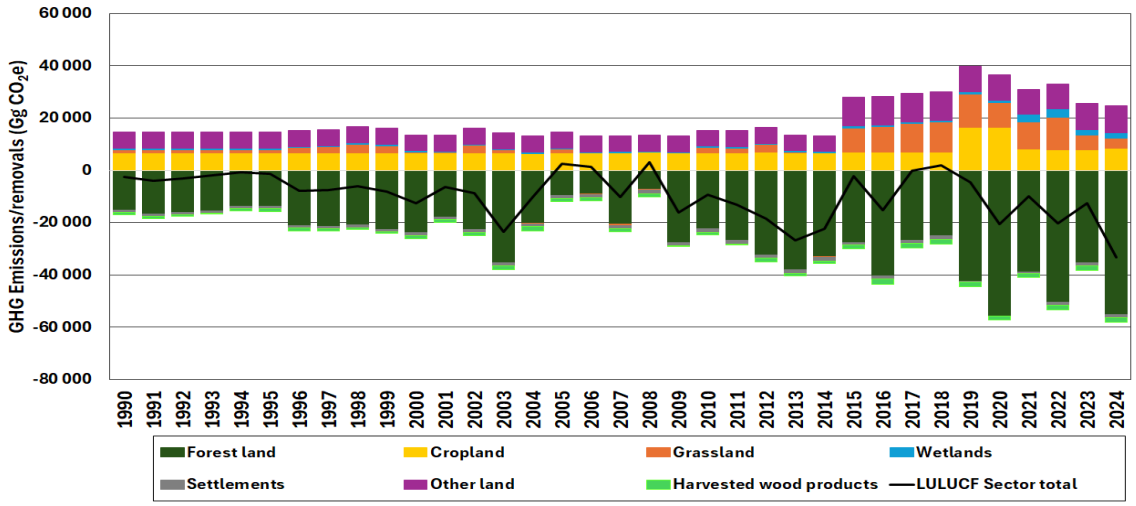


Figure 6.1: Time series for GHG emissions and removals by land type in the LULUCF sector, 1990-2024

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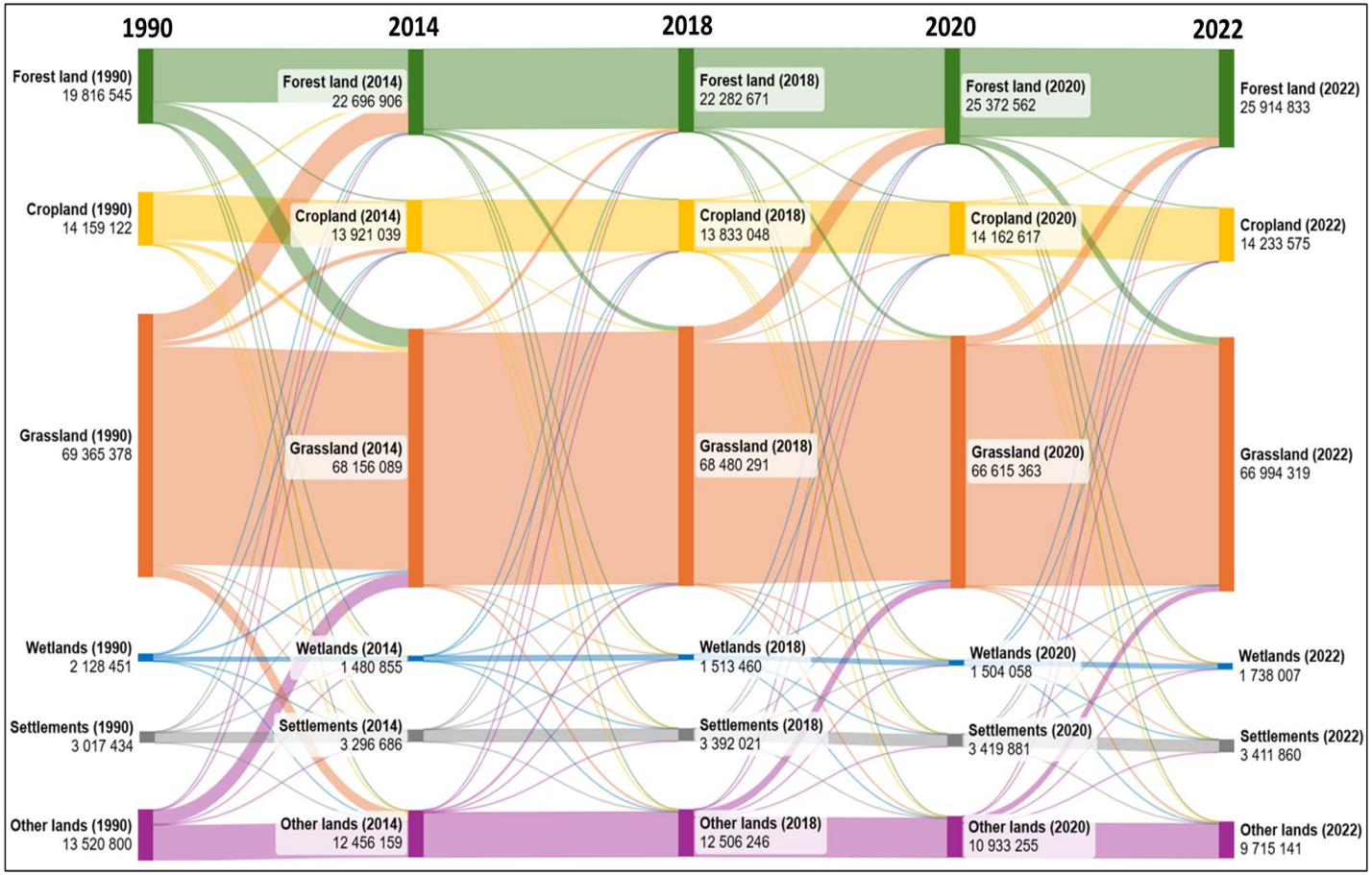


Figure 6.2: Land conversions between 1990 and 2022

In terms of emission sources, *Other lands* contribute the most and the emissions increase between 2014 and 2024. Between 2014 and 2018 there is an increase in conversion of *Forest land* to *Other land*, while from 2018 onwards there is an increase in conversion of *Grasslands* to *Other lands*. Much of these conversions are, however, thought to be related to seasonal variation rather than actual change. *Croplands* are a consistent source across the time-series except for an increase in emissions between 2019 and 2020. This increase is related to an increase in conversion from *Forest land* to *Croplands*. There is also a slight increase between 2018 and 2024 due to a slow increase in subsistence crop area. *Grasslands* are an emission source and shows increased emissions from 2014 onwards. This is mainly due to the conversion of *Forest lands* to *Grasslands* (Figure 6.2). The *Wetland* source is small but increases from 1990 to 2024 as there is an increase in conversion of all other land types to *Wetlands*.

Converted lands are the largest contributors to all land categories except *Settlements* (Table 6.2). Overall, the LULUCF sector increased its sink by 30 954 Gg CO_2e between 1990 and 2024. Of this change, 67.1% occurred between 2000 and 2024. The sink increased by 13 107 Gg CO_2e since 2022. Between 1990 and 2024 the greatest percentage increases were seen in the *Forest land*, while for the periods 2000 to 2024, and 2022 to 2024 the *Grassland* and *Wetland* categories showed the largest changes.

Biomass is the dominant carbon pool (Figure 6.3). Overall the SOC is a small source throughout the time-series. The DOM pool is slightly larger than the SOC pool and seems to vary between a source and a sink depending on the land changes.

CO_2 is the dominant gas in the LULUCF sector and is responsible for the sink (Figure 6.4). CH_4 and N_2O are emission sources and are produced through activities such as biomass burning, nitrogen additions to soil, loss of soil organic carbon due to land use change, and drainage and rewetting of soils.

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Table 6.2: Summary of the change in emissions from the LULUCF sector over the time-series 1990-2024 and since the last inventory in 2022.

GHG source and sink categories	Emissions (Gg CO_2e)				Difference (Gg CO_2e)			Change (%)		
	1990	2000	2022	2024	1990-2024	2000-2024	2022-2024	1990-2024	2000-2024	2022-2024
4. LULUCF	**-2 458**	**-12 643**	**-20 305**	**-33 412**	**-30 954**	**-20 769**	**-13 107**	**1 259.2**	**164.3**	**64.6**
4.A. Forest land	**-15 260**	**-23 838**	**-50 456**	**-55 037**	**-39 776**	**-31 199**	**-4 580**	**260.7**	**130.9**	**9.1**
4.A.1. Forest land remaining forest land	*20 235*	*11 788*	*4 444*	*8 486*	*-11 749*	*-3 302*	*4 043*	*-58.1*	*-28.0*	*91.0*
4.A.2. Land converted to forest land	*-35 495*	*-35 626*	*-54 900*	*-63 523*	*-28 027*	*-27 896*	*-8 623*	*79.0*	*78.3*	*15.7*
4.B. Cropland	**6 531**	**6 570**	**7 939**	**8 311**	**1 780**	**1 741**	**372**	**27.3**	**26.5**	**4.7**
4.B.1. Cropland remaining cropland	*747*	*710*	*29*	*336*	*-410*	*-373*	*307*	*-55.0*	*-52.6*	*1 049.1*
4.B.2. Land converted to cropland	*5 784*	*5 860*	*7 910*	*7 975*	*2 190*	*2 115*	*64*	*37.9*	*36.1*	*0.8*
4.C. Grassland	**1 404**	**430**	**10 369**	**3 918**	**2 514**	**3 488**	**-6 451**	**179.0**	**810.6**	**-62.2**
4.C.1. Grassland remaining grassland	*-5 963*	*-6 816*	*-41 542*	*-14 683*	*-8 720*	*-7 867*	*26 859*	*146.2*	*115.4*	*-64.7*
4.C.2. Land converted to grassland	*7 368*	*7 246*	*51 911*	*18 601*	*11 233*	*11 354*	*-33 311*	*152.5*	*156.7*	*-64.2*
4.D. Wetlands	**503**	**426**	**3 188**	**2 105**	**1 602**	**1 679**	**-1 083**	**318.4**	**394.5**	**-34.0**
4.D.1. Wetlands remaining wetlands	*217*	*165*	*474*	*309*	*92*	*144*	*-165*	*42.6*	*87.7*	*-34.8*
4.D.2. Land converted to wetlands	*286*	*261*	*2 714*	*1 796*	*1 510*	*1 535*	*-918*	*527.4*	*588.2*	*-33.8*
4.E. Settlements	**-760**	**-1 040**	**-1 285**	**-1 326**	**-566**	**-286**	**-41**	**74.5**	**27.5**	**3.2**
4.E.1. Settlements remaining settlements	*-1 287*	*-1 513*	*-3 050*	*-2 981*	*-1 695*	*-1 469*	*68*	*131.7*	*97.1*	*-2.2*
4.E.2. Land converted to settlements	*527*	*473*	*1 765*	*1 656*	*1 128*	*1 183*	*-110*	*214.0*	*250.3*	*-6.2*
4.F. Other land	**6 159**	**6 159**	**9 516**	**10 334**	**4 176**	**4 176**	**818**	**67.8**	**67.8**	**8.6**
4.F.1. Other land remaining other land	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.0*	*0.0*	*0.0*
4.F.2. Land converted to other land	*6 159*	*6 159*	*9 516*	*10 334*	*4 176*	*4 176*	*818*	*67.8*	*67.8*	*8.6*
4.G. Harvested wood products	**-1 036**	**-1 350**	**-1 675**	**-1 718**	**-683**	**-369**	**-43**	**65.9**	**27.3**	**2.6**

Note: Columns may not add up exactly due to rounding off

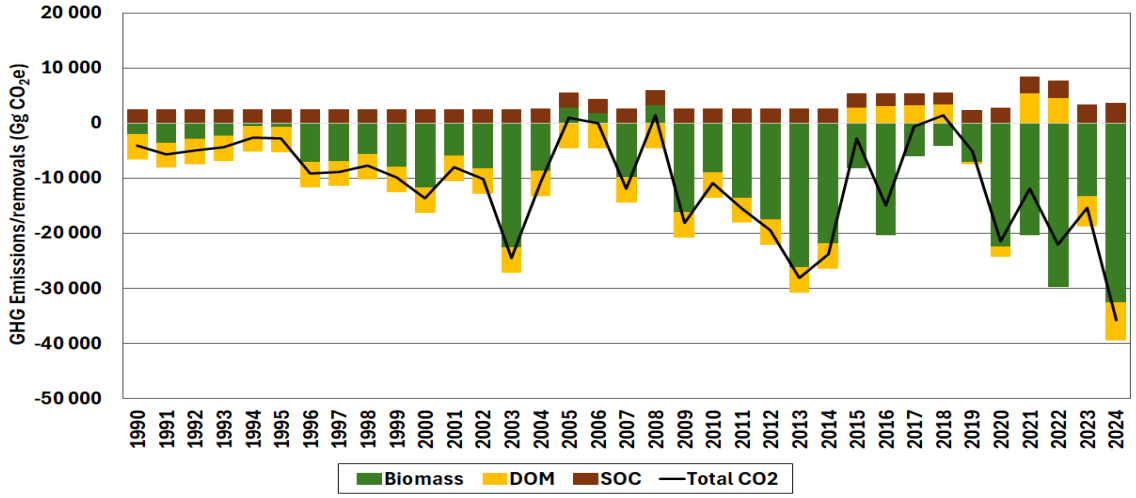


Figure 6.3: Time-series of GHG emission and removals by carbon pool for the LULUCF sector, 1990-2024

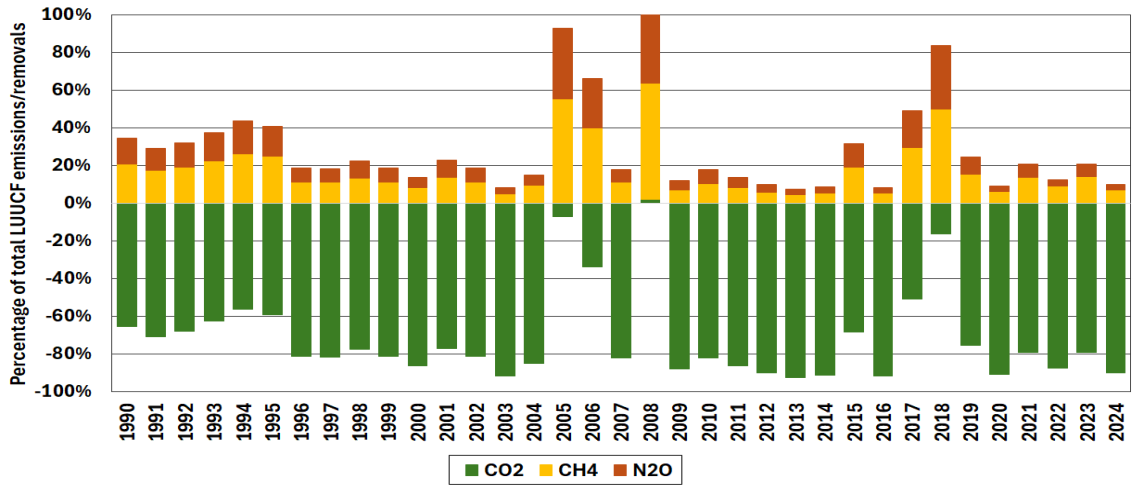


Figure 6.4: Time-series of percentage contribution of gases to the total LULUCF sector emissions/removals, 1990-2024

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6.1.2 Methodological issues

The emissions and removals in the LULUCF sector were estimated by following the guidance provided in the IPCC 2006 Guidelines (IPCC, 2006), parts of the IPCC 2019 Refinement (IPCC, 2019) and parts of the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC, 2014a) (hereinafter referred to as IPCC 2013 Wetland Supplement).

6.1.2.1 Overview of methodological approach (CRT 4.A to 4.F) and completeness

The following basic elements and processes were required to prepare the LULUCF inventory:

1. Land cover/use maps: SANLC maps, containing 73 land classes, were obtained for 1990, 2014, 2018, 2020 and 2022 (section 6.3.1 and Annex V.1). The relevant land uses, and the specific areas assigned to them, were explicitly determined for these years, while the areas applying to the periods between those years were obtained by linearly interpolating the calculated areas. It is assumed that the annual change between 1970 and 1990 was the same as for 1990-2014.
2. Land change matrix: The 73 classes from the SANLC maps were aggregated into 20 classes for land change determination. The classes were indigenous forests, thicket/dense bush, woodlands/open bush, forest plantations, vineyards, orchards, annual pivot crops, annual non-pivot crops, subsistence crops, grasslands, low shrublands, eroded land, wetlands, waterbodies, residential areas, commercial areas, industrial areas, small-holdings, mines, and bare ground. The annual land change areas were determined from the change matrix for 1990-2014, 2014-2018, 2018-2020 and 2020-2022 for the above-mentioned land categories (section 6.3.3) to assist in the calculation of "land remaining" and "land converted" categories.
3. Soil type stratification: A detailed soil map for South Africa is aggregated into the IPCC 2006 Guidelines soil types. The 20 class land conversion maps are clipped by soil type using this soil map and a land change matrix for each conversion period for each soil type is developed (section 6.3.4.1).
4. Burnt area: Monthly MODIS burnt area data is summed to obtain an annual burnt area data set. The SANLC data (aggregated to 20 classes) for 1990, 2014, 2018, 2020 and 2022 are intersected with the annual burnt area data for these years to obtain burnt area per land class for these base years. For the in-between years the annual burnt area data for 2001-2014 is intersected with the 2014 land cover

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map, 2015-2016 with 2014 land cover, 2017-2019 were intersected with 2018 land cover, 2020-2021 with 2020 land cover and 2022-2024 with 2022 land cover. Since MODIS data is only available from 2001 the annual burnt area for the years 1990-2000 is extrapolated using FAO data, Forestry SA data and averaging assumptions.

5. Adjustments applied to land change matrixes: Corrections for the coastal buffer, Landsat and Sentinel data impacts between 2014-2018, unlikely changes, Forestry South Africa plantation data, and wet and dry seasonal variation are implemented (see detail in section 6.3.3.2.1).
6. Addition of overseas territories: The overseas territories are not included in the SANLC maps so these were added to the land conversion matrixes as discussed in section 6.1.2.2 below.
7. 20-year default transition period: The land-use-matrix calculation is referenced to the year 1970, to make it possible to determine land-use-change areas for years prior to the actual reporting period. Identified conversion areas were assigned to the relevant land-use-change category, in the year in which the land-use change took place, and they remained in that category for a maximum of 20 years. At the end of the 20-year period, the areas were assigned to the remaining category within the final use category. The "land remaining" was calculated from the land area converted to that land category and the area converted to another land category. The "land converted" was calculated from the annual converted area accumulated over the period in which it remains in the "land converted" up to the default 20-year conversion period. Since land parcels were not tracked the annual converted area was always removed from the "land remaining" category as indicated in the IPCC 2006 Guidelines.
8. Annual increase in carbon stocks due to biomass growth: Estimated the annual increase in biomass carbon stocks for each land class with perennial vegetation by applying the IPCC 2006 Guidelines equations 2.9-2.10. Parameters obtained from scientific literature and weighted averages (based on area) applied. Forestry SA data provides additional data for forest plantations.
9. Annual decrease in biomass carbon stocks due to losses: Losses due to harvest, fuelwood collection, and disturbances are estimated using IPCC 2006 Guidelines equations 2.11 to 2.14. The disturbance losses are only for fires except for forest plantations where other disturbance losses (such as insects, wind) were also included. Activity data is obtained from Forestry SA, StasSA, and MODIS burnt area.
10. Biomass change due to land conversions: Estimated annual change in biomass carbon stocks due to land changes by applying the IPCC 2006 Guidelines equation 2.15 and 2.16 (Tier 2).

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11. Annual change in carbon stocks in biomass in land remaining categories: Outputs from points 7-10 above were incorporated into the IPCC Gain-loss equation (IPCC 2006 Guideline equation 2.7) to determine the annual change in biomass carbon stocks.
12. Annual change in carbon stocks in deadwood and litter (DOM): For "land remaining" the DOM was assumed not to change (Tier 1 assumption) so a value of zero is applied. The "converted land" categories the annual change in stocks in DOM were estimated using IPCC 2006 Guideline equation 2.23. Parameters obtained from scientific literature and weighted averages (based on area) applied.
13. Soil organic carbon reference values: Soils were classified into the 6 soil classes identified in the IPCC 2006 Guidelines and this was intersected with the land cover data to extract the "land remaining" areas of the natural (land cover) classes. The "land remaining" area under each soil class was then intersected with the ISRIC soils dataset to obtain SOC values for these areas. An average SOC reference value was determined from this for each soil type (section 6.4.3.1).
14. Soil carbon stock change factors: The IPCC 2006 Guidelines stock change factors were applied for *Forest land, Grassland, Wetlands and Settlements*, while detailed data on cropland management provided estimates of the stock change factors for *Croplands*.
15. Annual change in carbon stocks in mineral soils: This was estimated by applying the IPCC 2006 Guideline equation 2.25 (Approach B).
16. CO_2 emissions from drained organic soils: Organic soil area was determined from ISRIC data (section 6.4.3.2). The area of drained organic soils for *Grasslands remaining grasslands* and *Croplands remaining Croplands* were obtained from FAOSTAT. These datasets were used, together with IPCC default factors, in IPCC 2019 Refinement equation 2.2 to estimate CO_2 emissions from drained organic soils. These emissions were reported in CRT 4.B to 4.C.
17. Calculation of CO_2 emissions on the basis of the carbon-stocks values for the NID, via multiplication of carbon-stock changes by the factor -44/12.
18. N_2O emissions from nitrogen input: Nitrogen input to the various land categories was sourced and direct emissions estimated by applying IPCC 2006 Guideline equations 11.1-11.6, while indirect emissions are estimated using equations 11.9-11.11. N input data is very limited and only data for forest plantations and golf courses were included in this inventory. N inputs to agriculture are accounted for under Agriculture (CRT 3.D.1).
19. N_2O emissions and removals from drainage of organic soils (section 6.4.5). Organic soil area was determined from ISRIC data (section 6.4.3.2). The area of drained organic soils for *Grasslands remaining grasslands* and *Croplands remaining croplands* are obtained from FAOSTAT. These datasets were combined into IPCC

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2013 Wetland Supplement (IPCC, 2014a) equation 2.4 to estimate CH_4 emissions and IPCC 2006 Guidelines equation 11.1 to estimate N_2O emissions. The N_2O emissions from *Croplands remaining croplands* were included in Agriculture (CRT 3.D.1) and excluded from the LULUCF sector.

20. CH_4 emissions from rewetting of wetland mineral and organic soils (section 6.4.5): These were estimated for *Wetlands* as all areas, according to the land change matrixes, that were converted from any land type to a wetland were considered rewetted. Mineral and organic soils were included. Rewetted area was combined with IPCC default emission factors into equation 5.1 of the IPCC 2013 Wetland Supplement.
21. Direct and indirect N_2O emissions from N mineralisation/immobilisation associated with soil organic matter and management changes (section 6.4.6): Loss of soil carbon is already determined through the methods mentioned above, so this data is incorporated into IPCC 2006 Guidelines equations 11.1/2 and 11.8 along with IPCC default emission factors to estimate direct N_2O emissions. Indirect N_2O emissions are estimated with IPCC 2006 Guidelines equations 11.9-11.11.
22. Non-CO_2 emissions from biomass burning (section 6.4.7): CH_4 and N_2O emissions from each land class was determined from burnt area data (MODIS Collection 6), fuel loads, combustion factors and emission factors using IPCC 2006 Guidelines equation 2.27. Data was sourced from scientific literature and IPCC 2006 Guidelines and IPCC 2019 Refinement.
23. Indirect emissions: Emissions of CO, NO_x and NMVOC are estimated from biomass burning as indicated in point 22 above. These emissions are converted to indirect emissions of CO_2 and N_2O but these emissions are not reported under the LULUCF sector but rather Chapter 8 of this report and are report in Table 6 in the CRT.
24. Calculation of N_2O emissions from nitrogen values, via multiplication of the nitrogen-stock changes by the factor -44/28; the N_2O values are converted into CO_2 equivalents using the factor 265 (GWP 100 pursuant to IPCC AR5 (IPCC, 2014b)).
25. The CH_4 emissions are converted into CO_2 equivalents using the factor 28 (GWP 100 pursuant to IPCC AR5).
26. The data from the 20 classes were aggregated into the 6 IPCC 2006 Guidelines categories (section 6.2) for reporting purposes.

A summary of the tier level of the methods and types of emission factors incorporated into the inventory, along with completeness, are provided in Table 6.3.

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Table 6.3: Summary of methods, emission factors and completeness for the LULUCF sector

GHG source and sink categories	Sub-category	CO_2		CH_4		N_2O		NOx		CO		NMVOC	
		Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
4.A. Forest land													
Forest land remaining forest land	*4.A.1. Biomass*	*T2*	*CS*										
	4.A.1. DOM	*T1*	*CS*										
	4.A.1. SOC	*T2*	*CS*										
	4(I).A.1.					*T1*	*D*						
	4(II).A.1.	*NE*	*NA*	*NE*	*NA*	*NE*	*NA*						
	4(III).A.1.					*T1*	*D*						
	4(IV).A.1.			*T1/T2*	*D*	*T1/T2*	*D*	*T1/T2*	*D*	*T1/T2*	*D*	*T1/T2*	*CS*
Land converted to forest land	*4.A.2. Biomass*	*T2*	*CS*										
	4.A.2. DOM	*T2*	*CS*										
	4.A.2. SOC	*T2*	*CS*										
	4(I).A.2.					*T1*	*D*						
	4(II).A.2.	*NE*	*NA*	*NE*	*NA*	*NE*	*NA*						
	4(III).A.2.					*T1*	*D*						
	4(IV).A.2.			*T1/T2*	*D*	*T1/T2*	*D*	*T1/T2*	*D*	*T1/T2*	*D*	*T1/T2*	*CS*
4.B. Cropland													
Cropland remaining cropland	*4.B.1. Biomass*	*T1/T2*	*CS*										
	4.B.1. DOM	*T1/T2*	*CS*										
	4.B.1. SOC	*T2*	*CS*										

	4(I).B.1.					IE	NA						
	4(II).B.1.	T1	D	T1	D	IE	IE						
	4(III).B.1.					T1	D						
	4(IV).B.1.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
Land converted to cropland	4.B.2. Biomass	T2	CS										
	4.B.2. DOM	T2	CS										
	4.B.2. SOC	T2	CS										
	4(I).B.2.					IE	NA						
	4(II).B.2.	NE	NE	NE	NE	NE	NE						
	4(III).B.2.					T1/T2	D						
	4(IV).B.2.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
4.C. Grassland													
Grassland remaining grassland	4.C.1. Biomass	T1/T2	CS										
	4.C.1. DOM	T1/T2	CS										
	4.C.1. SOC	T2	CS										
	4(I).C.1.					NE	NA						
	4(II).C.1.	T1	D	T1	D	IE	IE						
	4(III).C.1.					T1	D						
	4(IV).C.1.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
Land converted to grassland	4.C.2. Biomass	T2	CS										
	4.C.2. DOM	T2	CS										
	4.C.2. SOC	T2	CS										
	4(I).C.2.					NE	NA						
	4(II).C.2.	NE	NE	NE	NE	NE	NE						
	4(III).C.2.					T1/T2	D						

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	4(IV).C.2.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
4.D. Wetlands													
Flooded land remaining flooded land	4.D.1.b. Biomass	T2	CS										
	4.D.1.b. DOM	NA	NA										
	4.D.1.b. SOC	NA	NA										
	4(I).D.1.b.					NO	NA						
	4(II).D.1.b.	NA	NA	T1	D	NA	NA						
	4(III).D.1.b.					NA	NA						
	4(IV).D.1.b.			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other wetlands remaining other wetlands	4.D.1.c. Biomass	T1/T2	D/CS										
	4.D.1.c. DOM	T1	CS										
	4.D.1.c. SOC	T2	CS										
	4(I).D.1.c.					NO	NA						
	4(II).D.1.c.	T1	D	T1	D	NA	NA						
	4(III).D.1.c.					T1	D						
	4(IV).D.1.c.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
Land converted to flooded land	4.D.2.b. Biomass	T1/T2	CS										
	4.D.2.b. DOM	NA	NA										
	4.D.2.b. SOC	NA	NA										
	4(I).D.2.b.					NO	NA						
	4(II).D.2.b.			T1	D	NA	NA						
	4(III).D.2.b.					T1	D						
	4(IV).D.2.b.			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4.D.2.c. Biomass	T1/T2	CS										

Land converted to other wetlands	4.D.2.c. DOM	T1/T2	CS										
	4.D.2.c. SOC	T2	CS										
	4(I).D.2.c.					NO	NA						
	4(II).D.2.c.			T1	D	NA	NA						
	4(III).D.2.c.					T1	D						
	4(IV).D.2.c.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
4.E. Settlements													
Settlements remaining settlements	4.E.1. Biomass	T1/T2	CS										
	4.E.1. DOM	T1	CS										
	4.E.1. SOC	T2	CS										
	4(I).E.1.					T1	D						
	4(II).E.1.	NE	NA	NE	NA	NE	NA						
	4(III).E.1.					T1	D						
	4(IV).E.1.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
Land converted to settlements	4.E.2. Biomass	T2	CS										
	4.E.2. DOM	T2	CS										
	4.E.2. SOC	T2	CS										
	4(I).E.2.					T1	D						
	4(II).E.2.	NE	NA	NE	NA	NE	NA						
	4(III).E.2.					T1	D						
	4(IV).E.2.			T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	D	T1/T2	CS
4.F. Other land													
Other land remaining other land	4.F.1. Biomass	NO	NA										
	4.F.1. DOM	NO	NA										
	4.F.1. SOC	T2	CS										

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	4(I).F.1.					NO	NA						
	4(II).F.1.	NE	NA	NE	NA	NE	NA						
	4(III).F.1.					T1	D						
	4(IV).F.1.			NO	NA	NO	NA	NO	NA	NO	NA	NO	NA
Land converted to other land	4.F.2. Biomass	T2	CS										
	4.F.2. DOM	T2	CS										
	4.F.2. SOC	T2	CS										
	4(I).F.2.					NO	NA						
	4(II).F.2.	NE	NA	NE	NA	NE	NA						
	4(III).F.2.					T1	D						
	4(IV).F.2.			NO	NA	NO	NA	NO	NA	NO	NA	NO	NA
4.G. Harvested wood products													
Harvested wood products	4.G.	T1	D										

NA = Not applicable; NO = Not occurring; NE = Not estimated; IE = Included elsewhere; T1 = Tier 1; T2 = Tier 2; D = IPCC default factor; CS = Country specific factor.

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6.1.2.2 *Inclusion of overseas territories*

At the recommendation of the TERT (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L.1) the overseas territories were included in the total area and emission estimates. It was noted that in the previous inventory this was not done correctly and so this has been addressed in this inventory. There is still a lack of land cover/use data related to these overseas territories so some assumptions have been made, but this inventory has worked to include the areas correctly into the methodology and any assumptions will be updated in future as more data becomes available.

6.1.2.2.1 *Methodology for inclusion of overseas territories*

The Prince Edward Islands are South Africa's overseas territories, and these consist of Marion Island (29 000ha) and Prince Edward Island (4 500 ha) (Smith & Mucina, 2006). This area has been included in the total land area for South Africa. Marion Island has 10 876.5 ha of polar desert (Smith, et al., 2001) and looking at the map of Prince Edward Island in Smith and Mucina (2006) it is assumed to be 2% of Prince Edward Island. The total Polar desert area for the overseas territories is therefore 10 966.4 ha. The rest of the area of these islands consists of various vegetation types, such as herbfields, mires, tussock grasslands, fernbrakes and fellfield (Smith, et al., 2001; Smith & Mucina, 2006) which are all grouped under the land category of subantarctic tundra. In tern the polar desert was considered under the *Other land* IPCC class, while the subantarctic tundra was included under *Grasslands*.

There are no land change maps or data for these overseas territories and there is very little human management of the land, so for the purposes of this inventory the land cover was assumed not to change over the time series. As data becomes available this assumption can be updated to reflect the situation.

Vegetation was also stratified by soil type. The spatial map for the Prince Edward Isalands were not available at the time of the inventory but a map and data for Marion Island soils is provided in Lubbe (2010). The soil types on the Prince Edwards Islands are based on this. It appears that the polar desert consists of Regosols which are classified as HAC soils (IPCC 2006 Guidelines, Table 2.3). Lubbe indicates that Regosols cover 58km2 of Marion Island and, based on the soil map, this is under the polar desert. It is also indicated there is 7km2 of rock and this is assumed to be allocated to polar desert. Based on the map it is then assumed the rest of the polar desert is on Andosol (Volcanic soil). As the polar desert is 109km2 it means that Andosols cover 44km2. Lubbe indicates that Andosols cover 98km2 which means 54km2 are allocated to tundra vegetation. Histosols (organic soils) and Histic Andosols (Volcanic soils) cover 62 and 64km2 respectively. All of this means

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that 53.2% of polar desert is HAC, 6.4% is rock and 40.4% is Volcanic, while tundra is estimated to be on 65.5% (30%+35.5%) Volcanic and 34.5% Organic soils. These same ratios were applied to the Prince Edward Island area.

6.1.3 Improvements and recalculations

Detailed improvements are discussed in each section land category section of this report, but the main inventory improvements that were carried out and which led to recalculation impacts in the different periods were:

- 1990 – 1999:
  - This part of the time-series was not included in the previous inventory so was not recalculated but rather estimated for the first time.
  - HWP data for this period was improved by updating activity data.
- 2000 – 2024:
  - Incorporation of 2020-2022 land change matrix data.
  - Updated land use change assumptions for technology corrections between 2014 and 2018.
  - Removal of "land remaining land" error that was identified in the previous inventory.
  - Incorporation of updated method and assumptions for removing seasonal variation changes in land use/cover.
  - Inclusion of initial estimates of organic soils in *Croplands* and *Grasslands*.
  - Improved soil data through the inclusion of land change matrix per soil type for each change period (1990-2014, 2014-2018,2018-2020, 2020-2022).
  - Updated biomass, carbon stock and emission factor data.
  - Improved burnt area methodology.
  - Updated fuelwood consumption data.
  - Methodological improvements, particularly to *Wetland* category, to improve alignment with IPCC methodologies and CRT's.

The recalculations showed the same trend between 2000 and 2014 as the previous data except that the sink was reduced by an average of 13.1% compared to the previous inventory (Figure 6.5). These differences were mainly due to updates in soil data, biomass data, burnt area and fuelwood estimates. After 2014 there is a change with recalculated estimates for 2014-2018 being very similar to the previous inventory, while estimates for 2018-2022 had an increased sink. The changes that lead to additional impacts during this period were the introduction of the 2020-2022 land use maps and the correction of the

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"land remaining" error. Recalculations led to an average reduction of 51.3% in the sink between 2014 and 2022. In the previous inventory the 2022 estimated sink for LULUCF was 43 181 Gg CO_2e, and in this inventory it is estimated at 20 305 Gg CO_2e which is a 53.0% decrease in the sink.

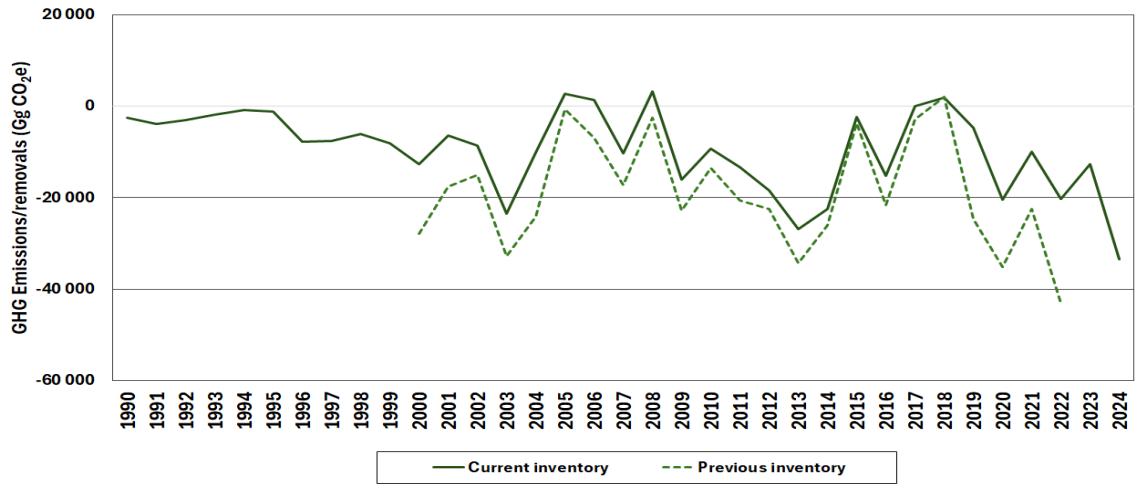


Figure 6.5: Change in LULUCF emission estimates due to recalculations since 2022 submission

6.1.4 Key categories in the LULUCF sector

The key categories in the LULUCF sector and their ranking are shown in Table 6.4. These show that the two most important categories are *Forest lands* and *Grasslands*, both remaining (4.A.1, 4.C.1) and converted lands (4.A.2, 4.C.2). Following this would be land converted to *Croplands* (4.B.2) and *Other lands* (4.F.2). In the previous submission *Grassland converted to forest land* was ranked at the main key category for LULUCF (1 overall) and *Forest land remaining forest land* as the second (3rd overall). In this submission these two have switched positions in the LULUCF key categories and moved down the overall ranking to 3rd and 6th position. There have been some shifts in the LULUCF rankings but generally the *Forest lands* and *Grasslands* are still the main categories. CH_4 emissions from Wetlands were on the key category list in the previous submission, but with the improved methodologies these have now dropped off the key

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category list. Biomass burning is also no longer on the key category list but has been replaced by CH_4 from drainage and rewetting (trend only).

Table 6.4: Key categories in the LULUCF sector in 2024.

Rank	IPCC code	IPCC Category	GHG	Criteria[#]
6	4.A.1.a	Forest land remaining forest land – biomass (above and below)	CO_2	L,T
3	4.A.2.b	Grassland converted to forest land – all pools	CO_2	L,T
19	4.B.2.a	Forest land converted to Cropland – all pools	CO_2	L,T
9	4.C.1.a	Grassland remaining Grassland – biomass (above and below)	CO_2	L,T
4	4.C.2.a	Forest land converted to Grassland – all pools	CO_2	L,T
33	4.C.2.b	Cropland converted to Grassland – all pools	CO_2	L,T
32	4.C.2.c	Wetland converted to Grassland – all pools	CO_2	T
7	4.C.2.e	Other land converted to Grassland – all pools	CO_2	L,T
22	4.E.1.a	Settlements remaining Settlements – biomass (above and below)	CO_2	L,T
34	4.E.2.b	Cropland converted to settlements – all pools	CO_2	T
28	4.F.2.a	Forest land converted to other land – all pools	CO_2	T
18	4.F.2.c	Grassland converted to other land – all pools	CO_2	L,T
24	4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	T
38	4.G	Harvested Wood Products	CO_2	T

[#]L = Level Assessment; T = Trend Assessment

6.1.5 Quality assurance and quality control

General quality control (QC), category specific quality control and quality assurance (QA) has been carried out in conformance with the QA/QC Plan for South Africa. This was developed in accordance with the IPCC 2006 Guidelines.

In the previous inventory the quality control process was identified as needing improvement and therefore several additional checks were completed for the LULUCF sector in this inventory. This is also based on the TERT recommendations (FCCC/ETF/TERR.1/2024/ZAF/Add.1/ID# 6.L.2) to improve the QC process for the LULUCF sector. There have been three major changes introduced to improve the QC process and estimates:

a) Redesign and recreation of the LULUCF sector calculation file. This was done to improve transparency and reduce errors. Previous files had been added to over the years and were becoming less transparent. In addition, the new files were

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setup to align with the new UNFCCC online reporting tool and CRT's. Numerous additional automatic checks were included in the new file. Outputs were compared to those in the previous inventory file and where there were discrepancies the calculations were assessed to understand the reasons for the differences.

b) Training of officials on the compilation of the LULUCF sector inventory to increase the number of eyes on the calculation files. DFFE had brought in a new team member during the compilation of the previous inventory to assist with the LULUCF compilation. The development of a new calculation file provided a good opportunity to train the LULUCF team members, so they were included from the start of the process. In addition, the person joining the team was involved in the development of the land use maps and so has a good understanding of the use of spatial data. This enabled the team to make more detailed assessments of the land cover data and provided someone who could do the checks on the land areas. Training is still ongoing so the ability to do more quality checks in future will improve in the next inventory.

c) Training on the latest version of the IPCC software was completed by the team. Even though the software is not being used to compile the inventory understanding how the software works enabled some of the methods and calculation done in the calculation file to be checked against the IPCC software. The software also shows where all the data fits into the CRT tables so this will improve the team's ability to complete and check the CRTs.

The general QC/QA process is described here with additional category specific checks being highlighted in the category specific sections below. All calculation checks were documented in the calculation file, with external reports being stored on the National GHG Inventory Management System (NGHGIMS).

6.1.5.1 General QC procedure

Automatic quality control checks are included in the calculation file, but a quality reviewer also completes checks on the calculation file. The QC reviewer incorporates comments into the calculation file by making use of the QA Analyst programme. For this all comments must start with a hashtag and include the initials of the QC reviewer, the date and the comment (see further details in the QA/QC Plan). After running QA Analyst, all comments are pulled out and listed in the QA log page at the front of the calculation file. The following steps are carried out during the QC of the calculation files:

(a) LULUCF compiler completes the inventory estimates;
(b) LULUCF compiler sends calculation file to QC reviewer;

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(c) QC reviewer checks the calculation file, makes comments, completes the QC reviewer sheets at the top of each worksheet and runs the QA Analyst programme to produce the QA log sheet;
(d) QC reviewer sends the checked calculation file back to the LULUCF compiler;
(e) Compiler responds to the QC reviewer comments, updates the QA log page by running QA Analyst and send the calculation file back to the QC reviewer;
(f) QC reviewer checks and signs off the QC comments and completes the review by updating the QA log file;
(g) QC reviewer exports log file and uploads it to the NGHGIMS under QA/QC Procedures/ QAQC Logs.

6.1.5.2 QC of input data, emission factors and calculation procedures

The land change data is the main driving activity data for the inventory and there were several checks that were conducted on this data. The following checks were completed on all land area data (including those for different soil types and for the full time-series):

- The national area is constant across the time series.
- The national area is the same for all land use change matrixes.
- The total area for each soil type is constant across the time-series.
- The total area of all soil types adds to the national total in all years.
- Addition calculations for "land remaining" and "land converted" are applied correctly and to the correct data.
- Adjustments to land change matrixes are applied correctly.
- The 20-year correction has been applied correctly.

In terms of other input data the following checks were conducted:

- The original data is transcribed correctly into the calculation file.
- If there are any sharp changes in the time-series data these are checked and explanations sought.
- Correct units are applied.
- All data sources are references in the calculation file.
- All data sources are uploaded and available on the NGHGIMS.
- IPCC extrapolation techniques to fill gaps are correctly applied.
- Assumptions are documented and explained.

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Emission factor checks included:

- Transcription errors.
- Differences from the previous inventory. If there are differences the reason for the change has been explained and documented.
- Consistency across time-series.
- Calculation of implied emission factors are correct.
- Provision of uncertainty data.

Calculation methodology and procedures were checked by comparing the methodology in the calculation file against the methodology applied in the IPCC software (ver 2.98). This was done by conducting spot checks on the different components of the various land categories and doing a complete re-run of the HWP data in the IPCC software. The following checks were also completed on calculations in the calculation file:

- Data in summary sections are added or combined correctly.
- Correct units and conversion factors have been applied.
- Data is consistent with that in CRT tables.

The final quality check was to compare the resulting emission estimates to any estimates calculated outside of the inventory calculation file.

6.1.5.3 QA process

A public commenting process took place whereby the inventory was published for public comment and issues arising were addressed where necessary.

6.1.5.4 Verification

The LULUCF sector inventory was prepared primarily from land use maps and data that was specific to South Africa which means that there was not often comparable data that could be used for verification. Land use and cover were also difficult to verify due to the different data sources using different classifications. If there were any reports that assessed the quality of the land use/cover maps through the use of other tools such as aerial photography, then these were utilised but these were often for small areas. The country specific classification of soils into the IPCC classes was compared to the ISRIC global dataset. The values obviously vary as the country specific map is more detailed, however similarities were looked for.

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Where possible country specific data was compared to international datasets such as FAOSTAT data and all emission factors or reference data were compared to IPCC default values. Parameters were also compared to neighbouring countries where available.

6.1.6 Planned improvements

There are four main improvements to be focussed on in the next inventory cycle, of which some, as indicated) were highlighted in the UNFCCC TERT Review report:

- Development of a land mapping system to move towards approach 3 (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L_CBN.4):
    - The major uncertainty in the LULUCF sector is still related to the land conversion areas. Currently there are various corrections that are being applied to distinguish seasonal and technology changes from actual change. As mentioned in the previous inventory, a detailed plan is being setup to improve the land change data in a systematic manner and to incorporate all corrections spatially to insure more consistency in the overlays. The aim is to obtain a better understanding of actual change. The UNFCCC TERT review also highlighted the need to develop a land mapping system that will allow for the tracking of land parcels. This tracking would also assist with improving the challenges with removal of seasonal variation, identifying conversions from already converted land and tracking burnt area.
    - The planned land change mapping system will also incorporate additional spatial data (soils, climate, peatlands, ecozones, etc) to improve the alignment of the overlay data. The overall improvement would mean a reduction in the uncertainty on LULUCF activity data.
    - Additional data, such as CHIRPS data, can also be included to assist with the development of a more consistent method for adjusting for seasonal variations.
    - To date a basic system design has been developed and costed out and so the focus in the next inventory cycle is implementation.
- Update the SOC Reference data:
    - Currently the SOC reference data relies on an older ISRIC data set and was based on the 2014 SANLC data. This needs to be updated with the improved data and more recent land use maps. There are some discrepancies between the SA SOC Reference values and the IPCC values, and this update might lead to an improvement in the comparability.

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- This would be incorporated as part of the land mapping system discussed in the point above, but if the system is not fully functional by the next inventory this improvement could be done separately and incorporated into the current system.

- Source data to complete the implementation of Tier 2 DOM methodology in *Forest lands*.
  - The Tier 2 equations and available data have been incorporated into the calculation files, however mortality rates and rates of transfer out of the DOM pools in *Forest land* need to be sourced and results verified before inclusion in the inventory outputs.
- Improve data collection on controlled fires (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L_CBN.3):
  - There is a need to separate out controlled fires and wildfires so that natural disturbances can be reported separately. Currently there is no system for collecting this data. In the next inventory cycle additional data sources will be explored and discussion will be started around developing a means to collect and report such data.

There is also still a need for a forest inventory (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L_CBN.1), and this will continue to be explored with the Department of Forestry.

6.2 Land use and cover definitions

The land-cover legend and associated information content within the SANLC 2018 (DEA, 2019), SANLC 2020 (DFFE, 2021) and SANLC 2022 (DFFE, 2024) dataset was based primarily on the new gazetted land-cover classification standard (SANS 19144-2)[21], but with modifications to ensure, as far as possible, comparability and compatibility with the legend and information content associated with the previous 1990 and 2013-14 South African National Land-Cover (SANLC) datasets (DEA, 2015a). The SANLC maps have 73 land classes (definitions are included in each of the relevant sections below) which were aggregated firstly into 20 classes for land change assessment, and then further aggregated into the 6 IPCC classes for reporting. The relationship between the IPCC classes, the change classes and the various SANLC datasets are shown in Table 6.5.

[21] *South African Land Cover Classes and Definitions (SDI Act No. 54 of 2003).*

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Table 6.5: Relationship between the IPCC categories, land change categories and the SANLC datasets in the 2024 inventory

SANLC 1990 and 2013/14 Class		Change class		IPCC category	SANLC 2018 - 2022 Class	
4	Indigenous forest	1	Indigenous forest	Forest land	1	Contiguous forest
5	Thicket/ dense bush	2	Thicket/dense bush	Forest land	2 24	Contiguous low forest & thicket Mangrove wetlands
6	Woodland/open bush	3	Natural woodland	Forest land	3 4 42 43	Dense forest and woodland Open woodland Fallow lands (trees) Fallow lands (bushes)
32 33 34	Plantations and woodlots	4	Planted forest	Forest land	5 6 7	Contiguous and dense plantation forest Open and sparse plantation forest Temporary unplanted plantation
8 9	Shrublands fynbos Low shrubland	5	Shrubland	Grassland	8 9 10 11	Low shrubland (other, fynbos, succulent karoo, nama karoo) Fallow lands (low shrub)
7	Grassland	6	Grassland	Grassland	12 13 44	Sparsely wooded grassland Natural grassland Fallow land (grass)
1 2 37 38	Water seasonal/permanent Mine water seasonal/permanent	7	Waterbodies	Wetland	14 15 16 17 18 19 20 21	Rivers Estuaries and lagoons Ocean and coastal Lakes Pans Artificial dams Artificial sewage ponds Artificial flooded mine pits
3	Wetlands	8	Wetlands	Wetlands	22 23 73	Herbaceous wetlands Fallow land (wetlands)
41	Bare non vegetated	9	Barren land	Other land	25 26 28 29 30 31 45	Rock surfaces Dry pans Sand dunes Coastal sand dunes Bare riverbed Other bare Fallow land bare
40	Erosion (donga)	10	Eroded land	Grassland	27	Eroded land
16 17	Cultivated orchards	11	Permanent orchards	Cropland	32 35	Permanent orchards Permanent pineapples

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SANLC 1990 and 2013/14 Class		Change class		IPCC category	SANLC 2018 - 2022 Class	
18 22	Cultivated pineapples					
19 20 21	Cultivated vines	12	Permanent vines	Cropland	33	Permanent vines
13 14 15 26 27	Commercial pivot crops Cane pivots Cane pivot - fallow	13	Annual pivot irrigated	Cropland	34 38	Sugarcane pivot irrigated Annual crops pivot irrigated
10 11 12 28 29 30 31	Commercial non-pivot crops Cane crop Cane fallow Cane emerging crop Cane emerging fallow	14	Annual non-pivot crops	Cropland	36 37 39 40	Sugarcane non-pivot Sugarcane emerging non-pivot Non-pivot irrigated Rainfed dryland
23 24 25	Cultivated subsistence	15	Cultivated subsistence	Cropland	41	Subsistence annual crops
44-52, 57-72	Various types of urban classes (informal, residential, sport, township, village, built-up)	16	Built-up residential	Settlements	47–56, 61-64	Various types of residential (formal, informal, village, recreational, urban)
53 54 55 56 42	Various urban small holdings	17	Built-up smallholdings	Settlements	57 58 59 60	Various smallholdings
42	Urban commercial	18	Built-up commercial	Settlements	65	Commercial
43	Urban industrial	19	Built-up industrial	Settlements	66	Industrial
35 36 39	Mine bare Mine semi-bare Mine buildings	20	Mines	Settlements	68 69 70 71 72	Mines Land-fills

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6.2.1 Forest land

The National Forest Act (Act 84 of 1998) (NFA) (RSA, 1998) states that:

- "forest" includes a natural forest, a woodland and a plantation (Section 1(2)(x) of NFA);
- "natural forest" means a group of trees whose crowns are largely contiguous, or which have been declared by the Minister to be a natural forest (Section 1(2)(xx) of NFA);
- "plantation" means a group of trees cultivated for exploitation of the wood, bark, leaves or essential oils (Section 1(2)(xxii) of NFA); and
- "woodland" means a group of indigenous trees which are not a natural forest, but whose crowns cover more than five percent of the area bounded by the trees forming the perimeter of the group (Section 1(2)(xxxix) of NFA).

The definition of Forests in South Africa's National Forest Act relates to international definitions and corresponds with the FAO definition of forests except that the FAO regards 10% as the lower boundary for woodland canopy cover. South Africa's NFA definition is lower (5%) and thus also includes degraded woodland into that definition so that other provisions of the statute would still remain applicable even to degraded woodlands.

Taking guidance from the Marrakesh Accord (2011) and adjusting the specific thresholds so as to be consistent with the NFA, the forest definition is given as "a minimum area of land of 0.05 hectares with tree crown cover of more than 10 per cent with trees with the potential to reach a minimum height of 2.5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high portion of the ground open forest. Young natural stands and all forest plantations which have yet to reach a crown density of 10 per cent or tree height of 2.5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes, but which are expected to revert to forest."

The *Forest land* category therefore includes indigenous forests, plantation/woodlots (hereinafter referred to as forest plantations), thicket/dense bush (hereinafter referred to as thickets) and woodland/open bush (hereinafter referred to as woodlands) as defined in Table 6.6. Note that Mangroves are included under *Forest land* as they are currently aggregated with thickets for the change analysis.

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Table 6.6: Definitions of the land classes, as given in the SANLC reports for 2018 onwards, that are included in the Forest land category (DEA, 2019; DFFE, 2021)

SANLC class number	Aggregated change class	Class name	Class definition
1	Indigenous forest	Contiguous Forest (*combined* very high, high, medium)	Natural tall woody vegetation communities, with 75% or more canopy cover, and canopy heights exceeding 6 metres. Typically representative of tall, indigenous forests.
2	Thicket/Dense bush	Contiguous Low Forest & Thicket	Natural tall woody vegetation communities, with 75% or more canopy cover, and canopy heights ranging between 2.5 - 6 metres. Typically representative of low, indigenous forests and dense thicket communities.
3	Woodland	Dense Forest & Woodland	Natural tall woody vegetation communities, with canopy cover ranging between 35 - 75%, and canopy heights exceeding 2.5 metres. Typically represented by dense bush, dense woodland and thicket communities.
4	Woodland	Open Woodland	Natural tall woody vegetation communities, with canopy cover ranging between 10 - 35%, and canopy heights exceeding 2.5 metres. Typically represented by open bush and woodland communities.
5	Plantation	Contiguous & Dense Planted Forest	Dense to contiguous cover, planted tree forests, consisting primarily of exotic timber species, with canopy cover exceeding 35%, and canopy heights exceeding 2.5 metres. Typically represented by mature commercial plantation tree stands. This class also includes smaller woodlots and windbreaks
6	Plantation	Open & Sparse Planted Forest	Open to sparse cover, planted tree forests, consisting primarily of exotic timber species, with canopy cover ranging between 5 - 35%, and canopy heights exceeding 2.5 metres. Typically represented by young or recently planted commercial plantation tree stands. This class also include smaller woodlots and windbreaks
7	Plantation	Temporary Unplanted Forest	Temporarily unplanted stands within commercial forest plantations that have recently been harvested, and/or re-planted but the tree saplings are undetectable on the imagery.
24	Thicket/Dense bush	Mangrove Wetlands	Naturally occurring mangrove community wetlands.
42	Woodland	Fallow Land & Old Fields (Trees)	Long-term, non-active, previously cultivated lands that are *now* overgrown with tree-dominated woody vegetation. Typically the cultivated land unit boundary is no longer image detectable.
43	Woodland	Fallow Land & Old Fields (Bush)	Long-term, non-active, previously cultivated lands that are *now* overgrown with bush dominated woody vegetation.

6.2.2 Cropland

The SANLC 2018 report defines *Croplands* as active or recently cultivated lands used for the production of agricultural crops (DEA, 2019). *Croplands* include annual commercial croplands (pivot and non-pivot), permanent perennial orchards, permanent perennial vines, and semi-commercial or subsistence croplands. The SANLC classes that are included under croplands, along with their definitions, are provided in Table 6.7.

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Table 6.7: Definitions of the land classes, as given in the SANLC reports for 2018 onwards, that are included in the Cropland category (DEA, 2019; DFFE, 2021)

SANLC class number	Aggregated change class	Class name	Class definition
32	Perennial orchards	Cultivated Commercial Permanent Orchards	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with commercial orchards consisting of tree and/or bush based plants.
33	Perennial vines	Cultivated Commercial Permanent Vines	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with commercial viticulture.
34	Annual pivot irrigated	Cultivated Commercial Sugarcane Pivot Irrigated	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with commercial sugarcane. Grown in pivot irrigated fields.
35	Perennial orchards	Commercial Permanent (Pineapples)	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with pineapples.
36	Annual non-pivot crops	Cultivated Commercial Sugarcane Non-Pivot (all other)	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with commercial sugarcane. Grown in rainfed or non-pivot irrigation fields.
37	Annual non-pivot crops	Cultivated Emerging Farmer Sugarcane Non-Pivot (all other)	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with small-scale / emerging farmer sugarcane.
38	Annual pivot irrigated	Cultivated Commercial Annuals Pivot Irrigated	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with commercial annual crops. Pivot irrigation.
39	Annual non-pivot crops	Cultivated Commercial Annuals Non-Pivot Irrigated	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with commercial annual crops. Non-pivot irrigation.
40	Annual non-pivot crops	Cultivated Commercial Annuals Non-Pivot / Non-Irrigated	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with commercial annual crops.
41	Cultivated subsistence crops	Subsistence Annual Crops	Active or recently active cultivated lands used for the production of agricultural crops, in this case specifically associated with small-scale commercial or subsistence-level annual crops.

6.2.3 Grassland

Grassland comprises of areas dominated by grasses and herbaceous vegetation, with woody cover generally less than 10%. In South Africa, *Grassland* includes natural and semi-natural grasslands, low shrublands and eroded land. It also includes range and pasture lands that were not considered cropland. The category covers all grasslands from

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wild lands to recreational areas as well as agricultural and silvi-pastural systems, consistent with national definitions. With the addition of the overseas territories the subantarctic tundra class was also included under *Grasslands*. Definitions of land areas included in the *Grassland* category are given in Table 6.8.

Table 6.8: Definitions of the land classes, as given in the SANLC reports for 2018 onwards, that are included in the Grassland category (DEA, 2019; DFFE, 2021)

SANLC class number	Aggregated change class	Class name	Class definition
8	Low shrubland	Low Shrubland (other regions)	Natural, low woody shrubland communities, where the total plant canopy cover is typically both dominant over any adjacent bare ground exposure, and the canopy height ranges between 0.2 – 2 metres. Typically representative of low, indigenous karoo-type vegetation communities, which have been identified using image-based spectral models, but which fall spatially *outside* the SANBI defined boundaries for Fynbos, Succulent and Nama-Karoo vegetation communities.
9	Low shrubland	Low Shrubland (Fynbos)	This is the same as class 8, Low Shrubland, but now represents low, indigenous karoo-type vegetation communities, which have been identified using image-based spectral models, but which fall spatially *inside* the SANBI defined boundaries for Fynbos vegetation communities.
10	Low shrubland	Low Shrubland (Succulent Karoo)	This is the same as class 8, Low Shrubland, but now represents low, indigenous karoo-type vegetation communities, which have been identified using image-based spectral models, but which fall spatially *inside* the SANBI defined boundaries for Succulent Karoo vegetation communities.
11	Low shrubland	Low Shrubland (Nama Karoo)	This is the same as class 8, Low Shrubland, but now represents low, indigenous karoo-type vegetation communities, which have been identified using image-based spectral models, but which fall spatially *inside* the SANBI defined boundaries for Nama Karoo vegetation communities.
12	Grassland	Sparsely Wooded Grassland	Natural woody vegetation, with a woody canopy cover ranging between only 5 - 10%, and canopy heights exceeding 2.5 metres, in a grass-dominated environment. Typically represented by very sparse woodland or lightly wooded grassland communities.
13	Grassland	Natural Grassland	Natural and/or semi-natural indigenous grasslands, typically devoid of any significant tree or bush cover, and where the grassland component is typically dominant over any adjacent bare ground exposure.
27	Eroded land	Eroded Lands	Permanent or semi-permanent, non-vegetated erosion surfaces, typically represented by gullies, dongas, and/or sheet erosion areas.
44	Grassland	Fallow Land & Old Fields (Grass)	Long-term, non-active, previously cultivated lands that are now overgrown with grass dominated woody vegetation.
	Subantarctic tundra		Includes subantarctic coastal vegetation, biotic herbfields and grasslands, mire, drainage lines and spring vegetation, fernbrake vegetation, fellfield, and cinder cone vegetation.

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6.2.4 Wetlands

Wetlands are lands saturated with water permanently or seasonally, supporting vegetation adapted to wet conditions. *Wetlands* include natural rivers, lakes, estuaries, lagoons, pans, and herbaceous wetlands, as well as artificial water bodies such as dams, sewage ponds, and flooded mine pits as defined in Table 6.9. Waterbodies are considered as the flooded lands and hereinafter are referred to as flooded lands. Mangroves are classified in the *Forest land* category so do not fall under *Wetlands*.

Table 6.9: Definitions of the land classes, as given in the SANLC 2018, that are included in the Wetland category (DEA, 2019; DFFE, 2021)

SANLC class number	Aggregated change class	Class name	Class definition
14	Waterbodies	Natural Rivers	Naturally occurring waterbodies associated with perennial and non-perennial rivers and associated tributaries.
15	Waterbodies	Natural Estuaries & Lagoons	Naturally occurring coastal region water bodies that are located at river mouths or are replenished by coastal tidal flows.
16	Waterbodies	Natural Ocean	Naturally occurring saltwater coastal and ocean waterbodies.
17	Waterbodies	Natural Lakes	Naturally occurring, large inland waterbodies containing freshwater.
18	Waterbodies	Natural Pans (flooded)	Naturally occurring inland waterbodies within pans, where the water extent is both spatially and temporally sufficient to be image-detectable.
19	Waterbodies	Artificial Dams	Man-constructed artificial inland waterbodies, ranging from small farm dams to large reservoirs, and if image-detectable, large irrigation canals.
20	Waterbodies	Artificial Sewage Ponds	Man-constructed artificial inland waterbodies, specifically associated with water and effluent treatment activities.
21	Waterbodies	Artificial Flooded Mine Pits	Man-generated artificial inland waterbodies, specifically associated with flooded mine pits, tailings ponds, or other surface-based mining activities.
22	Wetlands	Herbaceous Wetlands (currently mapped)	Natural or semi-natural wetlands covered in permanent or seasonal herbaceous vegetation. The class represents primarily riparian wetland areas, but can also include emergent aquatic vegetation in pans.
23	Wetlands	Herbaceous Wetlands (previous mapped extent)	Natural or semi-natural wetlands covered in permanent or seasonal herbaceous vegetation. The class represents primarily riparian wetland areas, but can also include emergent aquatic vegetation in pans.
73	Wetlands	Fallow Land & Old Fields (wetlands)	Long-term, non-active, previously cultivated lands that are currently classified as wetland vegetation.

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6.2.5 Settlements

The *Settlement* category covers transportation infrastructure and human settlements. This includes formal built-up areas in which people reside on a permanent or near-permanent basis identifiable by the high density of residential and associated infrastructure, as well as towns and villages, smallholdings, commercial, residential and industrial areas. These areas are characterized by built-up surfaces and limited natural vegetation. Mines are also included. Definitions are provided in Table 6.10.

Table 6.10: Definitions of the land classes, as given in the SANLC report for 2018 onwards, that are included in the Settlement category (DEA, 2019; DFFE, 2021).

SANLC class number	Aggregated change class	Class name	Class definition
47	Built-up residential	Residential Formal (Tree)	Built-up areas primarily containing formally planned and constructed residential structures and associated utilities. The dominant vegetation (in gardens etc) is tree-based.
48	Built-up residential	Residential Formal (Bush)	Built-up areas primarily containing formally planned and constructed residential structures and associated utilities. The dominant vegetation (in gardens etc) is bush-based.
49	Built-up residential	Residential Formal (low veg / grass)	Built-up areas primarily containing formally planned and constructed residential structures and associated utilities. The dominant vegetation (in gardens etc) is grass and/or low shrub based.
50	Built-up residential	Residential Formal (Bare)	Built-up areas primarily containing formally planned and constructed residential structures and associated utilities. The surface is predominantly non-vegetated.
51	Built-up residential	Residential Informal (Tree)	Built-up areas primarily containing informal, often unplanned residential structures and associated utilities. The dominant vegetation (in surrounding areas etc) is tree-based.
52	Built-up residential	Residential Informal (Bush)	Built-up areas primarily containing informal, often unplanned residential structures and associated utilities. The dominant vegetation (in surrounding areas etc) is bush-based.
53	Built-up residential	Residential Informal (low veg / grass)	Built-up areas primarily containing informal, often unplanned residential structures and associated utilities. The dominant vegetation (in surrounding areas etc) is grass and/or low shrub-based.
54	Built-up residential	Residential Informal (Bare)	Built-up areas primarily containing informal, often unplanned residential structures and associated utilities. The surface is predominantly non-vegetated.
55	Built-up residential	Village Scattered	Built-up areas primarily associated with scattered rural settlements and associated utilities. *Scattered villages* are defined as those represented by contiguous / adjacent village-classified cells which collectively *do not form the majority cover* in a surrounding 1 ha window.
56	Built-up residential	Village Dense	Built-up areas primarily associated with scattered rural settlements and associated utilities. *Dense villages* are defined as those represented by contiguous / adjacent village-classified

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			cells which collectively *do form the majority cover* in a surrounding 1 ha window.
57	Built-up smallholdings	Smallholdings (Tree)	Agricultural holdings typically located in peri-urban environments, where the dominant vegetation is tree-based.
58	Built-up smallholdings	Smallholdings (Bush)	Agricultural holdings typically located in peri-urban environments, where the dominant vegetation is bush-based.
59	Built-up smallholdings	Smallholdings (low veg / grass)	Agricultural holdings typically located in peri-urban environments, where the dominant vegetation is low shrub or grass based.
60	Built-up smallholdings	Smallholdings (Bare)	Agricultural holdings typically located in peri-urban environments, where the dominant cover is non-vegetation is bush-based.
61	Built-up residential	Urban Recreational Fields (Tree)	Non-built-up, vegetated urban areas primarily associated with formally planned and established parks, sports fields, and golf courses.
62	Built-up residential	Urban Recreational Fields (Bush)	Non-built-up, vegetated urban areas primarily associated with formally planned and established parks, sports fields, and golf courses.
63	Built-up residential	Urban Recreational Fields (Grass)	Non-built-up, vegetated urban areas primarily associated with formally planned and established parks, sports fields, and golf courses.
64	Built-up residential	Urban Recreational Fields (Bare)	Non-built-up, open urban areas primarily associated with formally planned and established parks, sports fields, and golf courses.
65	Built-up commercial	Commercial	Built-up areas primarily containing formally planned and constructed commercial structures and associated utilities. Includes shops, offices, schools, hospitals, and administration structures.
66	Built-up industrial	Industrial	Built-up areas primarily containing formally planned and constructed industrial structures and associated utilities. Includes both light and heavy industry, power generation, airports, rail terminals and ports.
67	Built-up commercial	Roads & Rail (Major Linear)	Built-up features represented by primary road and rail networks that are image-detectable (i.e. networks are non-contiguous), as well as smaller airfields and airstrips.
68	Mines	Mines: Surface Infrastructure	Built-up structures associated with the administration and/or industrial processing and extraction of mined resources.
69	Mines	Mines: Extraction Sites: Open Cast & Quarries *combined*	Non-vegetated, active and/or non-active extraction pits associated with surface-based mining activities, including open-cast mines, quarries, and road-side borrow pits etc.
70	Mines	Mines: Extraction Sites: Salt Mines	Non-vegetated, active or non-active extraction pits associated with evaporative salt-mining activities, typically associated with coastal or inland saline pan localities.
71	Mines	Mines: Waste (Tailings) & Resource Dumps	Non-vegetated, active or non-active mine generated material dumps or stockpiles, associated with both mine waste material (i.e. tailings dams) or mine generated resource stockpiles (i.e. coal stockpiles).
72	Mines	Land-fills	Primarily non-vegetated, active or non-active land-fill sites used for the large scale disposal of urban waste.

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6.2.6 Other land

Other Land is predominantly bare ground areas, typically barren or sparsely vegetated. This includes natural rock outcrops, dry pans, sand dunes (coastal and terrestrial), bare riverbeds, and other bare surfaces. It also covers fallow lands that have become predominantly bare ground. These areas generally have low productivity and limited vegetation cover. With the addition of the overseas territories the polar desert class was also included under *Other lands*. The definitions of the land classes included in *Other lands* are provided in Table 6.11.

Table 6.11: Definitions of the land classes, as given in the SANLC report for 2018 onwards, that are included in the Other land category (DEA, 2019; DFFE, 2021)

SANLC class number	Aggregated change class	Class name	Class definition
25	Barren land	Natural Rock Surfaces	Naturally occurring areas of non-vegetated, exposed rock and consolidated substrate.
26	Barren land	Dry Pans	Naturally occurring areas of non-vegetated, consolidated substrate, associated with permanent or long-term dry pans.
28	Barren land	Sand Dunes (terrestrial)	*Non-vegetated*, naturally occurring inland (non-coastal) sand dunes, which are typically associated with arid, desert-like environments.
29	Barren land	Coastal Dunes & Beach Sand	Non-vegetated, naturally occurring coastal sands, typically associated with both coastal dunes and beach environments.
30	Barren land	Bare Riverbed Material	Natural or semi-natural, non-vegetated, consolidated or unnaturally occurring coastal sands, typically associated with both coastal dunes and beach environments.
31	Barren land	Other Bare	Other natural, semi-natural or man-created non-vegetated areas.
45	Barren land	Fallow Land & Old Fields (Bare)	Long-term, non-active, previously cultivated lands that are now predominately non-vegetated bare ground surfaces.
	Polar desert		Areas that consist of black lava, thin layers of volcanic ash or unconsolidated deposits of pebble-sized scoria with the occasional rock or boulder. Moss can be present but usually covers less than 2% of the area.

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6.3 Land representation approaches and data processing

South Africa covers an area of 122 008 kha, which includes the Prince Edward Islands (Marion Island – 29 kha and Prince Edward Island – 4.5 kha). Land-cover[22] maps were developed for 1990 (DEA, 2016), 2013-14 (DEA, 2015a), 2018 (DEA, 2019), 2020 (DFFE, 2021) and 2022 (DFFE, 2024). These land cover maps exclude the Prince Edward Islands. There is no land change data for the islands and so for the purposes of this inventory the islands are assumed not to have any vegetation change. This assumption can be updated in future when more data becomes available.

The details of the processing and development of the land cover and change maps are provided in the relevant reports and are summarised below. In addition, further details are provided in Annex V.

A map for 2024 is currently being developed but was not completed by the time this inventory was compiled and therefore was not included. Data was extrapolated for 2023 and 2024 as outlined in section 6.3.6.

6.3.1 Land use and cover database and data processing

6.3.1.1 SANLC 1990

The 1990 72 x class South African National Land-cover dataset was generated primarily from digital, multi-seasonal Landsat 5 multispectral imagery, acquired mainly between 1990 and 1991. An excess of 600 Landsat images were used to generate the land-cover information, based on an average of 8 different seasonal image acquisition dates, within each of the 76 x image frames required to cover South Africa. The land-cover dataset, which covered the whole of South Africa, was presented in a map-corrected, raster format, based on 30x30m cells equivalent to the image resolution of the source Landsat 8 multi-spectral imagery. Each data cell contains a single code representing the dominant land-cover class (by area) within that 30x30m unit, as determined from analysis of the multi-date imagery acquired over that image frame. The original land-cover dataset was processed in UTM (north) / WGS84 map projection format based on the standard Landsat map projection format provided by the USGS2. The final product is available in

[22] *The term 'land cover' is used loosely here as the classes are a combination of land cover and land use.*

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UTM35(north) and (south), WGS84 map projections and Geographic Coordinates, WGS84.

6.3.1.2 SANLC 2013-14

The primary imagery source used in the generation of the 2013-14 SA National Land-cover dataset (referred to as SANLC 2014 in this report) was 30m resolution Landsat 8 imagery, acquired between April 2013 and March 2014. Unfortunately, due to localised, prolonged cloud cover problems in some regions during this April 2013 - March 2014 period, there were gaps in the data. In these cases, Landsat 5 imagery was used as a substitute, but only if it was from a suitable seasonal period to compliment the Landsat 8 data and was ± 100% cloud free.

All Landsat 8 and 5 imagery was standardised to 16-bit, Top-of-Atmosphere (ToA) reflectance values prior to land-cover modelling using a generic modelling approach. The original USGS generated UTM (north), WGS84 map projection format was retained without change or modification throughout all image-frame based modelling procedures. As far as possible only cloud free or image dates with limited cloud cover were used in the land-cover modelling (i.e. maximum ± 20% terrestrial cloud cover in any one date). Any cloud affected regions were corrected by merging cloud affected ToA corrected imagery with cloud free ToA corrected data from preferably the preceding or following overpass date; so that as far as possible, the final cloud-free merged imagery composite only represented a maximum difference of ± 16 days. Cloud masks were created using either conventional pixel classification procedures (within analyst defined sub-image areas), or spectral based modelling using generic thermal and blue light reflectance thresholds; depending on cloud characteristics. This was deemed acceptable in terms of minimising any changes in local vegetation cover growth changes. Approximately 35% of the 616 x images used in the landcover modelling were cloud-masked composites. No external atmospheric correction was applied to the image data.

Derived spectral indices, generated from the ToA corrected imagery were used as the only inputs into the land-cover models. No original spectral (i.e. ToA reflectance) data was used as an input, although collectively, 5 out of the 8 available non-thermal spectral bands were used in the various spectral indices.

The same two-step process as outlined below for the SANLC 2018 map was then followed to generate the land-cover dataset.

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6.3.1.3 SANLC 2018

The 20m resolution, raster format SANLC 2018 dataset was generated from automated mapping models (as opposed to conventional image classification procedures), using multi-seasonal 20m resolution Sentinel 2 satellite imagery. The imagery used represents the full temporal range of available imagery acquired by Sentinel 2 during the period 01 January 2018 to 31 December 2018.

The automated land-cover mapping models and associated procedures utilise both cloud-based image archives and cloud-based geo-data computing capabilities; although the final compilation and merging of the different land-cover and land-use information components (i.e. water, mining extent, forest plantations etc.), were completed in a conventional desk-top environment, using automated modelling capabilities within commercial mapping software.

The generation of the automated land-cover data in the new, Sentinel 2 based procedure involved two separate, but sequential processing steps:

- Step 1: Fully automated image modelling procedures were used to generate what is referred to as the "spectrally-defined" base land-cover characteristics. These 'base' land-cover characteristics were the primary 'building blocks' which were used to describe the entire landscape in terms of primary cover characteristics such as woody vegetation, grass, bare or water dominated surfaces. A standardised set of spectral indices were identified from which the required foundation cover classes, namely (1) tree dominated, (2) bush dominated, (3) grass dominated, (4) water and (5) bare ground could be modelled, using pre-determined, generic spectral threshold values. The generic threshold values associated with each indices and cover type were tested over several landscapes and seasons before being confirmed and accepted as such. The spectral indices included both existing algorithms such as the Normalised Difference Vegetation Index (NDVI) and Normalised Difference Water Index (NDWI), as well as algorithms developed in-house specifically for the GTI land-cover modelling requirements. No attempt was made at this stage to define additional detail such as whether the tree cover is a natural forest, or a managed forest plantation.
- Step 2: Ancillary spatial datasets, referred to as 'geographical masks' (such as "Mines & Quarries", "Built-up"), were used to convert the base land-cover classes into more detailed sub-classes. The geographical masks define specific, pre-determined areas-of-interest within the South African landscape, within which the primary, spectrally-defined base classes were de-constructed into more specific land-cover and/or land-use sub-classes. In each case, a specific set of modification

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rules were used to either amalgamate, sub-divide or re-allocate the primary, base-level class(es) to the required sub-class detail. The primary objective and reason behind the use of these geographical masks is to facilitate the delineation of sub-classes that cannot be achieved using spectral data alone, since many unrelated sub-classes can often share similar spectral characteristics, e.g. river water versus water-in-pans, or non-vegetated mine dumps and some natural rock exposures, or coastal dunes and sand-roads etc. The 'geographical masks' are described in detail in the SANLC 2018 report (DEA, 2019).

The automated land-cover mapping models and associated procedures used in the production of the SANLC 2018 dataset utilise both cloud-based image archives and cloud-based geo-data computing capabilities; although the final compilation and merging of the different land-cover and land-use information components (i.e. water, mining extent, forest plantations etc), has been completed in a conventional desk-top environment, using automated modelling capabilities within proprietary, i.e. commercial mapping software.

6.3.1.4 SANLC 2020 and 2022

The SANLC 2020 and 2022 datasets were produced using the same automated mapping approach developed for SANLC 2018, which was migrated to a cloud-based environment and fully automated under the Computer Automated Land-Cover (CALC) workflow. This process uses multi-seasonal Sentinel-2 imagery at 20m resolution, covering the full temporal range of 01 January to 31 December of the target year. CALC integrates cloud-based image archives and geospatial computing capabilities to generate land-cover maps, while final compilation and merging of thematic components (e.g. water bodies, mining extent, forest plantations) are completed in a desktop environment using automated modelling tools. All future SANLC products will be generated using this cloud-based automated workflow.

6.3.1.5 Computer Automated Land Cover (CALC) System Methodology

The Computer Automated Land Cover (CALC) is a DFFE automated system that generates land cover and land use change datasets. CALC is designed and operationally implemented as an automated, cloud-based solution for the future production of South African National Land-Cover datasets. The system produces national land-cover data for South Africa, based on the new Gazetted land-cover classes (SANS 19144-2), associated map accuracy and change detection analysis datasets and reports.

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Each CALC generated SANLC dataset represents a 20m resolution, raster format, land-cover and land-use (LCLU) automated classification of the entire South African landscape, including a 100-metre buffer into neighbouring countries, and 10 km buffer into coastal waters. The buffer area is then excluded during analysis. Each SANLC dataset represents a particular assessment year, not a specific date nor season. The CALC classification process used all available Sentinel-2 image acquisitions acquired between and including January and December in the assessment year. The automated land-cover mapping models and associated rules utilise both cloud-based image archives and cloud-based geo-data computing capabilities.

The land-cover / land-use (LCLU) legend and associated information content used with all CALC generated SANLC datasets is based primarily on the new gazetted land-cover classification standard (SANS 19144-2), but with modifications to ensure, as far as possible, comparability and compatibility with the legend and information content associated with the previous 1990 and 2013-14 South African National Land-Cover (SANLC) datasets. These modifications have been made in order to facilitate more representative change detection and reporting between the SANLC 1990 and SANLC 2013-14, 2018, 2020 and 2022 datasets.

CALC generated SANLC datasets are generated using only European Space Agencies (ESA) free-to-access Sentinel-2 satellite imagery. No other satellite image sources have been used. Sentinel-2 imagery has been chosen over Landsat as the preferred source of imagery due to its improved spatial, spectral and temporal (i.e. re-visit) capabilities, compared to Landsat. Sentinel-2A and 2B satellites are collectively able to provide 20 metre resolution imagery, containing 12 spectral bands, every 5 days, anywhere across the globe.

This system enables the DFFE to generate single-year-representative, full legend content, national land-cover datasets over South Africa that are compatible with both the new Gazetted land-cover classes (SANS 19144-2), and the information content in the existing 1990 and 2013/14 South African National Land-Cover datasets. The CALC system also supports the calculation and reporting of land-cover mapping accuracies against independently obtained validation points; and land-cover change assessments with statistical reporting based on a simplified legend (20 classes) and reduced spatial resolution (30 m). CALC also generates RGB false-colour image tiles from Sentinel-2 imagery that is used as a visual reference to update 12 dynamic geographical masks before classification takes place. These visual backdrops are only used for on-screen updating within a GIS environment and should not be used for spectral classification of the imagery.

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The CALC system is a fully functional, operational system capable of generating SANLC datasets for DFFE, enabling the Department to maintain and expand its inventory of SANLC content into the future.

6.3.2 Land mapping accuracy

6.3.2.1 SANLC 1990 and 2014

No accuracy assessment was undertaken on the historical 1990 South African National Land-Cover dataset, because no suitable historical reference data was available in the same format as that used for the verification of the 2013-14 dataset. However, since exactly the same mapping and modelling procedures and image formats have been used in the generation of the 1990 land-cover data, the map accuracies determined for the 2013-14 dataset can be used as a reliable indication of the likely mapping accuracies achieved for the 1990 dataset.

The overall map accuracy for the 2013-14 South African National Land-Cover, modelled from multi-seasonal Landsat 8 imagery is 82.53%, with a mean land-cover / land-use class accuracy of 88.36 %. This was determined from 6415 sample points. The associated Kappa Index value of 80.87 indicates that these results are very unlikely to be the result of chance occurrence.

6.3.2.2 SANLC 2018, 2020 and 2022

The land-cover mapping accuracy assessments for the 2018, 2020 and 2022 South African National Land Cover (SANLC) datasets were conducted using a consistent and established methodology to ensure comparability across years. In all three assessments, map accuracy was evaluated by comparing image-classified land-cover outputs with independently generated and/or sourced reference data, with results reported using conventional spatial accuracy statistics.

To minimise potential misclassification arising from short-term or transitional land-cover changes (such as recently clear-felled plantation areas), the accuracy evaluations were undertaken using a simplified, content-reduced 47-class legend rather than the full 73-class mapping legend. Reference sample points were primarily captured and spatially interpreted using Sentinel-2 imagery at 20 m spatial resolution corresponding to each respective year (2018, 2020 and 2022).

Table 6.12 details the map accuracy for the 2018, 2020 and 2022 SANLC datasets. The 2018 map achieved the highest overall accuracy, while a gradual decline in overall and

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mean class accuracies was observed in the subsequent 2020 and 2022 maps. Despite this trend, all three datasets demonstrate robust classification performance, with high overall accuracies, strong class-level agreement, and kappa indices indicating high agreement between mapped land-cover classes and reference data.

Table 6.12: Comparison of mapping accuracies for SANLC 2018, 2020 and 2022

SANLC Year	Overall Accuracy (%)	Mean Class Accuracy (%)	90% Confidence Limits (%)	Kappa Index
2018	90.14	89.63	89.65 – 90.62	89.91
2020	85.47	84.66	84.91 – 96.03	85.13
2022	84.22	83.55	83.67 – 84.77	83.81

6.3.2.3 Comparison between Landsat and Sentinel maps

One of the key intentions behind the production of the new Sentinel land cover datasets was to expand the timeline of available South African National Land Cover datasets in support of long-term environmental monitoring and change detection. To that end, the SANLC 2018, 2020 and 2022 datasets have been generated to provide as close as possible a repeat of the SANLC 1990 and SANLC 2014 data contents, format and landscape representations. However, improvements in landscape interpretation and mapping resulting from the improved spatial, spectral and temporal characteristics of Sentinel 2 imagery have resulted in changes between SANLC 2018 and the previous SANLC 1990 and SANLC 2014 datasets, which are not necessarily associated with true landscape changes, but rather improved interpretation and thus mapping quality. There has been no attempt to perpetuate both known and unknown errors from the SANLC 1990 and SANLC 2014 datasets into the SANLC 2018, 2020 and 2022 datasets if more accurate mapping could be achieved from the Sentinel 2 image interpretations, whilst retaining as far as possible the same class-based information content.

Generally, it can be assumed that comparisons between the current SANLC 2018 and both historical SANLCs will be more accurate in terms of documenting true land-use related changes, compared to land-cover related changes, as land-use features are typically associated with easily (image) detectable boundaries and/or unique (image) spectral characteristics. Mapping, and by association, change detection in natural landscapes, such as woodland, grassland and shrublands etc. are typically more challenging; since these landscape features typically do not have 'hard' boundaries, but rather gradients, within which a class boundary must be defined. This challenge is often compounded as a result

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of inter-annual seasonal differences, and associated differences in interpretable spectral/spatial image characteristics.

The end-result is that, if a user compares the current and historical SANLC datasets, many landscape differences will be correct, it is also likely that some of these differences, especially in natural vegetation landscape can be attributed to mapping errors in one or both land-cover input datasets. Although these are most likely to be associated with the historical Landsat generated SANLCs as a result of Landsat's poorer spatial, spectral and temporal characteristics, compared to Sentinel 2 imagery. The enhanced spectral, spatial and temporal characteristics associated with Sentinel 2 imagery, as well as enhancements to the content and integration of the geographical masks used in the latest SANLC 2018 and 2020 landcover modelling, are considered to have resulted in a more accurate SANLC 2018 landscape interpretation. This assumption is supported by the significantly higher woody class mapping accuracies reported for SANLC 2018 compared to those reported in the SANLC 2014 dataset (see Table 6.13).

Table 6.13: Comparison of mapping accuracies between SANLC 2014 and SANLC 2018

SANLC 2014 Class Mapping Accuracies	User/Producer Accuracy (2014)	User/Producer Accuracy (2018)	SANLC 2018 Class Mapping Accuracies
Indigenous forest	72.60/94.64	98.90/84.11	Contiguous (indigenous) forest
		80.60/92.31	Contiguous low forest & thicket
Dense bush/Thicket	53.74/83.64	76.44/93.59	Dense forest & woodland
Woodland/Open bush	60.84/54.13	78.79/92.86	Open woodland
Grassland	84.56/69.82	85.90/87.58	Grassland
Shrubland (non-fynbos)	70.59/61.82	66.67/86.25	Shrubland (non-fynbos)

6.3.3 Land use change map processing and refinement

6.3.3.1 Data processing for developing land change maps

Land-use changes were mapped using an Approach 2 method as described in IPCC 2006 Guidelines. The 1990-2014, 2014-2018, 2018-2020 and 2020-2022 land use change maps were utilized in this inventory and data was extrapolated to 2024 as described in

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Printed by and obtainable from the Government Printer, Bosman Street, Private Bag X85, Pretoria, 0001
Contact Centre Tel: 012-748 6200. eMail: info.egazette@gpw.gov.za
Publications: Tel: (012) 748 6053, 748 6061, 748 6065

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Government Gazette
Staatskoerant

REPUBLIC OF SOUTH AFRICA
REPUBLIEK VAN SUID AFRIKA

Vol. 731 29 May Mei 2026 No. 54758

PART 4 OF 7

N.B. The Government Printing Works will not be held responsible for the quality of "Hard Copies" or "Electronic Files" submitted for publication purposes

ISSN 1682-5845

9 771682 584003 54758

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section 6.3.6. The key data processing steps used in Computer Automated Land Cover (CALC) system to generate any two-date SANLC change assessment are:

- Generate the 73-class SANLC datasets for the target years.
- Convert all SANLC datasets to the new 20-class, simplified land-cover change legend format and content.
- Re-project the 20-class Geographic Coordinate format SANLC datasets to a standardised Albers Equal Area map projection.
- Spatially resample (using nearest-neighbour class code allocation) the Sentinel 2 derived 20 x 20 m SANLC datasets to the standardised 30 x 30 m resolution required for land use change maps.
- Ensure pixel-to-pixel registration between all 30 m resolution Albers Equal Area map projection outputs using the CALC 2018 SANLC as the generic reference dataset against which all other CALC generated SANLC datasets are registered. This approach has been taken as the ortho-precision of the source Sentinel 2 imagery from which all SANLC datasets are generated and is considered superior to the Landsat imagery used in the compilation of the 1990 and 2013/14 SANLC datasets.
- Ensure pixel-level equivalent land-cover geographic coverage between all SANLC datasets, so that the change assessment results do not include a null class values as a result of differences in total mapped extent resulting from different boundary delineations and associated buffer zones.
- Generate a national 30 x 30 m resolution land-cover class-pair based change-reporting matrix for each two-year land-cover change assessment.

6.3.3.2 Land change map refinements

The land change matrixes required further processing and refining before being incorporated into the inventory. At this stage these adjustments could only be made to the matrixes in excel and could not be included spatially. It is noted that this does lead to some misalignment with the soil and burnt area overlays but this issue will be addressed in the land mapping system which is planned to be developed (see planned improvements in section 6.1.6).

6.3.3.2.1 Coastal buffer adjustments

The SANLC land-cover datasets are initially generated with a 10 km buffer extending into coastal waters to ensure complete coverage of coastal features. However, this buffer artificially increases the total land area of South Africa and must be removed for accurate

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reporting. To address this, all land change maps were clipped to the official national boundary, excluding the coastal buffer. This adjustment eliminated an excess area of approximately 1 590 kha, which was originally attributed to the flooded land class. Consequently, the land change matrixes were recalculated to reflect the actual terrestrial land area of South Africa, which is 122 008 kha. This correction was done to ensure consistency with IPCC land representation requirements and maintain the integrity of national land-use statistics.

6.3.3.2.2 *2014-2018 change map adjustments*

As part of the SANLC 2018 land-cover mapping project, a comprehensive South African National Land Cover Change Assessment (DEA, 2019a) was undertaken to verify natural land class changes between 1990, 2014, and 2018. The assessment revealed that most apparent changes between natural land classes during 2014–2018 were not actual land conversions but were artifacts introduced by technological improvements, specifically the transition from Landsat imagery to higher-resolution Sentinel-2 imagery (see section 6.3.2.3). These sensor differences resulted in classification inconsistencies rather than real land-use changes.

A blanket correction factor of 80% was applied to all conversions identified as spurious, effectively reducing the reported change areas. The 80% adjustment was adopted as a conservative measure based on expert review and findings from the DEA assessment, which indicated that the majority of observed changes were classification errors rather than real land-use transitions. Applying this correction minimizes the risk of overestimating land-use change and associated emissions or removals in GHG inventories. Where no genuine conversion was considered to have occurred, the affected areas were reverted to their 2018 land class, as the 2018 dataset was deemed more accurate due to improved resolution and classification methods.

6.3.3.2.3 *Unlikely change adjustments*

Adjustments for highly unlikely land conversions were implemented across all four change periods: 1990–2014, 2014–2018, 2018–2020, and 2020–2022. Transitions such as indigenous forest converting to plantation, settlements converting to mines or cropland, and flooded land converting to settlements were deemed highly unlikely based on ecological, socio-economic, and practical considerations. These conversions typically result from classification errors rather than actual land-use dynamics. These areas flagged with these improbable transitions were reverted to their original land class prior to the reported change. This approach ensures that the land-change matrices reflect

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realistic land-use dynamics and prevents the inclusion of spurious changes that could distort activity data.

6.3.3.2.4 *Forest plantation adjustments*

Forest plantation corrections were applied across all the change periods (1990–2014, 2014–2018, 2018–2020, and 2020–2022) to address classification inconsistencies and align plantation areas with Forestry South Africa (FSA) statistics. The following specific adjustments were implemented:

- Unlikely conversions to forest plantations: Changes from flooded lands, wetlands, croplands, and settlements to forest plantations were considered highly improbable and were reverted to their original land classes. This correction prevents overestimation of forest plantation expansion in areas where such conversions are assumed not to occur.
- Unlikely conversions from forest plantations: Similarly, conversions from forest plantations to flooded lands or wetlands were assumed not to occur and were reverted to the original forest plantation class.
- Partial adjustment for remaining conversions: The total forest plantation area was compared with the FSA area data and the remaining land conversions were adjusted to occur at half the rate indicated in the matrixes. This conservative adjustment was applied to better align with observed forest plantation trends and FSA data.

6.3.3.2.5 *Adjustments for impacts of seasonal (wet/dry) variation on land use change*

In the previous inventory adjustments for seasonal changes were implemented for natural land areas that overlapped and showed interchanging conversions between two change periods. For example, the area of woodland converted to grassland in 2014-2018 was intersected with the area of grassland that was converted back to woodland in 2018-2020. The overlap area was assumed to therefore be non-permanent, and the area was reverted to the woodland class.

In this inventory a new approach for seasonal change adjustments was implemented for natural land classes where climate data was utilised to determine if the change periods were from a wet to a dry year or *vice versa*. If the change period was a "wetting" cycle, then different land category changes were expected to be affected compared to a "drying" change period. The following change categories were determined to be affected (i.e. show increased conversion area) if the change was from a wetter to a drier year ("drying" change period):

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- Thickets to woodlands
- Woodlands to grasslands
- Woodlands to bare ground
- Low shrublands to bare ground
- Grasslands to bare ground
- Low shrublands to eroded land
- Low shrublands to grasslands

On the other hand, in a conversion from a drier to wetter year ("wetting" change period) the conversions in the opposite direction to those indicated above are expected to increase. For example, there would be an increase in conversion of grasslands to woodlands and bare ground to shrublands.

To implement this correction, the first step was to identify if a change period was a "wetting" or "drying" change. The Annual State of the Climate in South Africa Report (SAWS, 2025) was the first data source used to complete this assessment. In addition, the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) data (CHIRPS, 2025) was also accessed to provide spatial climate data. In this case data for 2018 and 2020 was obtained and the difference between the two showed the regions of significant reduction of rainfall in this period. These areas anecdotally match the changes in woody vegetation for example. Unfortunately, due to time constraints, the assessment of CHIRPS data could not be completed for all the years., but this will be included into the improvement plan. The rainfall data will be incorporated into the land mapping system that is being developed. This will significantly improve the ability to correct for the seasonal changes due to rainfall impacts in future.

The second step in the process was to apply the correction factor to the change categories as provided above. It was assumed that 75% of these land changes are not real changes but are rather due to these seasonal fluctuations brought about by rainfall changes. This means that 75% of the change associated with that change class was reverted back to the original land class. For example, in a "drying" change period 75% of the change from low shrubland to bare ground was reverted back to low shrubland. If, however, it was a "wetting" change period then 75% of the change from bare ground to low shrubland would be reverted back to bare ground. It is noted that for now the approach applies some broad assumptions which could be improved in future with the use of spatial data and through the tracking of land parcels in the developing land mapping system.

This correction was not applied to the 1990-2014 change period as the 24-year period is long enough to include actual changes that are not seasonal. It was also not applied to the 2014-2018 period as this change map already has a correction applied to it due to the

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change from Landsat to Sentinel data so this correction would include seasonal change corrections. The correction was applied to 2018-2020 ("drying"), 2020-2022 ("wetting") and the 2022-2024 extrapolations ("drying").

6.3.3.2.6 Addition of overseas territory area

The SANLC data does not include the overseas territories in its area so these need to be added to the land change matrix for each change period. These territories include subantarctic tundra and polar desert. As indicated in section 6.1.2.2, there is assumed to be no land change data on these overseas territories. This assumption will be updated in future when further data becomes available.

6.3.3.2.7 Land change results

The resulting corrected annual change areas used as the basis for the calculations to determine land remaining and converted land areas as discussed in the next section are provided in Table 6.14 to Table 6.17. The original (uncorrected) annual areas are provided in Annex V.

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Table 6.14: Annual land change areas (ha) for 1990-2014 used as a basis for inventory calculations (20-year transition period)

Land categories		1990																					
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
2014	Indigenous Forest		1 617	672	1 308	344	1 462	29	270	22	0	8	0	0	55	35	73	3	3	1	0	0	0
	Thicket / Dense Bush	1 725		62 647	5 319	26 423	72 094	1 209	6 047	3 560	233	563	175	97	3 423	3 591	2 725	162	120	133	305	0	0
	Natural woodland	446	53 900		1 968	68 524	128 942	674	3 203	8 787	1 030	350	22	245	9 159	7 572	1 126	242	37	68	777	0	0
	Planted Forest	0	239	749		281	5 984	0	0	9	1	0	0	0	0	0	0	0	0	0	0	0	0
	Shrubland	88	16 780	62 477	1 052		176 234	1 221	5 444	148 400	7 478	234	190	139	16 664	1 232	737	49	49	69	584	0	0
	Grassland	436	36 562	78 471	5 765	184 838		1 602	16 522	8 422	3 517	393	49	216	31 291	3 471	3 904	290	79	142	2 091	0	0
	Waterbodies	5	519	540	66	592	1 102		528	1 185	10	8	10	2	139	45	24	7	2	3	110	0	0
	Wetlands	73	1 419	833	673	1 396	5 961	2 312		276	77	35	25	17	1 395	64	134	36	7	11	63	0	0
	Barren Land	38	989	6 436	43	105 562	7 688	3 761	378		1 456	6	8	5	293	27	62	4	9	22	171	0	0
	Eroded Land	0	101	613	1	1 451	1 981	11	27	31		1	0	2	116	226	46	0	1	1	13	0	0
	Permanent Orchards	33	955	474	258	535	433	15	89	10	0		143	144	1 295	114	0	0	0	0	0	0	0
	Permanent Vines	0	144	67	29	557	67	7	86	109	0	401		38	343	11	0	0	0	0	0	0	0
	Annuals Pivot Irrigated	1	370	1 439	25	2 875	2 852	8	251	75	9	148	24		16 209	75	0	0	0	0	5	0	0
	Annuals Non-Pivot	67	3 994	3 870	1 002	8 904	24 381	163	1 709	112	25	703	110	949		1 865	0	0	0	0	49	0	0
	Cultivated Subsistence	67	2 261	3 002	106	2 646	10 053	37	617	16	146	167	0	15	719		0	0	0	0	19	0	0
	Residential	112	1 915	3 170	796	2 445	7 874	0	137	171	45	33	11	15	785	423		408	165	192	29	0	0

Land categories		1990																				
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
	Smallholdings	0	48	238	346	97	366	0	8	1	6	7	10	1	349	38	21		1	2	2	0	0
	Commercial	1	65	30	20	51	121	0	8	5	0	1	0	0	11	1	433	27		26	3	0	0
	Industrial	1	77	33	19	97	189	0	8	17	0	5	2	0	34	0	49	33	8		23	0	0
	Mines	12	357	649	149	545	2 198	234	75	112	13	2	0	27	1 527	59	35	3	3	21		0	0
	Subantarctic tundra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
	Polar desert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 6.15: Annual land change areas (ha) for 2014-2018 used as a basis for inventory calculations (20-year transition period)

Land categories		2014																				
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
2018	Indigenous Forest		426	551	1 505	133	475	7	327	132	0	9	0	0	65	39	262	10	2	1	7	0	0
	Thicket / Dense Bush	4 693		6 568	1 673	1 740	7 177	142	621	280	1	331	35	69	1 657	1 014	521	26	23	24	2	0	0
	Natural woodland	2 063	204 147		1 981	67 424	179 952	837	2 573	1 414	1 027	1 516	249	994	9 164	6 778	2 266	153	191	127	416	0	0
	Planted Forest	0	2 939	1 507		382	4 765	0	0	25	2	0	0	0	0	0	0	0	0	0	0	0	0
	Shrubland	46	26 742	54 198	391		81 650	919	2 161	144 410	615	491	794	377	8 641	46	89	12	5	8	1 490	0	0
	Grassland	994	78 222	169 371	4 996	591 484		1 010	7 454	5 900	3 395	308	128	905	30 030	11 650	1 657	78	315	335	3 789	0	0

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Land categories		2014																					
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
	Waterbodies	21	1 802	1 064	54	945	2 186		1 901	2 024	26	13	11	14	172	45	60	14	1	2	302	0	0
	Wetlands	49	3 553	1 771	354	1 152	12 332	299		114	26	24	19	29	821	189	165	22	4	7	75	0	0
	Barren Land	30	6 735	14 724	173	120 767	21 973	1 494	1 392		337	54	59	39	1 100	604	91	3	4	7	93	0	0
	Eroded Land	3	398	1 121	9	7 778	5 937	8	63	1 336		0	0	2	48	233	15	0	0	0	8	0	0
	Permanent Orchards	6	619	157	125	283	173	10	55	7	0		829	121	1 162	28	0	0	0	0	0	0	0
	Permanent Vines	0	235	38	7	244	55	11	31	32	0	63		13	269	0	0	0	0	0	0	0	0
	Annuals Pivot Irrigated	1	280	626	13	797	1 065	5	92	12	4	135	20		5 105	19	0	0	0	0	4	0	0
	Annuals Non-Pivot	60	3 301	2 571	633	9 532	21 694	83	1 365	173	76	2 937	1 085	1 635		408	0	0	0	0	116	0	0
	Cultivated Subsistence	101	3 341	8 228	135	500	4 132	8	198	9	355	123	0	31	1 760		0	0	0	0	6	0	0
	Residential	52	4 950	3 340	845	3 206	10 944	0	219	368	145	63	65	18	1 234	2 107		223	217	23	47	0	0
	Smallholdings	1	108	345	250	57	301	0	18	3	1	3	1	1	372	15	241		10	23	1	0	0
	Commercial	1	157	67	14	130	147	0	6	21	1	2	2	0	16	2	1 783	8		50	5	0	0
	Industrial	1	209	188	19	429	395	0	13	191	2	191	9	30	183	4	834	30	23		71	0	0
	Mines	10	326	710	58	1 192	1 434	130	56	706	38	1	2	18	447	49	223	10	14	100		0	0
	Subantarctic tundra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
	Polar desert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

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Table 6.16: Annual land change areas (ha) for 2018-2020 used as a basis for inventory calculations (20-year transition period)

Land categories		2018																					
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
2020	Indigenous Forest		2	887	489	71	2 073	27	79	33	0	0	0	0	2	0	96	1	1	0	24	0	0
	Thicket / Dense Bush	1		129 657	10	5 671	11 724	248	128	162	1	118	0	58	158	219	339	0	33	10	18	0	0
	Natural woodland	755	84 677		94	130 694	1 868 624	6 224	474	29 944	4 445	2 121	6	989	15 656	70 530	11 313	43	1 059	847	2 042	0	0
	Planted Forest	0	1 017	1 853		1 557	15 863	0	0	365	15	0	0	0	0	0	0	0	0	0	0	0	0
	Shrubland	60	4 927	47 688	1 595		1 103 458	3 910	224	887 743	2 579	19	19	94	1 194	7	10	0	1	6	3 375	0	0
	Grassland	2 410	77 871	327 855	31 151	322 349		14 734	5 248	119 831	6 223	121	7	496	7 038	7 750	170	9	2 874	3 185	16 293	0	0
	Waterbodies	16	156	4 461	207	6 742	8 511		3 299	9 445	189	18	6	25	615	54	196	41	8	49	1 723	0	0
	Wetlands	154	206	613	1 367	1 549	7 725	4 058		1 398	0	3	0	10	89	27	67	26	8	16	169	0	0
	Barren Land	84	1 280	17 473	557	212 160	27 355	13 265	377		15	5	0	8	78	54	17	0	2	23	490	0	0
	Eroded Land	0	2	1 732	43	2 622	28 023	230	1	389		0	0	1	1	33	0	0	0	0	23	0	0
	Permanent Orchards	7	759	6 339	1 282	742	1 376	9	83	237	0		23	2 327	8 555	249	0	0	0	0	3	0	0
	Permanent Vines	0	43	596	14	1 171	161	3	9	92	0	11		16	57	0	0	0	0	0	3	0	0
	Annuals Pivot Irrigated	0	715	5 525	105	1 241	6 946	20	194	169	24	151	47		20 528	116	0	0	0	0	64	0	0
	Annuals Non-Pivot	48	2 140	56 466	2 528	13 428	119 605	344	2 760	5 550	137	4 107	63	9 922		6 105	0	0	0	0	1 342	0	0
	Cultivated Subsistence	48	462	16 598	84	138	23 656	162	186	2 606	1 545	181	0	154	1 205		0	0	0	0	150	0	0
	Residential	308	1 986	17 786	990	609	8 020	0	75	823	63	6	0	22	479	2 015		48	62	7	683	0	0

Land categories		2018																					
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
	Smallholdings	2	0	16	19	0	5	0	25	0	0	10	0	3	36	157	125		46	82	29	0	0
	Commercial	0	11	445	7	10	1 762	0	6	29	0	2	0	0	0	1	34	26		1	38	0	0
	Industrial	0	19	467	20	437	1 902	0	15	183	1	30	1	9	166	8	74	75	1		305	0	0
	Mines	37	9	955	413	5 031	9 787	1 347	185	738	57	4	2	106	2 220	221	369	13	25	203		0	0
	Subantarctic tundra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
	Polar desert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 6.17: Annual land change areas (ha) for 2020-2022 used as a basis for inventory calculations (20-year transition period)

Land categories		2020																					
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
2022	Indigenous Forest		6	780	440	78	2 730	9	149	70	0	0	0	0	0	0	262	2	0	0	19	0	0
	Thicket / Dense Bush	63		110 629	1	3 795	115 156	128	184	341	1	0	0	0	1	5	3 513	0	11	7	7	0	0
	Natural woodland	841	110 037		56	347 782	755 661	2 979	742	59 519	5 255	22	7	93	223	6 720	27 519	0	802	548	2 390	0	0
	Planted Forest	0	1 344	2 068		1 632	26 286	0	0	423	31	0	0	0	0	0	0	0	0	0	0	0	0
	Shrubland	40	4 749	44 263	1 888		34 107	2 434	291	734 586	727	16	18	2	133	0	52	0	9	6	4 704	0	0

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Land categories		2020																				
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine	Subantarctic tundra	Polar desert
	Grassland	1 057	7 582	914 627	16 831	4 010 564		4 310	5 079	62 471	17 991	30	6	125	1 951	225	465	1	2 502	3 113	20 906	0	0
	Waterbodies	79	886	20 145	611	15 875	42 795		13 607	37 257	505	24	16	183	3 213	446	434	149	9	46	2 703	0	0
	Wetlands	113	235	797	765	397	10 956	1 774		590	1	1	0	1	7	7	133	42	7	15	126	0	0
	Barren Land	30	231	14 163	281	221 295	49 462	3 150	882		5	0	0	6	35	17	18	0	2	1	940	0	0
	Eroded Land	0	0	1 030	15	13 399	5 975	61	0	112		0	0	0	0	1	1	0	0	0	151	0	0
	Permanent Orchards	0	3	214	21	151	301	7	6	23	0		0	0	115	0	0	0	0	0	5	0	0
	Permanent Vines	0	0	10	0	87	32	3	1	13	0	0		0	33	0	0	0	0	0	3	0	0
	Annuals Pivot Irrigated	0	81	2 282	57	460	2 745	19	104	21	6	42	0		4 017	207	0	0	0	0	59	0	0
	Annuals Non-Pivot	0	297	3 253	959	1 382	7 418	291	216	196	2	2	1	361		2	0	0	0	0	1 139	0	0
	Cultivated Subsistence	0	38	37 764	1	2	644	47	13	8	3	0	0	0	22		0	0	0	0	168	0	0
	Residential	117	379	14 881	571	1 305	16 193	0	69	2 081	290	10	6	13	461	2 311		33	802	46	870	0	0
	Smallholdings	2	0	36	19	0	39	0	31	7	0	0	0	0	0	1	205		29	72	27	0	0
	Commercial	1	19	573	9	35	1 673	0	6	115	1	1	0	0	12	8	722	28		20	40	0	0
	Industrial	0	13	542	29	388	1 958	0	18	543	3	3 748	1 567	174	1 498	19	640	105	86		386	0	0
	Mines	25	3	1 074	275	4 082	7 411	1 206	158	1 198	59	2	1	52	1 574	84	375	13	22	294		0	0
	Subantarctic tundra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
	Polar desert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

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6.3.4 Land stratification

6.3.4.1 Soils

South Africa's detailed soils map was reclassified into the 7 soil classes provided by IPCC 2006 Guidelines (DEA, 2015) (Figure 6.6). The map was derived from the 1:250 000-scale Land-type Survey of South Africa. This survey mapped over 7 000 unique land types, each of which has a specific combination of soil, terrain form and macroclimate. Within each land-type mapping unit, a number of different soil forms, as well as other land classes, such as rock, stream beds and pans, are recorded, and their percentage within the land type is used to allocate the land type to a specific broad soil pattern. Table 6.18 indicates the soil categories and what criteria was used for their classification. This map does not show organic soils and the inclusion of these is discussed in the section below.

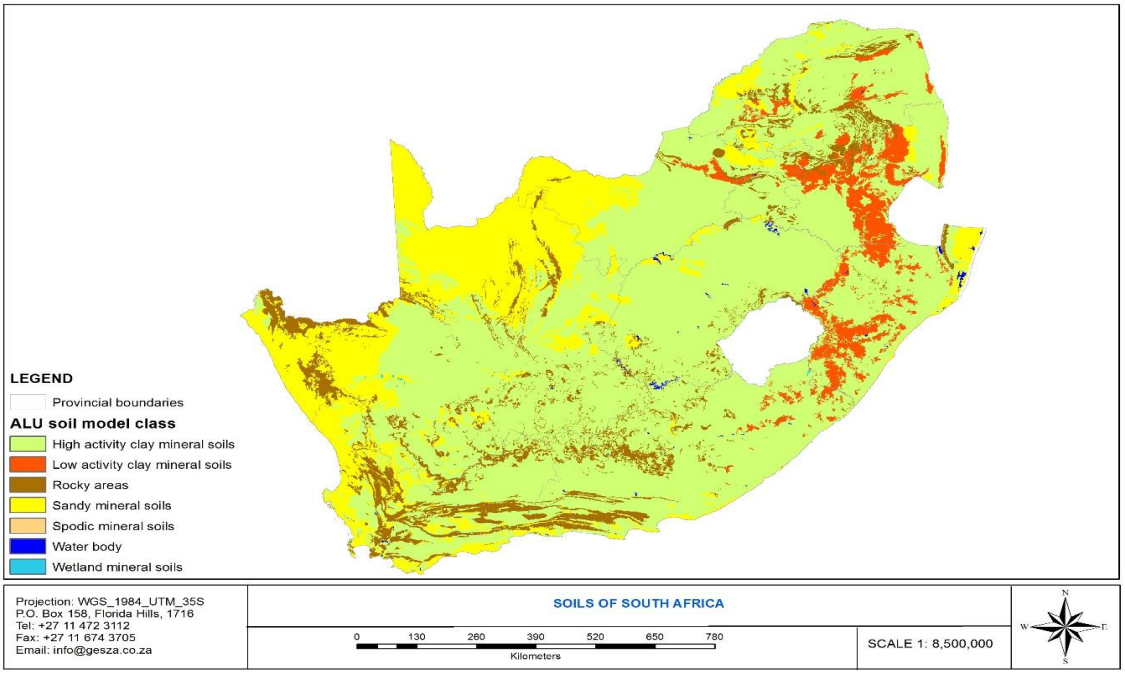


Figure 6.6: South African soils classified into the IPCC classes (DEA, 2015)

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Table 6.18: Soil types and their description (DEA, 2015)

	Description	Criteria
Sandy mineral soils	Sandy mineral soils comprise all soils where the texture class is sandy (***irrespective of taxonomy***). These areas generally have either sandy parent materials or have been subject to aeolian (wind-blown) deposition (such as the Kalahari sands of the Northern Cape).	Land types where soils with an average topsoil clay content less than 8% comprise more than 40%.
Wetland mineral soils	This map unit comprises all land types where soils with wetland characteristics are dominant. Most land types will have wetland soils in the lower parts of the landscape, but only a few land types have these soils as dominant, mainly in the north-east of KwaZulu-Natal.	Land types where Katspruit and Fernwood (series 30-42) soil forms, along with streambeds and pans, comprise more than 40%.
Organic soils	This map unit comprises all land types dominated by 'peat' soils. These soils typically occur in cool, often upland areas, so their distribution is limited to small zones in KwaZulu-Natal.	Land types where champagne soil forms comprise more than 40%.
Spodic mineral soils	This map unit comprises all land types where podzols (where leaching of iron/aluminium and organic matter has occurred) predominate. These areas are restricted to small zones in the south and south-west of the Western Cape.	Land types where Houwhoek and Lamotte soil forms comprise more than 30%.
Rocky areas		All I_b and I_c land types (rock outcrops more than 60%).
Low activity clay mineral soils	This map unit comprises all land types dominated by highly weathered, apedal (structureless) soils dominated by low activity (1:1) clay minerals such as kaolinite. Only soils where the base status is defined as part of the soil classification could be used, so it is very probable that the extent of such soils is larger than that shown on the map. These soils are found mainly in the warmer, higher rainfall areas, such as KwaZulu-Natal and Mpumalanga.	Land types where Kranskop, Magwa, Inanda, Nomanci, Avalon (series 10–17), Glencoe (series 10–17), Pinedene (series 10–17), Griffin (10–13), Clovelly (series 10–18), Bainsvlei (series 10–17), Hutton (series 10–18) and Shortlands (all series) comprise more than 40%, and where average topsoil clay percentage is more than 8%.
High activity clay mineral soils	This map unit comprises all land types dominated by lightly to moderately weathered soils, dominated by 2:1 silicate clay minerals, including vertisols, mollisols, calcareous soils, shallow soils and various others. This group covers most of South Africa.	Land types not falling into one of the categories given above.

To determine the area of each land class in a particular soil type, the soil type map was combined with the land cover data. The data was processed using a combination of QGIS and an Anaconda Python environment with NumPy and Rasterio packages installed to process the geospatial data. The data processing flow was as follows:

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- Soil type dataset:
    - Geo-reference the soils file (.ovr pyramid structure) to corresponding raster outline of South Africa (EPSG 4326 (WGS84)).
    - Resample the resolution of the soil type raster (50 m) to the highest resolution necessary for the analysis. i.e., the dataset with the smallest resolution (28.986m, SANLC Change Raster).
- Overlay and counts:
    - Convert the raster datasets into arrays for processing. The data sets were set to an equal extent to ensure the layers fit on top of one another.
    - Index spatial extent to assign each pixel in the spatial dataset a value (location) in the array.
    - Code instructed to loop through each array and counts the number of unique pixels that correspond to the unique cells of the other raster data (np.unique = Counts the unique values in the array).
    - A code loop finds the soil type for each corresponding Landcover change class and then counts the number of pixels that occurred.
    - Determine the counts of pixels for each LC Change class corresponding to the unique 7 soil classes of the soil dataset.
    - Export results to excel file and multiply the pixel count by the pixel area (resolution 28.986m x 28.986m = 840.19m^2) to give the landcover change class per soil type.
    - Convert m^2 to ha.
- Reformat data into land change matrix per soil type (i.e. 7 land change matrixes per change period.
- Add in the soil data for overseas territories (see section 6.1.2.2 for soil details).

These overlays use the original SANLC change data, however adjustments were made to these matrixes in excel. These then lead to some misalignments in the overlay data. This will be corrected in future, with the improved land mapping system, so that the original maps are adjusted before the overlays are done. In the meantime, the soil matrix data were normalised to the area of the adjusted matrix areas by dividing the change area by the total change in overlay data and then multiplying this by the change area in the adjusted matrix.

6.3.4.2 Climate

Long term climate maps were developed for South Africa (DEA, 2015) which categorize the climate into the classes provided by IPCC 2006 Guidelines. Four climate types (Figure 6.7) are present for the mainland in South Africa, with the dominant climate being the

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warm, temperate dry climate (99.6% of the area). This was followed by warm, temperate moist (0.2%), cool temperate dry (0.08%) and lastly cool, temperate moist (0.02%). The climate classification is used to select the appropriate emission factors, however South Africa uses country specific data and so incorporating the climate classification has little impact on the emission results. It is however useful to know the classification so that verification can be done with the IPCC default values.

It should be noted that the Prince Edward Islands have their own climate classification. According to the IPCC 2006 Guidelines decision tree in Figure 3A.5.2 and Smith and Mucina (2006) the Prince Edward Islands would fall into the cool, temperate dry category so emission factors in this climate zone were selected for the subantarctic tundra land category.

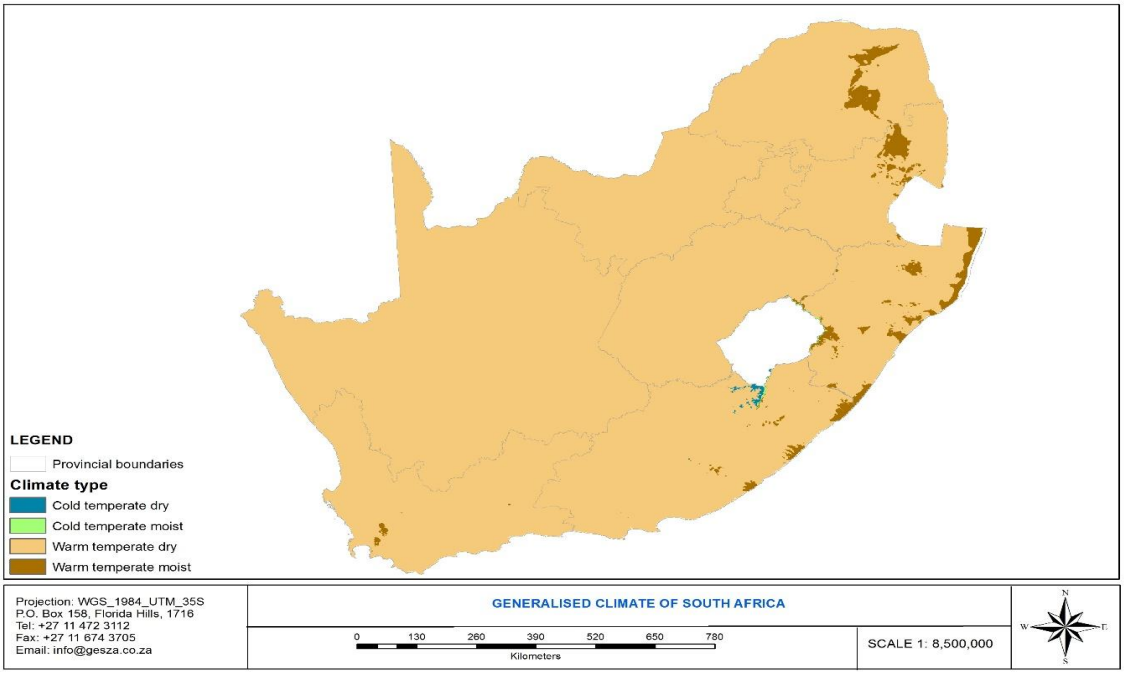


Figure 6.7: South Africa's long term climate map classified into the IPCC climate classes (DEA, 2015)

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6.3.4.3 Ecological zones

IPCC default values are provided based on the climate and ecological zone (ecozone). This is particularly relevant for the *Forest land* category. To enable the selection of the appropriate factor or for purposes of verification the relevant ecozone for each land class was determined. This was done by intersecting the FAO ecozones (Table 6.19), which are those used in the IPCC 2006 Guidelines (see Table 4.1, Volume 4, Chapter 4), with the 2014 land cover map. Results for *Forest land* categories are shown in Table 6.20. In this inventory country specific parameters and emission factors were applied in most cases for *Forest land* so the main purpose of this data was for verification. For other land categories there were some cases where IPCC default values were required and this ecozone data was utilised to created area based weighted averages for the land categories (see details in category specific sections below).

Table 6.19: FAO Global Ecological Zoning framework for 2000 (Simons, 2001; IPCC, 2006)

EZ Level 1 – Domain		EZ Level 2 – Global Ecological Zone		
Name	**Criteria** *(Equivalent to Köppen-Trewartha Climatic groups)*	**Name** *(reflecting dominant zonal[a] vegetation)*	**Code**	**Criteria** *(approximate equivalent of Köppen – Trewartha Climatic types, in combination with vegetation physiognomy and one orographic zone within each domain)*
Tropical	All months without frost: in marine areas over 18°C	Tropical rain forest	TAr	Wet: 0 – 3 months dry[b]. When dry period, during winter
		Tropical moist deciduous forest	TAwa	Wet/dry: 3 – 5 months dry, during winter
		Tropical dry forest	TAwb	Dry/wet: 5 – 8 months dry, during winter
		Tropical shrubland	TBSh	Semi-Arid: Evaporation > Precipitation
		Tropical desert	TBWh	Arid: All months dry
		Tropical mountain systems	TM	Approximate > 1000 m altitude (local variations)
Subtropical	Eight months or more over 10°C	Subtropical humid forest	SCf	Humid: No dry season
		Subtropical dry forest	SCs	Seasonally Dry: Winter rains, dry summer
		Subtropical steppe	SBSh	Semi-Arid: Evaporation > Precipitation
		Subtropical desert	SBWh	Arid All months dry
		Subtropical mountain systems	SM	Approximate > 800-1000 m altitude
Temperate	Four to eight months over 10°C	Temperate oceanic forest	TeDo	Oceanic climate: coldest month over 0°C
		Temperate continental forest	TeDc	Continental climate: coldest month under 0°C
		Temperate steppe	TeBSk	Semi-Arid: Evaporation > Precipitation
		Temperate desert	TeBWk	Arid: All months dry
		Temperate mountain systems	TeM	Approximate > 800 m altitude
Boreal	Up to 3 months over 10°C	Boreal coniferous forest	Ba	Vegetation physiognomy: coniferous dense forest dominant
		Boreal tundra woodland	Bb	Vegetation physiognomy: woodland and sparse forest dominant
		Boreal mountain systems	BM	Approximate > 600 m altitude
Polar	All months below 10°C	Polar	P	Same as domain level

[a] Zonal vegetation: resulting from the variation in environmental, i.e. climatic, conditions in a north south direction.
[b] A dry month is defined as the month in which the total of precipitation P expressed in millimeters is equal to or less than twice the mean Temperature in degrees Centigrade.

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In the next inventory the overlay will be updated by intersecting the updated ecozone map (FAO, 2012) with the more recent sentinel derived land cover maps (2018 onwards). In future it is proposed that the spatial ecozone map be incorporated into the developing land mapping system so the zones can be associated with specific pixels and land areas. This could assist in providing further stratification of country specific data and improve the accuracy of the estimates.

Table 6.20: Ecozone classification for each of South Africa's Forest land categories

IPCC ecozone type	Fraction within each ecozone[a]			
	Indigenous forest	Thickets	Woodlands	Forest plantations
Subtropical humid forest	0.49	0.29	0.04	0.15
Subtropical dry forest	0.03	0.09	0.03	0.03
Subtropical mountain system	0.19	0.12	0.08	0.54
Tropical moist deciduous forest	0.07	0.02	0.01	0.01
Tropical dry forest	0.12	0.37	0.52	0.22
Tropical shrubland	0.00	0.01	0.16	0.00
Tropical desert	0.00	0.06	0.13	0.00
Tropical mountain system	0.10	0.04	0.03	0.05

[a] *Dominant category shown in red; secondary category shown in orange.*

6.3.5 Incorporating the 20-year transition period

Each land type is divided into "land remaining land" and "land converted to" that land class. IPCC states that land remains in the land converted to category for the default 20-yr period. After 20 years the converted land moves to the land remaining land category. In this inventory the 20-year transition period was included for each land category. It was assumed that the same annual rate of change occurred prior to 1990, therefore the area of land converted to and land remaining land for each land type in 1990 was calculated as:

$LC_{i\ 1990} = ALC_{i\ 1990} * 20\ yrs$

$LRL_{i\ 1990} = A_{i\ 1990} - LC_{i\ 1990}$

Where:

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$LC_{i\ 1990}$ = area (ha) of land in land converted to land category *i* in 1990;

$ALC_{i\ 1990}$ = annual total area (ha) converted to land category i in 1990;

$LRL_{i\ 1990}$ = area (ha) of land in the land remaining in the land category *i* in 1990;

$A_{i\ 1990}$ = total area of land in category *i* in 1990.

For subsequent years these categories were calculated as follows:

$LC_{i\ t} = LC_{i\ t-1} + ALC_{i\ t} - ALC_{i\ (t-20)}$

$LRL_{i\ t} = LRL_{i\ t-1} + ALC_{i\ t} – ACF_{i\ t}$

Where:

$LC_{i\ t}$ = area (ha) of land in land converted to land category *i* in year t;

$LC_{i\ t-1}$ = area (ha) of land in land converted to land category *i* in year t-1;

$ALC_{i\ t}$ = annual total area(ha) converted to land category *i* in year t;

$ALC_{i\ (t-20)}$ = annual total area (ha) converted to land category *i* in year t-20;

$LRL_{i\ t}$ = area (ha) of land in the land remaining in the land category *i* in year t;

$LRL_{i\ t-1}$ = area (ha) of land in the land remaining in the land category *i* in year t-1;

$ACF_{i\ t}$ = annual total area (ha) converted from land category *i* to another land category in year t.

In accordance with the IPCC Approach 2, all land conversions occur from the "land remaining land" categories. In the previous inventory this led to some negative land areas and therefore a correction was added which assumed that some of the conversions occurred from "converted land". Unfortunately, there were errors in the way this correction was applied. The assumption is true but tracking of land parcels is required to fully implement this approach (Approach 3). Due to the error and the lack of parcel tracking the correction approach was removed in this inventory and the focus shifted to refining the land conversion matrixes (see section 6.3.3.2) prior to applying the 20-year correction. This meant the land conversion areas were smaller and the application of the Approach 2 assumption of all lands being converted from "land remaining land" did not lead to negative land areas. This assumption was therefore reinstated as it aligns more accurately with the IPCC Approach 2 methodology.

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It is acknowledged that land conversions do occur on "converted land" but land parcels need to be tracked to be able to apply the Approach 3 correctly. With the land area challenges, along with requirements to track burnt area, there is a need to shift towards tracking land parcels and moving to Approach 3. This was highlighted as a capacity building need in the UNFCCC TERT review (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L_CBN.4) and has been incorporated into the improvement plan.

This process was applied to each land change matrix (per soil type) to produce a complete time-series of land area per soil type since 1990.

6.3.6 Extrapolation to 2024

It was assumed that the annual change between 2020 and 2022 continued to 2024. In addition, the data from the Annual State of the Climate South Africa (SAWS, 2025) indicates that 2024 was a drier year than 2022. The seasonal variation corrections for a drying year were therefore applied to the 2020-2022 change matrix data to project data to 2024.

6.3.7 Resulting land areas for 1990 - 2024

The time-series of the resulting land areas per land class, which form the activity data for the emission estimates, are provided in the relevant land category sections below. Table 6.21 provides the land change matrix (including the 20-year transition period) for 2024. The diagonal shaded cells represent the land remaining areas while the conversions show the total converted area over the 20-year transition period.

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Table 6.21: Land change (ha) matrix for South Africa for 2024 (including 20-year conversion periods)

Land categories	Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Low shrubland	Grassland	Eroded land	Subantarctic tundra	Waterbodies	Wetlands	Residential	Smallholdings	Commercial	Industrial	Mines	Barren land	Polar desert	Sum of reductions	Additions - reductions
Indigenous Forest	420 517	17 891	14 032	21 933	117	0	3	816	502	4 415	30 268	1	0	440	4 624	3 026	83	40	17	154	1 021	0	**99 384**	**-15 966**
Thicket / Dense Bush	36 147	4 320 502	1 392 623	59 928	7 195	1 891	1 360	41 180	40 428	301 460	1 026 860	2 340	0	13 904	63 831	44 059	1 724	1 409	1 467	3 121	38 052	0	**3 078 978**	**444 419**
Natural woodland	17 411	1 914 375	3 667 349	28 093	13 888	1 253	8 778	160 450	270 780	2 173 282	10 995 046	42 697	0	40 944	45 705	153 023	3 116	6 457	5 075	23 073	332 344	0	**16 235 790**	**-8 104 309**
Planted Forest	0	20 900	25 067	905 186	0	0	0	0	0	13 831	194 930	140	0	0	0	0	0	0	0	0	2 490	0	**257 358**	**187 547**
Permanent Orchards	366	13 552	18 906	5 727	246 405	4 787	6 579	35 170	1 753	8 567	8 977	5	0	230	1 300	0	0	0	0	33	689	0	**106 641**	**-21 509**
Permanent Vines	0	2 472	2 061	346	4 284	147 814	465	4 746	109	9 240	1 337	0	0	130	1 002	0	0	0	0	19	1 454	0	**27 666**	**188**
Annuals Pivot Irrigated	11	6 573	37 077	737	2 489	412	486 730	239 638	1 887	36 260	57 648	175	0	215	3 684	0	0	0	0	429	1 215	0	**388 451**	**-319 630**
Annuals Non-Pivot	1 011	58 611	174 925	21 437	26 998	5 567	37 314	9 704 630	32 506	159 550	599 468	831	0	3 816	28 941	0	0	0	0	8 192	13 689	0	**1 172 858**	**83 554**
Cultivated Subsistence	1 172	37 051	247 185	1 770	2 529	0	579	16 736	1 499 724	28 746	166 943	5 979	0	913	7 388	0	0	0	0	1 189	5 436	0	**523 615**	**-26 896**
Low shrubland	1 383	303 977	1 120 844	22 244	4 410	5 189	3 096	204 127	12 514	22 298 231	6 570 987	89 008	0	36 400	64 561	7 950	539	546	762	37 367	7 081 782	0	**15 567 686**	**3 787 130**
Grassland	20 088	1 005 158	4 602 868	235 899	5 524	1 037	7 265	454 905	97 709	13 524 840	5 863 937	109 629	0	87 621	226 186	47 872	3 227	17 809	21 590	152 280	712 084	0	**21 333 590**	**-526 851**
Eroded land	11	2 608	19 599	250	15	1	28	1 354	3 263	82 909	167 607	41 014	0	1 187	522	530	4	7	6	814	7 435	0	**288 150**	**-15 462**
Subantarctic tundra	0	0	0	0	0	0	0	0	0	0	0	0	22 534	0	0	0	0	0	0	0	0	0	**0**	**0**
Waterbodies	357	14 789	67 791	2 928	260	216	860	16 165	2 526	68 415	139 400	1 970	0	175 262	53 298	2 605	799	72	320	16 563	132 240	0	**521 578**	**-178 369**
Wetlands	1 772	29 701	19 465	15 141	459	325	313	17 439	1 478	25 561	161 755	874	0	44 092	713 203	2 670	662	130	228	1 778	9 991	0	**333 836**	**185 176**

Land categories	Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Low shrubland	Grassland	Eroded land	Subantarctic tundra	Waterbodies	Wetlands	Residential	Smallholdings	Commercial	Industrial	Mines	Barren land	Polar desert	Sum of reductions	Additions - reductions
Residential	2 406	44 437	140 153	15 603	636	394	315	15 593	25 931	43 708	203 326	2 321	0	0	2 676	2 232 963	5 194	5 853	2 211	5 325	13 155	0	**529 237**	**-239 741**
Smallholdings	21	915	3 937	4 575	101	111	18	5 053	757	1 195	5 027	66	0	0	323	2 238	232 550	257	561	185	50	0	**25 391**	**-8 356**
Commercial	19	1 371	3 751	305	31	12	3	223	50	1 195	12 014	11	0	0	140	14 418	471	15 650	540	284	655	0	**35 493**	**-2 061**
Industrial	13	1 700	4 184	423	15 863	6 326	833	7 393	107	5 118	15 105	24	0	0	239	6 535	1 017	514	21 837	2 666	3 473	0	**71 532**	**-36 268**
Mines	333	4 907	15 536	3 654	45	16	762	27 792	1 561	36 605	76 928	637	0	10 373	1 979	3 479	142	220	2 191	41 811	10 212	0	**197 374**	**62 920**
Barren land	895	42 408	221 477	3 911	286	316	250	7 632	2 855	2 829 920	373 111	15 979	0	102 945	12 615	1 091	57	118	295	6 822	4 521 323	0	**3 622 985**	**4 744 485**
Polar desert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10 966	**0**	**0**
Sum of additions	**83 418**	**3 523 397**	**8 131 482**	**444 905**	**85 131**	**27 854**	**68 821**	**1 256 412**	**496 719**	**19 354 816**	**20 806 740**	**272 688**	**0**	**343 209**	**519 012**	**289 496**	**17 035**	**33 432**	**35 264**	**260 293**	**8 367 470**	**0**		
Sum for land category	**503 935**	**7 843 899**	**11 798 831**	**1 350 091**	**331 536**	**175 668**	**555 551**	**10 961 042**	**1 996 442**	**41 653 048**	**26 670 676**	**313 702**	**22 534**	**518 471**	**1 232 215**	**2 522 459**	**249 585**	**49 082**	**57 100**	**302 104**	**12 888 793**	**10 966**		
Total land area	**122 007 731**																							

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6.4 General emission/removal methodologies and data preparation

This section describes the general methodologies, along with stratification and data preparation processes, required to prepare the LULUCF emission estimates. Further category specific details are provided in sections 6.6 to 6.11.

6.4.1 Carbon emissions from biomass (CRT 4.A to 4.F)

South Africa used a combination of Tier 1, and Tier 2 methods for estimating emissions for the LULUCF sector. There are two methods for estimating carbon stock changes in biomass, namely the Gain-loss method and the Stock-difference method. The Stock-difference method requires carbon stock inventories for a given land area, at two points in time. This method is applicable in countries that have national inventory systems for forests and other land-use categories where the stocks of different biomass pools are measured at periodic intervals (IPCC, 2006). South Africa does not have a forest inventory and so the Gain-loss method was applied.

For the "land remaining" category in *Forest land, Cropland, Grasslands* and *Wetlands* the annual increases in biomass carbon stocks were estimated using equation 2.9 of the IPCC 2006 Guidelines, where the mean annual biomass growth was estimated using equation 2.10 (Tier 1 approach) but with country specific data. For forest plantations the Tier 2 approach of this equation was applied. For *Settlements* equation 8.2 was applied. For pure grasslands the assumption of equivalence was applied (Tier 1), however the *Grassland* category also incorporates low shrublands which has a small shrub element that was included. For *Wetlands* and *Other lands* the Tier 1 assumption of equivalence was applied. The above-ground biomass and biomass gains for all woody or perennial land categories were sourced from the scientific literature. Literature was also relied on for root to shoot ratios so that below-ground biomass could be determined. Data on MAI for estimating growth in forest plantations were obtained from collected forestry data.

The annual decrease in carbon stocks due to disturbance losses were estimated from IPCC 2006 Guidelines equations 2.11 to 2.14 (IPCC, 2006). Fire disturbance losses (from both wildfires and controlled fires) were incorporated for *Forest land, Croplands, Grassland, Wetlands*, and *Settlements*. *Other lands* were assumed not to burn due to the lack of biomass on these lands. The burnt area estimation is discussed under section 6.4.7.1.

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Harvest losses were included for forest plantations and perennial crops, while the woodland/open bush category included fuelwood collection losses. Forest plantations were the only category where other losses (such as losses due to insects and climate) were included due to a lack of data in other land categories.

The IPCC 2006 Guidelines equations 2.15 and 20.16 were utilised for estimating emissions from biomass changes on converted land. A Tier 2 approach was applied as country specific biomass stocks were utilised and natural land classes[23] were not assumed to be cleared but rather transition slowly from initial to final biomass levels. Land was only assumed to be cleared for forest plantations, croplands and settlements, so carbon stocks immediately after conversion were set to zero. For land transitions to land categories with woody components the carbon growth values were used and carbon was gained over the 20-default transition period. Woody losses were assumed to be immediate and were accounted for in the year of conversion. Growth in converted lands was estimated using the growth rates for the various land categories.

6.4.2 Carbon emissions from litter and deadwood (CRT 4.A to 4.F)

The dead organic matter (DOM) pool includes litter and deadwood for *Forest lands* and wooded *Grasslands*, while only litter is included for all other land classes. It is assumed that there are no DOM changes in "land remaining" categories (Tier 1) unless otherwise state in the category specific sections, and it is assumed that in "converted land" all litter pool carbon losses occur entirely in the year of transition (Tier 1). The IPCC 2006 Guidelines equation 2.23 was used to estimate changes in litter in converted land. Litter and deadwood estimates for the various land categories were determined from literature or from intersecting the SANLC data with the National Terrestrial Carbon Sinks Atlas (NTCSA) carbon density maps (DEFF, 2020) and are provided in the relevant land category sections below.

[23] *This refers to land cover classes rather than land use classes, such as indigenous forests, thickets, woodlands, grasslands, low shrublands, wetlands and other lands.*

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6.4.3 Emissions from soils (CRT 4.A to 4.F)

6.4.3.1 Mineral soils

Annual SOC change for each land use category was determined by applying IPCC 2006 Guidelines equation 2.25 (Formulation B). This combines the SOC reference data for each soil type with the stock change factor for each vegetation type.

The land cover/use maps were stratified by soil type (see section 6.3.4.1) to obtain a land change matrix per soil type.

SOC reference data was determined from the ISRIC dataset. The ISRIC (2017) soil organic carbon stock at 30 cm depth[24], which is based on many data points in South Africa, was used as the SOC reference data. A soil carbon value for each soil type was determined by extracting the ISRIC SOC to fit the South African boundary (South African Boundary shapefile (2018)) obtained from the Municipal Demarcation Board[25]. This was then re-projected to match the same co-ordinates as the land cover dataset (UTM 35 S). The SOC data set was re-sampled to change the cell size from 250 x 250 m to 100 x 100m to match the soil map. The soil data was sub-divided to create a stand-alone file for each soil type, and the SOC data was extracted for each soil type to determine a SOC reference value for each soil type (weighted average SOC per soil type using the 'Value' (t/ha) and counts or number of cells that match the value). Only data for "land remaining land" categories were used as the reference values is a SOC value without any land conversions. Since the Prince Edward Islands were not included in this analysis due to a lack of spatial data, no value was determined for volcanic soils. In this case the IPCC 2019 Refinement value for cool, temperate dry climate was applied. The resulting SOC reference values are shown in Table 6.22.

Table 6.22: Soil carbon reference data per soil type as obtained from ISRIC database

	SOC reference value (t C/ha)	IPCC 2006 default[26]	IPCC 2019 Refinement
Sandy mineral soils	20.85	19	10 ±5%
Wetland soils	40.53	88	74 ±17%

[24] https://data.isric.org/geonetwork/srv/eng/catalog.search;jsessionid=D59E70CBD401A199C806783D11B4B656#/metadata/ea80098c-bb18-44d8-84dc-a8a1fbadc061

[25] https://dataportal-mdb-sa.opendata.arcgis.com/search?tags=2018

[26] *Defaults are for warm, temperate climates*

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	SOC reference value (t C/ha)	IPCC 2006 default[26]	IPCC 2019 Refinement
Spodic soils	71.65	115[27]	143 ±30%
Rocky soils	47.03	NA	NA
Low activity clay	65.54	24	19 ±16%
High activity clay	35.21	38	24 ±5%
Volcanic	20.00		20 ±90%

Comparisons were made with the IPCC data (Table 6.22) and this shows that the country specific values for wetlands mineral soils and spodic soils are lower than the IPCC default values, but for low activity clay the value is much higher. The values for sandy soil and high activity clay are within the IPCC default range, and these two soils cover the majority of the land area (19.8% and 66.4% respectively). The differences, particularly with the IPCC 2019 Refinement defaults, could be because the data is outdated as the soil data was from 2017, and the overlay was with the lower resolution 2014 land cover map. An update of the SOC reference data has been put on the improvement list (section 6.1.6) for updating in the next inventory cycle. The impact of changing to the IPCC 2019 Refinement default values is a 0.5% decrease in the sink in 2024 so improving this data set would have a small impact on the overall emissions.

IPCC 2006 Guidelines default values are the main source of the stock change factors, although some country specific values (particularly for croplands) are applied and these are all described in the carious land category sections below.

6.4.3.2 Organic soils

Inclusion of estimates for organic soils in *Croplands* and *Grasslands* is an improvement that has been incorporated in the 1990-2024 inventory. Literature indicates that high organic soils are in Kwa-Zulu Natal (KZN) Province (Schutte, et al., 2019; Moeletsi, et al., 2015) therefore this inventory focussed on identifying and incorporating organic soils in this province. In the next inventory a more complete assessment of organic soils will be included.

The initial mapping of organic soils for KZN province involved raster data processing and analysis using the soil type map, ISRIC 20m Total Soil Organic Carbon for 2018, SANLC datasets and the SANBI Vegmap bioregions layer. A threshold of >200 t/ha in the Total Soil Organic Carbon 2018 raster dataset was used to extract areas with higher organic

[27] This is the default value for cold, temperate climates as there is no value for warm, temperate environments.

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soil values and used as an initial mask. This Total Soil Organic Carbon 2018 high organic soils mask was then used to intersect areas within the grassland biome of the SANBI vegmap, as well as with the cropland and wetland areas in the SANLC maps. The focus on these biomes was because the FAOSTAT data provided drained organic soil areas for these land categories. Again, a more extensive organic soil assessment going beyond these land categories will be completed in the next inventory.

As the organic soils have not yet been incorporated into the overall soil type map the next step was to identify what soil types these organic soils were associated with in the soil type map. An overlay of the soil type and organic soil map for KZN showed that organic soils were classified as high and low activity clays (with a close to 50% split) in the soil type map. To maintain the consistent land area the organic soil area was subtracted equally from the high and low activity clay soils in *Croplands* and *Grasslands* thereby incorporating organic soils into the matrix. The *Cropland* organic soil area was determined to be 59 041 ha, while for *Grasslands* it was 427 410 ha.

6.4.4 Direct and indirect N_2O emissions from nitrogen inputs to managed lands (CRT 4(I))

Direct N_2O from nitrogen inputs to managed soils were estimated using IPCC 2006 Guidelines equations 11.1-11.6, while indirect emissions were estimated from equations 11.9 -11.11. These emissions were only included for Forest lands and Croplands due to a lack of data in other land categories. Emissions for Croplands were not included in the LULUCF sector but are rather reported in the Agriculture sector under 3.D.1.

6.4.5 Emissions and removals from drainage, rewetting and other management of soils (CRT 4(II))

The area of drained organic soils for *Grasslands* and *Croplands* was obtained from FAOSTAT and CH_4 emissions were estimated using Equation 2.4 of the IPCC 2013 Wetland Supplement (IPCC, 2014). There was insufficient data on drained organic soils in the other land categories so these were not estimated in this inventory.

Methane from rewetted inland wetland mineral soils were estimated for the wetland category. Rewetted areas were considered to be those that were converted from other lands to wetlands. Emissions were estimated with equation 5.1 from the IPCC 2013 Wetland Supplement (IPCC, 2014a).

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6.4.6 Direct and indirect N_2O emissions from N mineralisation/immobilisation associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (CRT 4(III))

Direct N_2O emissions in this category were estimated based on IPCC 2006 Guidelines equations 111, 11.2 and 11.8. Indirect N_2O emission estimates were determined by applying IPCC 2006 Guidelines equations 11.9 and 11.10. Direct and indirect emissions for *Croplands remaining croplands* are included under the Agriculture sector (3.D.1.e).

6.4.7 Biomass burning (CRT 4(IV))

6.4.7.1 Burnt area data processing

Burnt area data for the time-series has been developing over time and as technology has evolved. The MODIS Collection 5 Burnt Area data was utilised for the 2017 inventory (2000-2017). At the time of the 2017 inventory the land cover maps had 17 land categories. In the following inventory (2000-2019) land cover maps were updated to include more disaggregated settlement classes bringing the total number of land categories to 20. An updated 1990 and 2014 land cover map, as well as the 2018 map, were released. During this inventory the burnt area was also updated to utilise the MODIS Collection 6 Burned Area Product Geotiff version (http://modis-fire.umd.edu/pages/BurnedArea.php?target=GeoTIFF). This product is a level 3 gridded 500 m product, and the quality of the information is described in Giglio et al. (2018). Monthly data was combined to obtain annual burnt area maps for each year. Each year's dataset was clipped (extract by mask) to the actual South African boundary The burnt area maps were intersected with the SANLC data to obtain burnt area per land class. Land cover maps are not available for every year, so the 2014 map was intersected with the burnt areas for 2000 to 2014, the 2018 intersected with the years 2015-2020.

Due to time limitations not all the past years could be reanalysed using the Collection 6 data. The years 2001, 2005, 2010 and 2014 – 2020 were analysed and for the in between years the previous Collection 5 data was used as a proxy and the IPCC splicing technique was applied to adjust the years in between. As the updated data made use of the 20 category maps it could be used to include the additional settlement categories in the in between years. This was done by applying the average fraction of the total settlements allocated to each disaggregated class. This produced a consistent time series between

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2000 and 2020 for all 20 land categories. There was very little difference in the two data sets for the years since 2010 (<1%), but there was a 15% difference for the 2001 dataset (Figure 6.8).

For the 2000-2022 inventory land cover and burnt area data overlays were not completed. The total burnt area from MODIS for 2021 was obtained and disaggregated by land class by using the same ratio to the total as found in 2020. The 2022 burnt area data was not yet available, so this data was estimated based on average burnt area for the previous 5 years.

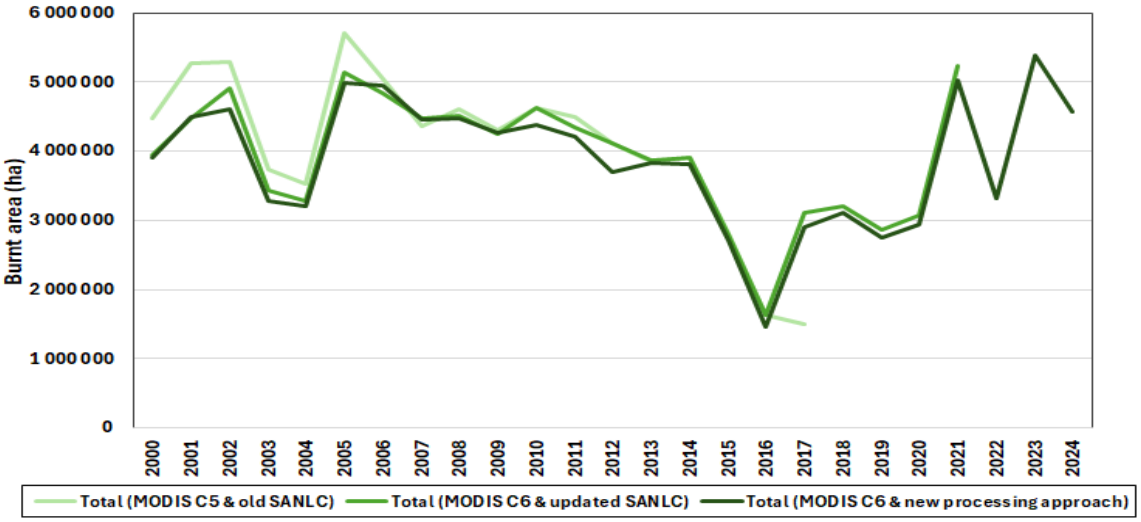


Figure 6.8: Progression and comparison of the burnt area data estimates from the application of updated approaches over time

In this current inventory for 2024 a change in processing methodology was applied. Tracking land parcels is becoming more important and there are plans to develop an improved mapping system for the LULUCF sector. This is to reduce small inconsistencies in all the base maps and overlay processes and to increase automation so all corrections are applied consistently through the time series and in future updates. One way to do this is through georeferencing of all input maps. In this inventory the land cover, soil and burnt area maps were georeferenced, and a programme developed to automate the overlay system. The MCD64A1 Burned Area Product (hereafter the MCD64A1) is a

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monthly, Level-3 gridded 500-m product containing per-pixel burning and quality information, and tile-level metadata. The MCD64A1 files (window 13 files) were downloaded directly from the USGS servers for the 2018 to 2024 annual periods. (Window 13 of the MCD64A1 contains southern Africa). The original soil map from previous inventories (Moeletsi et al., 2015) was utilised along with the 2018, 2020 and 2022 SANLC maps (downloaded from https://www.dffe.gov.za/egis). The data was processed using a combination of QGIS and an Anaconda Python environment with NumPy and Rasterio packages installed to process the geospatial data (see Annex V for Burnt Area Data Processing Workflow).

This new processing approach was used to determine burnt area for the years 2018 to 2024. The 2018 and 2019 burnt area was overlaid with the 2018 SANLC, 2020 and 2021 against the 2020 SANLC and 2022-2024 against the 2022 SANLC. As it is a new approach the years 2018-2020 were completed to ensure there is an overlap for comparison. The total burnt area for both methods was very similar (Figure ??), however there was found to be some differences in the area burnt per land category. The largest changes being a reduction in burnt area in thickets, low shrublands and indigenous forests (83%, 43% and 14% respectively) and an increase in burnt area in grasslands and woodlands (235 and 4% respectively). These updates do appear to be an improvement as thickets and indigenous forests are not fire-prone vegetation types (DEAT, 2009; Forsyth & Le Maitre, 2019; Van Wilgen, 2025) and fires are classed as rare. The updated values, therefore, bring the data more into alignment with this concept. For this reason, the IPCC overlap splicing technique was applied to years 2000 – 2017 using 2018-2020 data to ensure time series-consistency. In future the new processing approach will be applied to years prior to 2018 and data will replace the spliced dataset.

In the previous inventory it was assumed that flooded lands and *Other lands* (barren land) do not burn due to the lack of vegetation. This assumption is carried through for barren land, but for flooded land it is assumed that the burning occurs on the converted land. Lastly, the MODIS burnt area data for forest plantations is replaced by ground based data on fires in forest plantations obtained from Forestry SA (https://forestry.co.za/industry-info/statistical-data/).

To estimate the burnt area per land conversion category, the fraction of the land class that was burnt was assumed to occur evenly across all conversions, so the fraction was applied to each land conversion area.

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6.4.7.2 Back extrapolation of burnt area data from 2000 to 1990

MODIS burnt area data is only available from 2001, therefore extrapolation is needed to extent the time series back to 1990. FAO provides data on burnt area for forests, savannas and grasslands from 1990 to 2023 (https://www.fao.org/faostat/en/#data/GI). The exact definitions of the various land categories may differ from FAO, however the total burnt area data for forest, savannas and grasslands shows a similar trend to that of forests, savannas and grasslands in this inventory (Figure 6.9). This data was therefore used as proxy data to extend the timeline for forests, savannas and grasslands back to 1990.

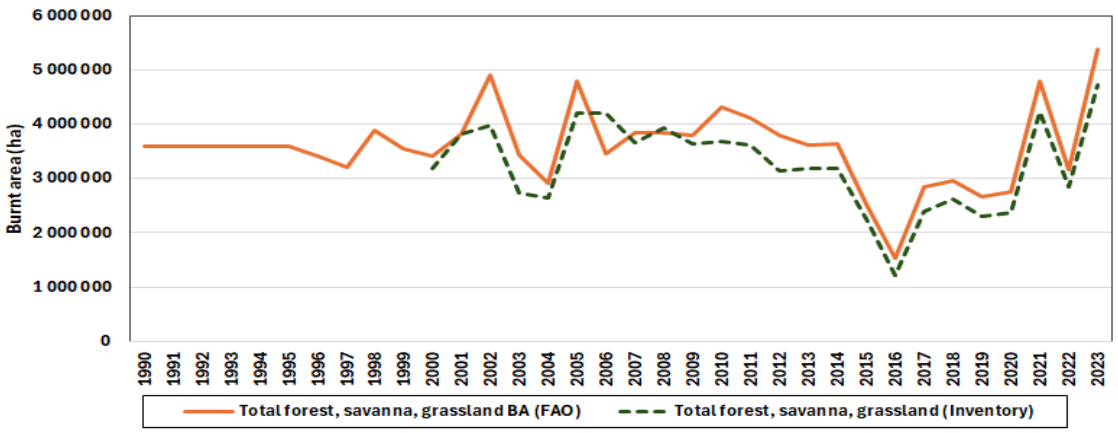


Figure 6.9: A comparison of MODIS and FAO burnt area data for forests, savannas and grasslands

As the category definitions are different between FAO and the SANLC data it was difficult to match the data for the specific categories. It was found that FAO forest burnt area trends were the same as burnt area trends for Indigenous forests and forest plantations combined. FAO shrubland burnt area had the same trends as the inventory low shrubland category. Comparing the savanna and grassland categories the differences were larger due to the different classifications, however the total savanna and grassland burnt area from FAO corresponded well to the savanna and grassland burnt inventory for the inventory. These groupings were therefore used with the IPCC overlap splicing technique to extend the timeseries to 1990. Splitting this aggregated data into the specific land categories was done by applying the average (2001-2005) ratio of the burnt area of that

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category to the total for the grouping by the total FAO burnt area total for that grouping. For forest plantations, ground-based data is available back to 1990, so this actual data is applied. Indigenous forest data was therefore the total FAO burnt area for forests and forest plantations minus the actual plantation burnt area data[28]. This was the approach for indigenous forests, forest plantations, thickets, woodlands, grasslands, low shrublands and eroded land. For all other land categories and average burnt area for the period 2001 to 2010 was applied to the years 1990-1999.

The resulting burnt area activity data for all land categories across the full time series (1990 – 2024) are provided in the relevant land category sections below.

6.4.7.3 Verification

Burnt area data was compared to those from the Meraka Institute (Meraka Institute, 2019) for 2014-2018 who also used the MODIS collection 6 data. The Meraka Institute dataset shows the same trend but the inventory burnt area estimates are about 20% higher than the Meraka Institute data. Data was also compared to the SASSCAL data[29] and again the annual burnt area trends are the same, with the inventory data being 3.2% lower than the SASSCAL burnt area data. Also discussed above, the burnt area for forests, savannas and grasslands was compared to the FAO data and the inventory data is on average 10.2% lower than the FAO data. Differences between the dataset are likely due to different processing methods and because the inventory data includes an overlay with soil and land cover data. The overlay process can lead to a small loss of burnt area due to the different resolutions of the input data sets. The inventory data is, however, within the ranges provided in the literature.

6.5 Country specific approaches

6.5.1 Approach for natural disturbance

The total emissions and removals reported for South Africa in this NID **include** natural disturbance. This is being clarified due to a recommendation made by the TERT (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L.5). The NDC on the other hand, sets out emission targets based on the emissions excluding natural disturbance. It is stipulated

[28] *It was found that the indigenous forest burnt area data for 1996-2000 was very high and was uncharacteristic as indigenous forests mostly do not burn. For this reason, the FAO proxy data for these years was replaced by an average burnt area for 2001-2010 as done for other categories. The FAO data for 1990-1996 was still higher than usual but left this data as is. This could perhaps be improved in future if other data becomes available.*

[29] *https://sasscal.org/wp-content/uploads/2024/06/SASSCAL-Burnt-area-20240603.pdf*

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that this separation is to be reported in the NID so this section explains the methodology used for separating out natural disturbance (for NDC purposes) and provides the relevant data for the NDC in Annex VII. The explanation of the methodology is also in response to the TERT recommendation (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L.5).

Natural disturbance includes all the emissions and removals associated with wildfires and any other non-anthropogenic events affecting forest plantations (such as losses due to storms, windthrow, animals and disease). There is insufficient data on other disturbances (besides fire) in the other land classes and so these are not included in the inventory or this natural disturbance.

Estimating the overall impact of natural disturbance involves estimating the biomass losses (which usually occur immediately) and subsequent gains (which usual occur over time) related to natural disturbance events. There is insufficient disaggregation at this stage to include DOM and SOC. The gains and losses are summed to obtain the overall impact of disturbances. This can then be subtracted from the overall LULUCF emissions (including natural disturbance).

The losses (emissions) due to natural disturbance include:

- Emissions of CH_4, N_2O, NO_x, CO and NMVOC from wildfires.
- Woody vegetation biomass losses (as CO_2) due to wildfires and other disturbances.

The gains are all the vegetation growth that occurs on the disturbed areas. The IPCC 2006 Guidelines indicates that the gains on that disturbed area are to be removed as part of natural disturbance until such time as the carbon returns to the original level. As South Africa does not track land parcels this becomes a bit more challenging, as some areas may burn more than once in the time that it takes to gain the carbon back. A land system to track land change and disturbance is included in the improvement plan (a recommendation from the TERT) but for now the gains have been estimated using a more simplistic approach. The following steps were followed:

- Estimate the amount of carbon lost on the burnt area per land class.
- Using the growth rates estimate the number of years it would take for the carbon to return to original levels.
- Allow the carbon to grow on the annual disturbed areas at the given growth rate for the determined number of years.
- After this any further gains are not included under natural disturbance but rather move to the main inventory of anthropogenic emissions and removals.

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This basic method uses the assumption that no burning occurs on a disturbed area that is recovering before it has reached the original carbon level. This assumption is most likely not realistic, and probably leads to an overestimation of the gains, but these assumptions will be improved once South Africa is able to track the fires and land use changes.

The inclusion of the removal of the subsequent gains on disturbed lands was not done in the previous inventory, therefore the overall LULUCF sink (excluding natural disturbance) (Figure 6.10) is reduced compared to that reporting the previous NID.

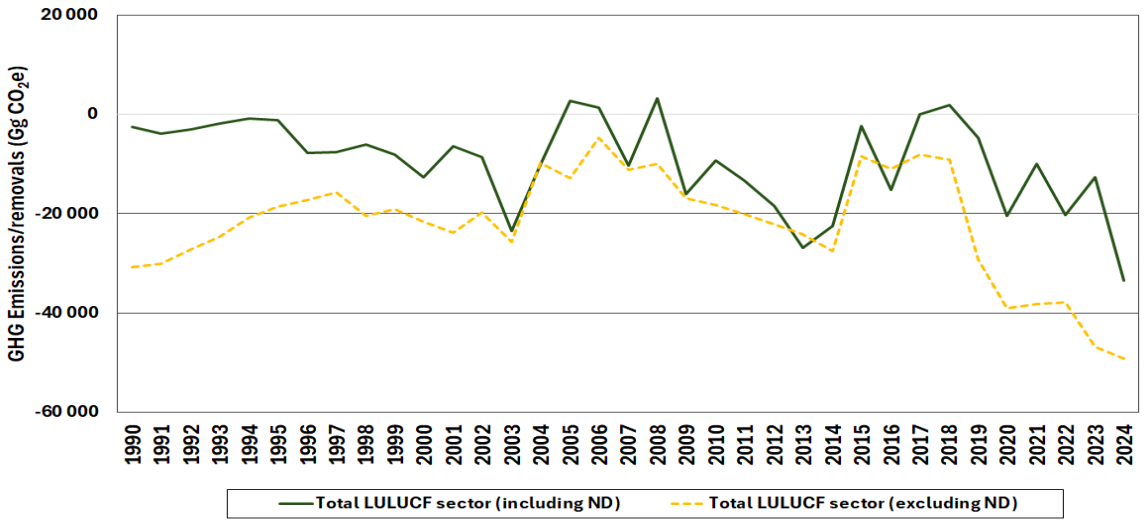


Figure 6.10: LULUCF sector sink with and without natural disturbance

6.5.2 Approach for harvested wood products

In this inventory the production approach was applied to estimate HWP emissions, but this was also compared to the other approaches (Atmospheric flow, Simple decay, Stock difference). The IPCC 2019 Refinement methodology was applied, which is largely the same as the IPCC 2006 Guidelines methodology, but it gives better guidance on the calculation of the initial carbon stock in the HWP pool. HWP in SWDS are not included in this inventory. The HWP estimates were compared to the emission estimates using the

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IPCC software which applies the IPCC 2006 Guidelines methodology. Details are provided in section 6.12.

6.6 Forest land (CRT 4.A.)

6.6.1 Category description

The *Forest land* category is subdivided into *Forest land remaining Forest land* (4.A.1) and *Land converted to Forest land* (4.A.2). Calculations were carried out based on a 20-year transition period in that once a land area is converted it remains in the converted land category for 20 years. Both sub-categories are key categories for CO_2 emissions and removals in terms of the level and trend assessment.

Emissions in *Forest land* include CO_2 emissions/removals from above- and below-ground biomass, litter, deadwood and mineral soils. Organic soil area in *Forest land* was not separated out due to a lack of data so all soils were treated as mineral soils. It also covers direct and indirect N_2O emissions from nitrogen inputs and mineralisation in mineral soils. Finally, it includes CH_4 and N_2O emissions from wildfires. Indirect emissions from wildfires were also estimated but these are reported under indirect CO_2 and N_2O in Chapter 8 of this report.

The *Forest land* category covers indigenous forests, forest plantations, thickets (including mangroves), and woodlands.

The *Forest land* is a sink of 55 037 Gg CO_2e in 2024, which is more than a 2-fold increase since 1990 (Table 6.23). Biomass is the dominant pool in 2024, followed by DOM. *Grasslands converted to Forest land* contributed the most towards the *Forest land* sink (Figure 6.11). The larger *Forest land remaining Forest land* emissions between 1990 and 2000 are related to the much higher burnt area estimates for this period. These values were extrapolated from FAO data and so another data source may need to be found to update or verify this data.

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Table 6.23: *Forest land* emissions for 1990 and 2024

Category	Pool	Gas	1990	2024	Change between 1990-2024 (%)
			Emissions (Gg CO_2e)	Emissions (Gg CO_2e)	
Forest land	All	All	-15 260	-55 037	260.7
Forest land	All	CO_2	-16 075	-55 744	246.8
Forest land	All	CH_4	487	399	-18.1
Forest land	All	N_2O	328	309	-5.9
Forest land remaining Forest land	All	All	20 235	8 487	-58.1
Land converted to Forest land	All	All	-35 495	-63 523	79.0
Forest land	Biomass	All	-7 645	-42 129	451.0
Forest land	DOM	All	-8 084	-12 508	54.7
Forest land	Mineral soil	All	-346	-1 107	220.1

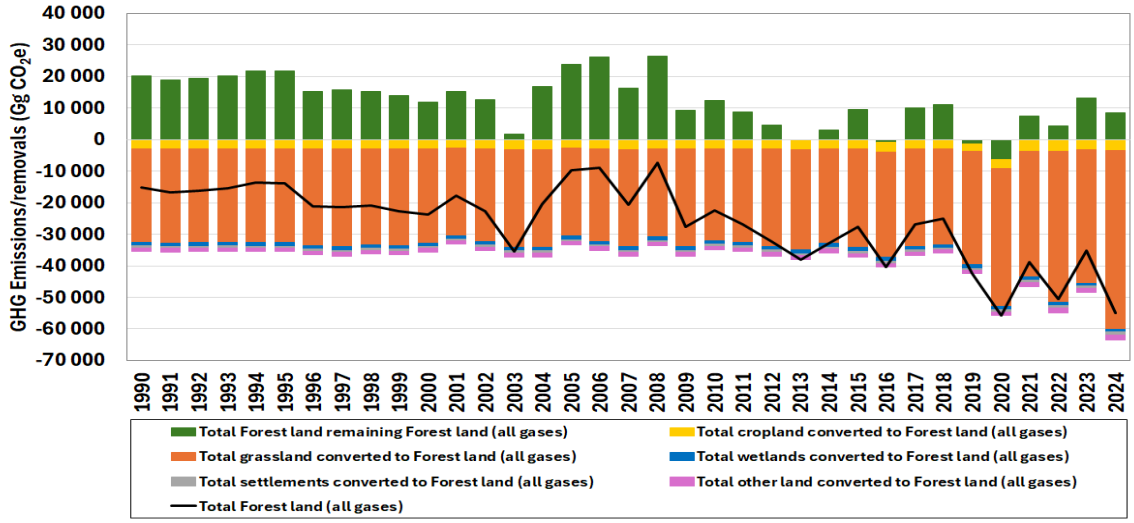


Figure 6.11: *Forest land* emission trends between 1990 and 2024

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6.6.2 Methodological issues

The methodologies and emission factors applied to *Forest lands* are provided in Table 6.24. In the previous inventory both *Forest land remaining Forest land* and *Land converted to Forest Land* were identified as key categories and, based on the IPCC decision tree, the Tier 2 approach is suitable for this category.

Table 6.24: Methodologies and EF applied for estimating emissions from *Forest land*

Category	Gas	Method used	Source of activity data	Emission factor used
Forest land remaining Forest land	CO_2	Tier 2	CS	CS
Forest land remaining Forest land	CH_4	Tier 1/Tier 2	CS	D
Forest land remaining Forest land	N_2O	Tier 1/Tier 2	CS	D
Land converted to Forest land	CO_2	Tier 2	CS	D/CS
Land converted to Forest land	CH_4	Tier 1/Tier 2	CS	D
Land converted to Forest land	N_2O	Tier 1/Tier 2	CS	D

(NO = Not occurring; NA = Not applicable; CS = Country specific; D = IPCC default)

The Stock-Difference approach was considered for forest plantations, but due to the fact that (a) detailed age-class population data from DFFE was only available from 2001 (therefore stock change data from 2002 only) and (b) land conversion losses were not fully incorporated into this methodology at this stage the Stock-Difference approach was used as verification and is discussed in more detail in section 6.6.5.

6.6.2.1 Land area activity data

The activity data was country specific land area data determined as outlined in section 6.3 with an Approach 2 methodology and included areas for both *Forest land remaining Forest land* and *Land converted to Forest land* (Table 6.25).

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Table 6.25: Country specific land areas (kha) (including 20-year transition period) for Forest land

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Forest land remaining Forest land	12 613	12 733	12 853	12 973	13 093	13 213	13 333	13 453	13 573
Land converted to Forest land	7 204	7 204	7 204	7 204	7 204	7 204	7 204	7 204	7 204
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Forest land remaining Forest land	13 693	13 813	13 933	14 053	14 173	14 293	14 413	14 533	14 653
Land converted to Forest land	7 204	7 204	7 204	7 204	7 204	7 204	7 204	7 204	7 204
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Forest land remaining Forest land	14 773	14 893	15 013	15 133	15 253	15 373	15 493	15 454	15 415
Land converted to Forest land	7 204	7 204	7 204	7 204	7 204	7 204	7 204	7 139	7 074
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Forest land remaining Forest land	15 377	15 338	15 059	14 780	14 046	13 312	13 087	12 862	
Land converted to Forest land	7 010	6 945	8 769	10 593	11 597	12 602	14 363	16 123	

6.6.2.2 Biomass gains

6.6.2.2.1 Indigenous forests, thickets and woodlands

In *Forest land remaining Forest land* the biomass gains were determined using the IPCC 2006 Guidelines gain-loss equations 2.9 and 2.10 with country specific data. Indigenous forests were divided into primary and secondary forest so that different growth rates and biomass data could be applied. There was no data on the area of primary forests and so in the last inventory protected area was used as a proxy for primary forests. On further investigation, this was likely an overestimate. Widespread logging was practiced during the mid-1800s to early 1900s (Fisher, 2024; Lawes, et al., 2007) and as a result these areas are classified as secondary forests. Very few primary forests remain in South Africa and protected areas include both primary and secondary forests (Fisher, 2024). Primary forest area was therefore assumed to be 10% of the indigenous forest area which is less than the protected area. All thickets and woodlands were assumed to be secondary forests.

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Parameters for estimating carbon gains were obtained from scientific literature. Indigenous forests were divided into the forest types provided in the 2006 SANBI Vegmap (Mucina, et al., 2007) and area weighted averages of the various factors were calculated for Indigenous forests in general. For thickets a similar weighting process was followed except that there was insufficient data for the numerous thicket types indicated in the Vegmap. There was data on Albany thickets, other thickets (areas obtained from SANLC map intersected with Vegmap) as well as Mangroves (as these are included within the Thicket/Dense bush class). Albany thickets were further divided into intact and degraded thickets assuming 52% of the area was degraded based on information from Carvalho, et al. (2022). The weighting for thickets was therefore based on these categories. For woodlands the two divisions provided in the SANLC maps, namely Dense forest and woodland, and Open woodland, were utilised. The resultant weighted averages are provided in Table 6.26 with additional background data in Annex V. Values are within the range of the IPCC 2019 Refinement default factors. The IPCC 2006 Guidelines default carbon fraction of 0.47 t C/t dm for all tree parts in tropical and subtropical vegetation (IPCC 2006, Volume 4, Chapter 4, Table 4.3) was applied.

Table 6.26: Forest land biomass growth parameters

Forest class	Forest age	Annual AGB growth (G_w) (t dm/ha/yr)		Ratio of BGB to AGB (t dm BGB/t dm AGB)	
		Factor applied	IPCC 2019 Refinement	Factor applied	IPCC 2019 Refinement
Indigenous forest	Primary	0.0	0.15[a]	0.25	0.23
	Secondary (>20yrs)	0.92	1.08[a]		
	Secondary (<20 yrs)	2.86	2.98[a]		
Thickets	Secondary (>20yrs)	1.18	1.08[a]	0.22	
	Secondary (<20 yrs)	2.92	2.98[a]		
Woodlands	Secondary (>20yrs)	0.77	1.08[a]	0.32	
	Secondary (<20 yrs)	1.31	2.98[a]		
	Herbaceous	NA	NA	0.5	

[a] *Weighted average based on climate zone areas*

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6.6.2.2.2 Forest plantations

As in the previous inventory the forest plantations were sub-divided into Eucalyptus sp., softwood sp., Acacia (wattle) and other plantation species. Softwoods were further divided into sawlogs, pulp and other as the growth and expansion factors of these forest plantations differed. *Eucalyptus grandis* and *Other Eucalyptus* species were separated.

For forest plantations a Tier 2 method as applied to calculate biomass gains. The plantation area provided in the land cover datasets is overestimated according to the Forestry SA data (FSA, 2019)[30], therefore in the calculation files a correction was made to the SANLC matrix data (section 6.3.3.2.4) to align the areas with the Forestry SA data (Table 6.27). At the time of completing this inventory forest plantation data was not available for 2020 onwards as there was no service provider to collect the data over this period. The years 2020 to 2024 were extrapolated using the IPCC extrapolation splicing technique and this was done per species. It is noted that this is a long extrapolation, however the data source (DFFE) has indicated that a service provider has been appointed, and data collection has resumed. It is therefore expected that in the next inventory there will be data that can be used to update this extrapolated period.

Table 6.27: Forest plantation area (kha) comparison

Plantation data	1990	1991	1992	1993	1994	1995	1996	1997	1998
FSA Plantation area	1 241	1 296	1 301	1 307	1 366	1 429	1 487	1 518	1 384
Applied forest plantation area	1 514	1 502	1 490	1 479	1 467	1 455	1 444	1 432	1 420
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
FSA Plantation area	1 402	1 331	1 352	1 351	1 372	1 339	1 334	1 282	1 266
Applied forest plantation area	1 409	1 397	1 385	1 373	1 362	1 350	1 338	1 327	1 315
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
FSA Plantation area	1 257	1 275	1 271	1 273	1 268	1 266	1 233	1 224	1 221
Applied forest plantation area	1 303	1 292	1 280	1 268	1 257	1 245	1 233	1 230	1 226
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
FSA Plantation area	1 212	1 192	1 195	1 183	1 174	1 165	1 157	1 148	
Applied forest plantation area	1 222	1 219	1 199	1 178	1 187	1 196	1 179	1 163	

[30] *Statistical Data - Forestry in South Africa*

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MAI curves were obtained from Forestry SA (FSA, 2019). The MAI at rotation age for each of the products (sawlogs, pulp, mining timber, poles and other uses) per each of the 5 plantations species (Pines, E.grandis, other Eucalyptus species, Wattle and other hardwood species) were weighted based on the area under production for each species and product. The overall MAI therefore varied slightly each year but data for 2024 is shown in Table 6.28.

The $BCEF_S$ values were calculated by using the equations given in Dovey et al. (2021) which estimates the $BCEF_S$ from the volume data. Stock volumes (m^3/ha) were determined from the MAI for each age class multiplied by the age of the stand. Age class data was obtained from DFFE Timber Statistics reports (DFFE, 2020). The $BCEF_I$ values were derived from the $BCEF_S$ data by analysing the IPCC 2006 Guidelines default values and applying a ratio for $BCER_I$ to $BCEF_S$. For softwood the $BCEF_I$ was determined to be 78% of the $BCEF_S$, while for the other species it was 60%. The age class area weighted $BCEF_S$ and $BCEF_I$ for 2024 are provided in Table 6.28 but the values did vary slightly from year to year due to the changes in the areas of the different species and the areas of each age class. The root to shoot ratios (du Toit, et al., 2016) were then applied to include the below-ground biomass.

The above-ground biomass data for forest plantations was determined from the age class and MAI data provided by Department of Forestry (DFFE, 2020). This data was utilised with the equations provided in (Dovey, et al., 2021) to determine the $BCEF_S$ values and the biomass (Table 6.28). Age class area weighted $BCEF_S$ and biomass values were calculated and these varied slightly across the years due to changes in species composition and age structure. The $BCEF_I$ values were determined by looking at the relationship between the $BCEF_S$ and $BCEF_I$ values in Table 4.5 of the IPCC 2006 Guidelines. The $BCEF_R$ were determined from the relationship between $BCEF_R$ and $BCEF_I$ provided in IPCC 2006 Guidelines (Vol. 4, Chapter 4, page 4.14).

Table 6.28: Factors applied for forest plantations in 2024 with IPCC default values for comparison

		Softwoods (e.g. Pines)	Eucalyptus grandis	Other Eucalyptus sp.	Acacia sp. (Wattles)	Other hardwood sp.
Mean annual increment (m^3/ha/yr)	Weighted average applied	15.6	17.9	18.3	9.9	18.5
	IPCC 2019 Refinement	12 - 18	18 - 24	12-14 (general) 22-28 (E.nitens)	10 - 12	
$BCEF_S$	Weighted average applied	0.90	0.60	1.09	0.71	0.98

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		Softwoods (e.g. Pines)	Eucalyptus grandis	Other Eucalyptus sp.	Acacia sp. (Wattles)	Other hardwood sp.
	IPCC 2006 default (temperate)	0.6 – 1.0	0.8 – 2.6	0.8 – 2.6	0.7 – 1.9	0.7 – 1.9
$BCEF_i$	Weighted average applied	0.71	0.63	0.65	0.64	0.66
	IPCC 2006 default (temperate)	0.6	1.3	1.3	0.9	0.9
$BCEF_R$	Weighted average applied	0.60	0.71	0.71	0.99	0.68
	IPCC 2006 default (temperate)	0.83	1.89	1.89	1.55	1.55
Ratio of BGB to AGB (t dm/t dm)	Weighted average applied	0.28	0.24	0.24	0.28	0.26
Above-ground biomass (t dm/har)	Weighted average applied	100.10	62.39	58.59	52.46	119.44
	IPCC 2019 Refinement	10-100 (SMS) 20 - 194 (TDF)	40 - 150 (SMS) 30 - 70 (TDF)			

SMS = Subtropical mountain system; TDF = Tropical dry forest

6.6.2.3 Biomass losses

Carbon losses in *Forest land* included wood removal, fuelwood collection, and losses due to other disturbances. Harvested wood was included for forest plantations, while fuelwood collection was estimated for all forest land and included under Woodlands as it was not possible to disaggregate it by forest type. All emissions from the burning of fuelwood for energy or heating purposes were reported as part of the energy sector. In forest plantations, disturbance from fires and other disturbances were included, while for all other subcategories only disturbance from fire was included due to a lack of data on other disturbances.

6.6.2.3.1 *Indigenous forests and thickets*

Biomass losses for indigenous forests and thickets only include losses from fires. These losses are determined using IPCC 2006 Guidelines equation 2.14, with the burnt area data (Table 6.29) coming from MODIS (see section 6.4.7). There is insufficient data to separate controlled fires from wildfires so all losses are included under wildfires.

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Table 6.29: Burnt area (ha) data for natural forests

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Indigenous forest	53 523	62 766	57 977	55 522	49 531	43 309	16 933	16 596	30 561
Thicket/Dense bush	60 340	60 340	60 340	60 340	60 340	60 340	53 183	48 475	56 736
Woodlands	707 939	707 939	707 939	707 939	707 939	707 939	623 972	568 733	665 659
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Indigenous forest	19 362	10 681	11 889	10 951	13 809	10 796	14 195	14 426	18 868
Thicket/Dense bush	53 442	49 732	63 125	78 341	47 082	48 442	83 196	64 895	75 769
Woodlands	627 009	746 504	1 073 551	937 745	359 586	672 691	1 135 776	986 575	567 677
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Indigenous forest	15 789	15 569	12 766	9 966	14 633	14 299	12 648	8 981	7 142
Thicket/Dense bush	83 361	60 618	74 075	58 397	74 911	60 485	76 478	42 118	25 405
Woodlands	1 025 122	675 485	951 624	869 381	700 735	546 601	835 283	551 254	148 941
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Indigenous forest	9 610	16 687	13 869	11 690	12 051	7 499	11 587	18 769	
Thicket/Dense bush	45 281	56 167	65 277	31 371	34 880	28 260	51 916	109 925	
Woodlands	437 810	432 481	518 064	388 709	1 030 627	641 708	1 729 159	1 026 898	

Above-ground biomass data (Table 6.30) was determined from scientific literature (Annex V.3) and weighted averages determined as outlined for biomass growth in section 6.6.2.2.1. The values for thickets are similar to the IPCC 2019 Refinement default values, whereas the indigenous forest values are higher and woodland values are lower. It is expected that the woodland value is lower as this includes open woodlands (savannas) which are not always included under *Forest land*. The indigenous forest values were, however, quite a bit higher than the IPCC 2019 Refinement default vales. This value has been checked, and information comes from more than one study (see Annex V) so it is assumed to be more accurate than the default value. The data will continue to be updated as more data becomes available. Indigenous forests make up around 2% of the *Forest land* area. Root losses were also included (Table 6.30).

There is no country specific data on the fraction of biomass lost (*fd*) during the fire disturbance, so the combustion fractions provided by 2019 Refinements of the IPCC 2006 Guidelines were used as a proxy. For indigenous forests and thickets the value of 0.45 for all other temperate forests was applied and this was combined with the IPCC default carbon fraction of 0.47.

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Table 6.30: Above-ground biomass data for natural forests

Forest class	Forest age	AGB (B_w) (t dm/ha/yr)	
		Factor applied	IPCC 2019 default
Indigenous forest	Primary	497.7	78.60[a]
	Secondary (>20yrs)	239.8	67.32[a]
	Secondary (<20 yrs)	29.8	
Thickets/ Dense bush	Secondary (>20yrs)	58.02	
	Secondary (<20 yrs)	14.93	
Woodlands	Secondary (>20yrs)	35.83	
	Secondary (<20 yrs)	18.2	
	Herbaceous	4.8	

6.6.2.3.2 Woodlands

Biomass losses for woodlands include disturbances losses from fires and losses due to fuelwood collection.

Fire disturbance losses are estimated as for indigenous forests and tickets/dense bush by combining burnt area (section 6.4.7; Table 6.29), above-ground biomass (Table 6.30), root ratio (Table 6.30), an fd value of 0.45 and carbon fraction of 0.47. An improvement in this inventory was the separation of controlled fires. This was based on a recommendation from the TERT (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L.5). Controlled burns are carried out in the Kruger National Park (KNP) for veld management purposes, and these were the controlled fires included in this inventory. There may be other sources however there is no sustainable data for controlled fire data, so this is a first attempt at including these estimates. Setting up a system for the collection of controlled fire data has been included in the improvement list. Annual area of controlled fires burnt in the KNP were determined from literature which indicates 16-22% of the park (1 948.5 kha) burns and 25-50% of this is due to natural causes (van Wilgen, et al., 2000; van Wilgen, et al., 2008; van Wilgen, 2025), while the rest is due to management.

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This area was subtracted from the total woodland wildfire burnt area (Table 6.29) and allocated to controlled fires.

Fuelwood losses are estimated using IPCC 2006 Guidelines equation 2.13 where all wood is removed as tree parts. The amount of fuelwood removed is estimated from the number of households and an average annual household fuelwood consumption rate. There is insufficient data to distribute the fuelwood removal to the different forest land classes, so it is all allocated to woodlands as these are the dominant areas where wood is sourced from. All losses due to fuelwood collection are allocated to the *Forest land remaining forest land* as there was insufficient data to provide a split on the losses between remaining and converted lands.

The amount of fuelwood collected was determined from the number of households using fuelwood for cooking and heating (StatsSA, 2025). It was assumed that there is overlap between the houses that use wood for heating and cooking and so the higher value (households for heating) was taken to be the total number of households using wood. An average household fuel wood consumption rate of 3.5 t per household per year (Twine & Holdo, 2016; Shackleton, et al., 2022) and an average wood density of 0.65 t dm/m^3 was applied to estimate the volume of fuelwood used (Table 6.31).

Table 6.31: Estimated volume (m^3) of fuelwood extracted from Woodlands

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Fuelwood volume	12 736 068	12 526 428	12 316 788	12 107 149	11 897 509	11 687 869	11 478 229	11 268 590	11 058 950
	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fuelwood volume	10 849 310	10 639 670	10 430 030	10 206 000	10 510 500	10 500 000	9 145 500	9 208 500	9 117 500
	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fuelwood volume	10 230 500	9 443 000	10 024 000	7 738 063	8 025 500	6 433 000	6 121 500	5 999 000	6 083 000
	2017	2018	2019	2020	2021	2022	2023	2024	
Fuelwood volume	6 881 000	6 299 776	6 569 927	6 667 540	6 870 039	7 072 921	7 275 037	7 196 812	

The number of households using wood was only available from 2002 onwards. The FAOSTAT fuelwood bioenergy consumption data was converted to volume of fuelwood consumed by applying a conversion factor (NCV for wood) of 17 MJ/kg (DEA, 2017) to get the mass of wood and then applied the average wood density value to obtain volume of wood. These derived fuelwood consumption values were very similar to the fuelwood

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determined from household number and showed the same trend. This data extended back to 1990 and therefore the IPCC overlap splicing techniques was used with this data set to extrapolate the data back to 1990.

6.6.2.3.3 Forest plantations

Losses from forest plantations include both harvest losses and disturbance losses. Disturbance losses include losses from fires (both natural and human-induced fires such as arson and accidental fires) and other disturbances such as insect and animal disturbance losses. Emissions from *Harvested wood products* were included under 4.G.

Loss of carbon from harvested wood was estimated from the IPCC 2006 Guidelines equation 2.12. Harvested wood data (Table 6.32) was obtained from Timber Statistics report from the Department of Forestry at DFFE (DFFE, 2020) and from Forestry SA (Oberholzer, 2021). The industry conversion factors provided by Forestry SA[31] were used to convert between tonnes and m^3. Biomass data, $BCEF_R$ and root ratios are provided in Table 6.28. The harvested wood included the wood used for fuelwood and charcoal as it is all removed as whole trees. All losses due to harvesting were allocated to *Forest land remaining forest land* as it was assumed that recently converted land would not be harvested due to the longer harvest cycle. As indicated in the gains section above, plantation data was only available up to 2019, and a linear extrapolation technique was used (per species and wood use) for the remaining years. Once the new data becomes available these values will be updated and this is on the improvement list for the next inventory.

Table 6.32: Forest plantation carbon loss activity data

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Harvested wood volume (m3)	15 962 700	15 766 983	15 982 226	15 919 850	17 163 207	17 037 252	18 191 221	18 559 363	15 553 778
Fire disturbance area (ha)	15 923	6 680	11 469	13 924	19 915	26 137	11 733	13 901	8 276
Other disturbance area (ha)	8 855	4 068	15 233	22 527	10 532	10 773	6 387	8 738	5 029
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Harvested wood volume (m3)	15 839 028	16 680 299	16 606 874	16 619 310	19 205 509	20 311 189	21 979 338	22 827 192	20 330 501

[31] *South African Forestry & Forestry Products Industry Facts 1980-2019 (Statistical Data - Forestry in South Africa)*

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Fire disturbance area (ha)	16 455	20 221	17 266	16 727	28 983	28 326	22 445	28 895	70 697
Other disturbance area (ha)	5 488	2 925	2 776	2 022	3 766	12 904	19 498	23 827	26 896
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Harvested wood volume (m3)	20 137 591	18 887 579	17 514 015	18 517 492	18 196 071	17 846 463	16 865 916	17 897 483	16 442 017
Fire disturbance area (ha)	70 812	19 805	15 812	15 348	9 599	21 297	16 486	11 962	14 222
Other disturbance area (ha)	6 338	3 003	7 445	24 830	8 516	5 230	3 301	19 233	13 580
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Harvested wood volume (m3)	18 332 661	18 683 137	16 599 681	14 271 073	16 128 115	17 129 211	16 393 525	16 393 525	
Fire disturbance area (ha)	16 145	17 266	12 195	15 033	15 033	15 033	15 033	15 033	
Other disturbance area (ha)	9 537	12 177	6 208	11 006	11 006	11 006	11 006	11 006	

Disturbance losses are estimated using IPCC 2006 Guidelines equation 2.14. Fire and other disturbance losses were included separately. The forest plantation area that was burnt by fires or was disturbed by other disturbances was obtained from Forestry SA[32] (Table 6.32) and this was split by hardwoods and softwood. For the years 2020 to 2024 a 10-year average was applied for disturbances, and these are expected to be updated in future once new data becomes available. Disturbed area is provided for the total area of each species and in order to split this into land remaining land and land converted to forests the fraction of disturbed area was calculated and applied to the land remaining and the converted land areas.

Fire disturbance included both controlled and wildfire estimates. In Forestry SA annual presentations for 2012 to 2019 (Oberholzer, 2021) the source of the fires is indicated to be arson, accidental, natural and unknow with percentages being provided. Natural fires constitute 10%-32% of the fires, however the source of a large portion (39-47%) of fires is not known. If it is assumed that maybe half of this is natural fires, then natural fires would account for 25%-50% (average of 36%) of the planted forest burnt area provided by Forestry SA. The rest of the area is allocated to controlled burns.

The $BCEF_R$, root ratios and biomass values are provided in Table 6.28.

[32] *South African Forestry & Forestry Products Industry Facts 1980-2019 (Statistical Data - Forestry in South Africa)*

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Forestry SA data reports on the severity of the disturbance, therefore disturbance matrices were developed for disturbances where there was (a) slight damage, (b) serious damage but where wood was salvaged and (c) severe damage where all biomass was lost. For slight damage it was assumed that half of the non-utilisable biomass would be burnt. The non-utilisable component was determined from the Dovey et al. (2021) equation for hardwoods and softwoods. In the case where there was serious damage but wood was salvaged it was assumed that all the non-utilisable biomass and an additional 10% was lost, while for severe damage with no recovery it was assumed all biomass was lost. The overall average fraction (*fd*) of plantation biomass lost to fires and other disturbances was 0.661 and 0.363, respectively. Losses due to disturbance were calculated for both the *Forest land remaining forest land* and *land converted to forest land* by applying the percentage disturbance area to each of the land sub-categories.

6.6.2.4 Gains and losses due to land conversions

The same methodology was applied to all forest categories. The IPCC 2006 Guidelines equations 2.15 and 20.16 were utilised for estimating emissions from biomass changes on converted land. The conversions also included conversions between forest types but then these losses were included under the "land remaining" category. The biomass changes in *Land converted to Forest lands* involves the determination of gains and losses, but also initial biomass changes due to the conversion. Biomass gains and losses for land converted from other land types to forest lands are calculated as for *Forest lands remaining forest lands* (described above). These gains and losses were incorporated into IPCC 2006 Guidelines equation 2.15 along with the initial change in biomass carbon stocks on the converted land determined with IPCC 2006 Guidelines equation 2.16.

The carbon stocks on the land before conversion were determined from above- and below-ground biomass data provided in the relevant land category sections. Land being converted to forest plantations is assumed to be cleared and therefore the biomass values immediately after conversion were assumed to be zero. For land being converted to the natural forest land classes (indigenous forests, thickets and woodlands) it was assumed that there was no abrupt change, unless it was a conversion from a higher biomass category.

6.6.2.5 Deadwood and litter

The DOM pool for *Forest lands* includes both deadwood and litter. In the previous inventory the DOM category for *Forest land remaining Forest land* was determined to be a key category. According to the IPCC decision tree, a Tier 2 approach should be used for this category. In this Tier 2 Gain-loss approach the change in carbon stocks are estimated

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from the average annual transfer of biomass into and out of the DOM pool due to annual processes and disturbances (IPCC 2006 Guidelines equation 2.18). This approach was investigated during this inventory. Most of the data is available for determining biomass transfer into the DOM pool (IPCC 2006 Guidelines equations 2.20 – 2.22), but mortality rate data is very limited for the various forest categories (particularly for natural forest classes). In addition, there was a lack of data on the decay and disturbance losses out of the DOM pool. For these reasons the Tier 2 approach could not be fully implemented, and further data collection would be required to implement this approach. A Tier 1 approach was therefore applied in this inventory, and the Tier 2 approach was incorporated into the improvement plan.

The Tier 1 approach assumes there is no change in DOM in *Forest land remaining forest land*. Change, however, does occur where one forest type is converted to another and these changes are included under "land remaining" but are estimated as described for land conversions.

Changes in the DOM pool in converted land was estimated using IPCC 2006 Guidelines equation 2.23. The initial DOM is given in the relevant land category section, and the final DOM for the forest land types is shown in Table 6.33. Litter and deadwood data was obtained from scientific literature and the weighted average approach described for biomass was again applied to get an average litter and deadwood value for each forest category. If there is a gain in DOM this is assumed to occur over the 20-year default period, while losses are assumed to occur within the year of conversion (Tier 1).

The deadwood and litter data is generally in range of the IPCC 2019 Refinement default values, however the deadwood value for woodlands is very low. The Woodland category does include open woodlands which would have a lower value than is provided by IPCC. It is also considered that a lot of the deadwood in this forest category gets collected for fuelwood and could therefore be the reason for the lower value. If the Tier 2 approach is applied, which accounts for DOM inflow and outflow then this estimate may improve. Data comparison with the National Terrestrial Carbon Sinks Assessment (NTCSA) data, does however shows a lower value for Woodlands which supports the data used in this inventory.

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Table 6.33: Deadwood and litter data for the various forest land categories

	Average value applied		Comparison with other data			
			NTCSA	IPCC 2019 Refinement		
	Deadwood (t C/ha)	Litter (t C/ha)	DOM (t C/ha)	Deadwood (t C/ha)	Litter (t C/ha)	Forest type#
Indigenous forests	6.12	3.82	9.93	13.2 (0.2 - 43.8)	8.7 (1.2 - 24.0)	Subtropical humid forest
				10.67	4.95	Weighted average
Thickets	7.71	3.54	4.99	9.0 (1.3 – 17.3)	2.4 (2.1 – 2.7)	Tropical dry forest
				8.88	3.53	Weighted average
Woodlands	0.59	1.36	2.16	9.0 (1.3 – 17.3)	2.4 (2.1 – 2.7)	Tropical dry forest
				6.26	1.65	Weighted average
Forest plantations	9.00	2.40	4.81	11.8 (7.2 – 16.3)	NA	Subtropical mountain system
				10.54	1.91	Weighted average

Plantations The first forest type is the dominant ecozone for each forest category (see section 6.3.4.3) while the weighted average is the IPCC default average weighted by ecozone area in each forest type.

6.6.2.6 Soil carbon

6.6.2.6.1 Mineral soils

Soil carbon changes were estimated for all forest categories as described in sections 6.3.4.1 and 6.4.3.1. The IPCC 2006 Guidelines default stock change factor of 1 was applied for indigenous forests, woodlands and forest plantations, while for thickets (which are shown to be degraded) a value of 0.95 (moderately degraded) was applied for management regime.

6.6.2.6.2 Organic soils

Organic soils were not separated from mineral soils for *Forest lands*, therefore all soils were included under mineral soils.

6.6.2.7 Direct and indirect N_2O from N inputs

Nitrogen is not applied to the natural forest classes (indigenous forests, thickets, woodlands), however it is known that forest plantations are fertilised when they are

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planted. Through the GHG Reporting Regulations (DFFE, 2016) some forest plantation companies are required to report data to the SAGERS system, and this includes information on fertiliser use. This system has, however, only been operating since 2021 so data is only available for 3 years. This data was extracted and an average application rate per ha per year was obtained and applied to the area of forest plantations. It is assumed that it is a once off application when trees are planted. This value will be improved once more data becomes available, but it is not a high priority as fertiliser use in forest plantations is very small.

Direct N_2O emissions were estimated by combining the amount of nitrogen applied was combined with the IPCC 2019 Refinement default average emission factor for synthetic fertilisers (0.01 kg N_2O-N/kg N) in IPCC 2006 Guidelines equation 11.1. Indirect emissions from atmospheric deposition of N volatilised from managed soils were determined with equation 11.9, a $Frac_{GASF}$ of 0.11 kg N volatilised/kg N applied (IPCC 2019 Refinement, Chapter 11, Table 11.3) and an emission factor of 0.01 kg N_2O-N/(kg NH_3-N + NO_x -N volatilised) (IPCC 2019 Refinement, Chapter 11, Table 11.3). Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

6.6.2.8 Emissions and removals from drainage and rewetting

There is no data on the area of drained or rewetted *Forest land* soils, therefore these emissions were not estimated.

6.6.2.9 Direct and indirect N_2O from N mineralisation/immobilisation

Direct N_2O from N mineralisation/immobilisation associated with loss of soil carbon from soil organic matter as a result of changes to land use were incorporated through the application of the IPCC 2006 Guidelines equations 11.1 and 11.8. The annual loss of carbon due to land use change comes from analysis described in section 6.6.2.6.1 and the C:N ratio of 12.5 was obtained from IPCC 2006 Guidelines (average of 10 and 15). The IPCC 2019 Refinement emission factor was 0.01 kg N_2O-N/kg N.

Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

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6.6.2.10 Non-CO_2 emissions from biomass burning

Biomass burning emissions were identified as a key category in the previous inventory and therefore a Tier 2 approach is, according to IPCC decision tree, recommended. In this inventory, even though the emission factors were taken from the IPCC 2006 Guidelines, more specific fuel loads and combustion factors were applied (Tier 2). The CO_2 emissions from biomass burning were incorporated as disturbance losses in the gain-loss method described above. This category therefore only includes the emissions of CH_4 and N_2O emissions. Emissions were also estimated for CO, NO_x and NMVOCs but these are not reported here but rather under the section on Indirect emissions (Chapter 8).

Emissions were estimated with IPCC 2006 Guidelines equation 2.27. Burnt areas are provided in Table 6.29 and Table 6.32, and the division of data into controlled and wildfires in woodlands is described in section 6.6.2.3.2. Emission factors from IPCC 2006 Guidelines Table 2.5 were applied (Extra tropical forest values for indigenous forests, thickets and forest plantations; Savana values for woodlands). A NMVOC emission factor of 30 g/kg dm burnt for indigenous forests, thickets and forest plantations, and 3.4 g/kg dm burnt for savannas was taken from the literature (Andreae, 2019).

Indigenous forests were estimated with a fuel load of 76 t dm/ha which was derived from IPCC 2006 Guidelines fuel density and combustion factors for "All secondary tropical forests" in Tables 2.4 and 2.6. A combustion fraction of 0.4 was taken from an earlier inventory (DEA, 1999). The thicket fuel load (1.4 t dm/ha) was derived from the literature, along with a combustion factor of 0.95 (DEA, 1999). Fuel load (6.69 t dm/ha) and combustion factor (0.75) for woodlands were derived from literature data using a weighting approach based on the area of the different woodland types as described in the biomass section (data shown in Annex V). These values were found to be comparable to the IPCC 2006 Guidelines default values. For forest plantations the fuel loads were equivalent to the biomass data for the various species, with a combustion factor of 0.63 (IPCC 2006 Guidelines, Table 2.6, Eucalyptus forest).

6.6.3 Uncertainty

Uncertainties were provided for individual factors, based on literature and the IPCC 2006/2019 Refinement Guideline default values, and are combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

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6.6.3.1 Activity data uncertainty

Uncertainty for the land areas were provided by the SANLC data accuracy assessments (DFFE, 2021). The mapped areas of indigenous forests, thickets, woodlands and forest plantations have uncertainties of ±16%, ±21%, ±26% and ±12%, respectively. An additional 5% was added to this for indigenous forests and forest plantations, and 10% for woodlands and thickets to account for uncertainty on the corrections. The uncertainty for converted areas was taken to be the combined uncertainty (applying the propagation of errors as indicated in IPCC 2006 Guidelines) for the two land areas. The results of this approach indicate the converted lands had a higher uncertainty than the individual land types as was to be expected. Mapped areas for land converted to Forest land had an estimated uncertainty of 57.3%.

Harvested wood uncertainty is around ±2% (expert opinion) as the forestry companies measure the harvested wood so it is fairly accurate data. The uncertainty lies in whether all the harvested wood is accounted for as not all small growers report to Forestry SA. The fuelwood removal data is very uncertain as it was determined from household statistics on number of households using wood (±5.6% uncertainty for rural households and ±3.2% for urban households based on Shackelton et al., 2022), a single wood density value (±5% based on data from IPCC 2006 Guidelines) and an average household wood consumption value (±40% based on Shackelton et al., 2022). The burnt area data determined from MODIS collection 6 has an uncertainty of <6% (Boschetti et al., 2021) and the soil maps are estimated to have an uncertainty of ±10%. The overall activity data uncertainty for forest land remaining forest land was estimated at ±42.3% and ±58.7% for land converted to forest land.

6.6.3.2 Emission factor uncertainty

The uncertainty on biomass gains was estimated from uncertainties and data ranges provided in the scientific literature and IPCC 2006 Guidelines and 2019 Refinement. The BCEF and root to shoot ratios had uncertainties of ±20% and ±30% respectively. Carbon fraction uncertainty is ±6% (IPCC, 2006). In terms of carbon losses, the wood density value is estimated to have an uncertainty of around 5% based on data provided in IPCC 2006 Guidelines. Since the DOM and SOC data have greater uncertainty than the biomass data an uncertainty of ±20% is assigned to these categories. The CO_2 emission factor uncertainty for Forest lands was estimated at ±57%, while for land converted to forest lands it was ±62%.

For CH_4 and N_2O biomass burning emission factors have uncertainties of ±40% and ±47% respectively for forest lands. Direct emission factors for inputs (of N and FSOM) to

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managed soils have, based on defaults from IPCC 2019 Refinement, uncertainties of -90% and +80%, while indirect emissions for volatilisation and leaching are ±80% and -100% to +82% respectively.

6.6.4 Time-series consistency

The land change maps had some inconsistency in that there was a switch from Landsat to Sentinel data between 2014 and 2018, however some corrections were made to bring these two datasets into alignment. All other datasets were consistent through the time-series, using the same methodology and data sources. The calculations are consistent over time and complete for the entire reporting period (1990-2024).

6.6.5 Category specific QA/QC and verification

Forest plantation area and harvest data is compared to FAO data.

Forest plantation emissions were estimated with the Stock-Difference approach for verification. Age class data for the 5 plantation species groups (Pines, Eucalyptus grandis, Other Eucalyptus species, Acia species, and Other hardwood species) was obtained from DFFE Timber Statistics reports (DFFE, 2020). Data was available for 2001 to 2019. MAI curves for each species (obtained from Forestry SA) were used to determine MAI at each age. Stock volume was estimated from the MAI and age of the trees. The stock volume was combined with the BCEFs value (determine for each species and age class using the equation provided by Dovey et al., 2021) to estimate carbon biomass stock per age class. These were then added to determine the total carbon stock per year.

As the carbon stock is determined from area, it does not actually account for losses due to damage (fire or other disturbances). Disturbances losses, as determined for the Gain-Loss method, were therefore subtracted from the total carbon stock to get the overall carbon stock per species per year.

The change in carbon stock was then determined by subtracting the initial year carbon stock from the final year carbon stock. The area of forest plantations changes from year to year therefore an area correction[33], as described by IPCC, was applied. Ideally the area should be the same and then the carbon gains or losses due to land conversions in that area are accounted for. The area correction means that only the plantation area is being considered and so the gains and losses due to land conversion to/from other land classes

[33] *Area corrected carbon stock difference = ((Final carbon stock/Final plantation area) - (Initial carbon stock/Initial plantation area)) x Final plantation area.*

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is not accounted for. This is one area where the Gain-loss and Stock-difference approach applied in this inventory differ and is one of the reasons why the Gain-loss method was included in the inventory instead of the Stock-difference.

The carbon change determined by the Stock-Difference method had a similar trend to the estimates based on the Gain-Loss method, except that there were some variations between years (Figure 6.12). It is noted that between 2008 and 2016 there seems to be a mismatch in the years but there is no clear explanation for this. The Stock-difference method shows a sharp decline in carbon in 2012 and increase in 2013 which is not seen in the Gain-loss data. These peaks are due to large changes in temporarily unplanted (TUP) area. Effectively the carbon losses in the Stock-difference method are based on the area of TUP, whereas in the Gain-loss method the amount of wood harvested is taken into account. The harvested wood and the TUP area show differing patterns which causes much of the variation between the Gain-loss and Stock-difference method.

Overall, the two methods produce values in a similar range, but the differences will be explored further in the next inventory.

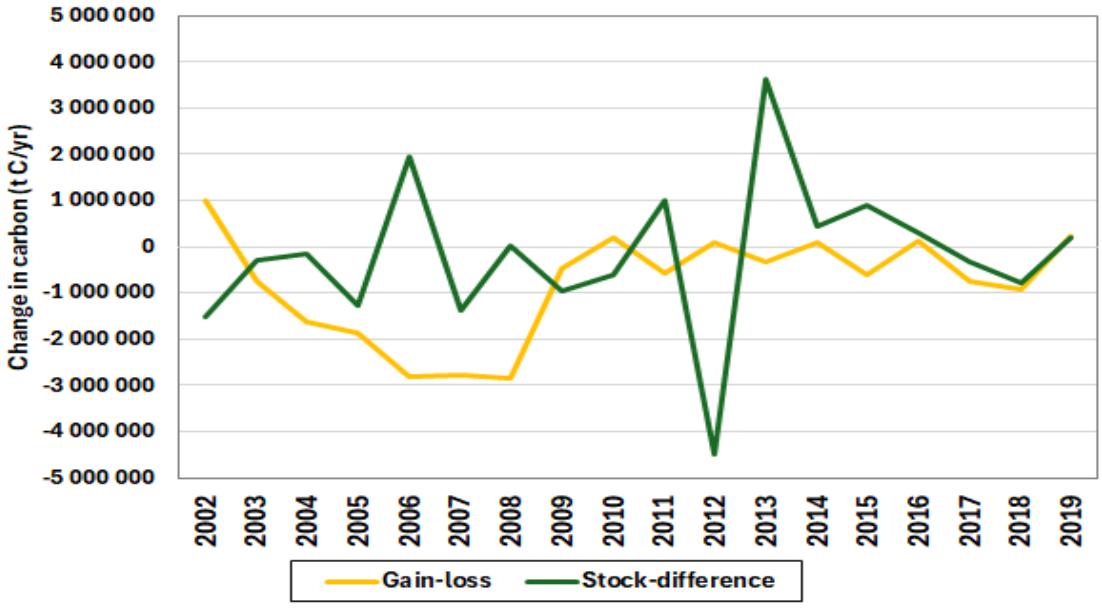


Figure 6.12: Carbon change for plantations estimated by the Gain-loss and Stock-difference methods

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6.6.6 Category-specific recalculations

The following main improvements led to a recalculation of the *Forest land* emission estimates:

- Inclusion of 2020-2022 land change maps.
- Updated land change matrix corrections for change in technology between 2014 and 2018, and wet and dry season variations.
- Removal of error from 2014 onwards (mentioned in last inventory) relating to a correction for land conversions on already converted land.
- Updated methodology for estimating burnt area per land class.
- Incorporation of soil type map overlay with 2014-2018, 2018-2020 and 2020-2022 land cover maps.
- Updated biomass, deadwood and litter carbon data.
- Updated assumption for primary and secondary forest division.
- Updated household fuelwood consumption data.
- Inclusion of direct and indirect N_2O emissions from N inputs and N mineralisation.

The recalculated emission estimates for *Forest land* show an average sink reduction of 42.3% between 2000 and 2022, with this percentage varying from year to year. The 2021 and 2022 estimates were reduced by 39.2% (25 095 Gg CO_2e) and 38.7% (31 884 Gg CO_2e) respectively compared to the previous submission.

6.6.7 Category-specific planned improvements

There are no additional category specific improvements beyond those mentioned in section 6.1.6.

6.7 Croplands (CRT 4.B)

6.7.1 Category description

The *Cropland* category is subdivided into *Cropland remaining Cropland* (4.B.1) and *Land converted to Cropland* (4.B.2). Calculations are carried out based on a 20-year transition period in that once a land area is converted it remains in the converted land category for 20 years.

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Emissions in *Croplands* include CO_2 emissions/removals from above- and below-ground biomass, litter, and mineral soils. It also includes CH_4 emissions from drained organic soils. In keeping with the IPCC 2006 Guidelines (IPCC, 2006) direct and indirect N_2O emissions from nitrogen inputs, mineralisation in mineral soils and drained organic soils are reported under Agriculture (CRT 3.D.1) and are listed as "IE" in the LULUCF sector. Finally, it includes CH_4 and N_2O emissions from wildfires. Indirect emissions from wildfires are also estimated but these are reported under indirect CO_2 and N_2O in Chapter 8.

The *Cropland* category covers perennial crops (orchards and vineyards) and annual crops (pivot irrigation, non-pivot and subsistence crops).

The *Cropland* category is an overall source of 8 311 Gg CO_2e in 2024, which is a 27.3% increase since 1990 (Table 6.34). Most of the emissions come from land conversions and biomass is the dominant pool in 2024. *Grasslands converted to Cropland* and *Forest land converted to Cropland* are the largest contributors to the emissions (Figure 6.13). There was a doubling of emissions between 2018 and 2019. This was due to an increased conversion of woodlands to annual croplands during this period. These emissions drop back down in 2021.

Table 6.34: *Cropland* emissions for 1990 and 2024

Category	Pool	Gas	1990	2024	Change between 1990-2024 (%)
			Emissions (Gg CO_2e)	Emissions (Gg CO_2e)	
Cropland	All	All	6 531	8 311	27.3
Cropland	All	CO_2	6 352	8 084	27.3
Cropland	All	CH_4	57	71	24.6
Cropland	All	N_2O	122	157	28.0
Cropland remaining Cropland	All	All	747	336	-55.0
Land converted to Cropland	All	All	5 784	7 975	37.9
Cropland	Biomass	All	3 013	4 118	36.7
Cropland	DOM	All	386	148	-61.7
Cropland	Mineral soil	All	2 953	3 818	29.3

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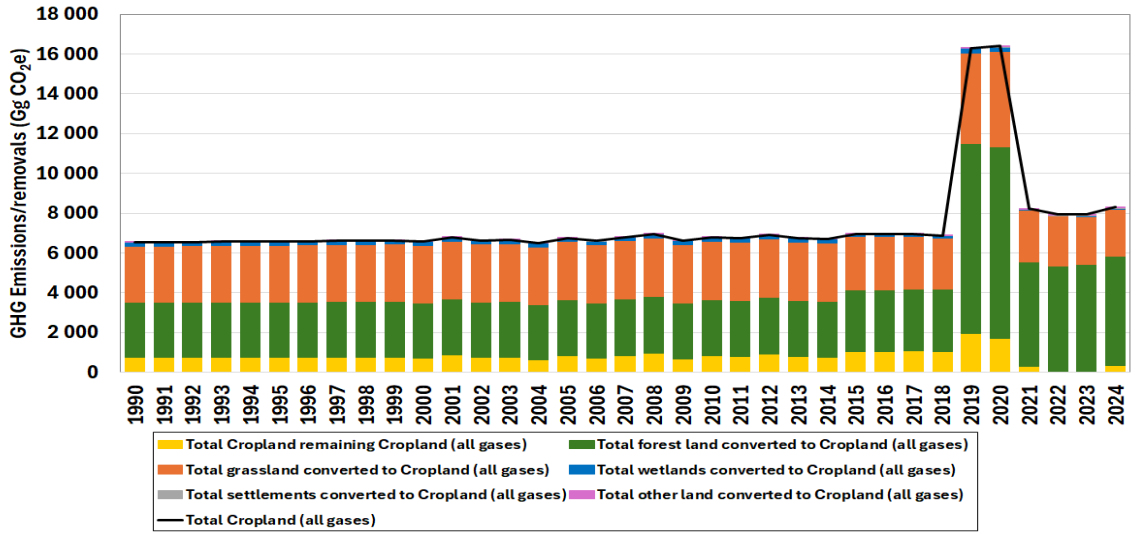


Figure 6.13: *Cropland* emission trends, 1990-2024

6.7.2 Methodological issues

The methodologies and emission factors utilised for *Croplands* are shown in Table 6.35. In the previous inventory *Grassland converted to Cropland* was identified as a key category for all carbon pools and these are calculated using a Tier 2 methodology. This is consistent with IPCC decision tree on the appropriate methods to apply.

Table 6.35: Methodologies and EF applied for estimating emissions from *Cropland*

Category	Gas	Method used	Source of activity data	Emission factor used
Cropland remaining Cropland	CO_2	Tier 1/Tier 2	CS	D/CS
Cropland remaining Cropland	CH_4	Tier 1/Tier 2	CS	D
Cropland remaining Cropland	N_2O	Tier 1/Tier 2	CS	D/CS
Land converted to Cropland	CO_2	Tier 2	CS	D/CS
Land converted to Cropland	CH_4	Tier 1/Tier 2	CS	D
Land converted to Cropland	N_2O	Tier 1/Tier 2	CS	D

(NO = Not occurring; NA = Not applicable; CS = Country specific; D = IPCC default)

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6.7.2.1 Land area activity data

The activity data was country specific land area data determined as outlined in section 6.3 with an Approach 2 methodology and included areas for both *Cropland remaining Cropland* and *Land converted to Cropland* (Table 6.36).

Table 6.36: Country specific land areas (kha) (including 20-year transition period) for *Croplands*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Cropland remaining Cropland	12 759	12 744	12 728	12 713	12 698	12 683	12 668	12 653	12 637
Land converted to Cropland	1 400	1 406	1 411	1 416	1 421	1 427	1 432	1 437	1 442
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Cropland remaining Cropland	12 622	12 607	12 592	12 577	12 561	12 546	12 531	12 516	12 501
Land converted to Cropland	1 448	1 453	1 458	1 464	1 469	1 474	1 479	1 485	1 490
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Cropland remaining Cropland	12 485	12 470	12 460	12 450	12 440	12 431	12 421	12 412	12 403
Land converted to Cropland	1 495	1 500	1 500	1 500	1 500	1 500	1 500	1 487	1 474
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Cropland remaining Cropland	12 395	12 386	12 348	12 310	12 360	12 410	12 460	12 510	
Land converted to Cropland	1 460	1 447	1 650	1 853	1 838	1 824	1 809	1 795	

6.7.2.2 Biomass gains

6.7.2.2.1 Annual crops (pivot, non-pivot and subsistence crops)

A Tier 1 approach was applied for annual crops where the increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year. A Tier 1 approach is appropriate as *Croplands remaining croplands* were not identified as a key category in the previous inventory. Where there was conversion

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between the *Cropland* categories these biomass changes were calculated as described for land conversions, but the emissions were reported under *Croplands remaining croplands*.

6.7.2.2.2 Perennial crops (orchards and vines)

Biomass gains for perennial crops were estimated with IPCC 2006 Guidelines equation 2.9 and 2.10. Above-ground biomass growth rates were determined by dividing the above-ground biomass ((DEA, 2015) by the maturity cycle (30 years). Root to shoot ratios are provided in Table 6.37.

6.7.2.3 Biomass losses

6.7.2.3.1 Annual crops (pivot, non-pivot and subsistence crops)

As there were no gains in these classes, no losses were accounted for either. If there were conversions between different cropland categories, then these losses were determined as described for converted lands and included here.

6.7.2.3.2 Perennial crops (orchards and vines)

Losses accounted were those from biomass burning and harvest losses. For harvest losses the maturity cycle was 30 years and so the area was divided by 30 to divide the crops into age classes. Every year it was assumed then that the oldest age class was harvested. All harvest losses were allocated to *Cropland remaining cropland*.

Biomass losses for perennial crops were determined using IPCC 2006 Guidelines equation 2.14, with the burnt area data (Table 6.38) coming from MODIS (see section 6.4.7), biomass data provided in Table 6.37, an *fd* value of 0.85 (IPCC 2006 Guidelines, Table 2.6, Other crops) and a carbon fraction of 0.5. Annual crop burning losses are not included due to the assumption of equivalence, in addition any burning in annual crops are assumed to be due to residue burning which falls under the Agriculture sector (3.F).

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Table 6.37: Biomass and growth factors for the various cropland categories

	Inventory biomass data						IPCC 2019 Refinement	
	AGB (t dm/ha)	Data source	Root to shoot ratio	Data source	Total biomass (t dm/ha)	Biomass growth rate (t dm/ha/yr)	Biomass (t dm/ha)	Biomass accumulation rate (t dm/ha/yr)
Orchards	76.0	(DEA, 2015)	0.42	(Scandellari, et al., 2016)	107.9	2.53	55.5 – 148.7 (AGB, Table 5.1, temperate)	1.9 – 5.0 (Table 5.1, temperate)
Vineyards	28.0	(DEA, 2015)	0.42	(Zhang, et al., 2021)	39.8	0.93		
Annual non-pivot crops	8.1	Area weighted average calculated from production, yield and harvest index data (DLRRD, 2022; Stats SA, 2021; DEA, 2015)	0.20	Varies slightly for each crop type (IPCC 2019 Refinement) and this was an area weighted average	9.72	NA	9.4 (Total biomass, Table 5.9, annual crops)	NA
Annual pivot crops								
Subsistence crops	4.1	Assumed to be 50% of commercial			7.8			

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Table 6.38: Burnt area (ha) data for perennial crops

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Orchards	2 263	2 274	2 284	2 295	2 305	2 315	2 326	2 336	2 347
Vineyards	486	489	493	496	499	503	506	509	512
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Orchards	2 357	1 503	2 890	2 196	2 248	1 237	2 788	1 722	2 993
Vineyards	516	2 541	1 674	405	634	159	440	616	296
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Orchards	3 815	1 629	2 737	2 137	3 501	2 437	2 175	1 989	1 949
Vineyards	222	333	552	1 891	449	537	204	953	921
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Orchards	2 096	1 852	3 649	2 367	3 833	1 919	1 955	4 060	
Vineyards	1 137	560	742	433	2 230	1 254	182	967	

6.7.2.4 Gains and losses due to land conversions

The same methodology was applied to all cropland categories. The IPCC 2006 Guidelines equations 2.15 and 2.16 were utilised for estimating emissions from biomass changes on converted land. The conversions also included conversions between cropland types but then these losses were included under the "land remaining" category.

A tier 2 approach was adopted where the initial change in biomass carbon stocks on the converted land was added to the equation. Carbon gains and losses were calculated as for *Cropland remaining cropland* (described above) with only the woody perennial crops being included. Losses were also only for fire disturbance. The carbon stock change due to the removal of biomass from the initial land use (i.e. $\Delta C_{CONVERSION}$) was only calculated for the area of lands undergoing a conversion in a given year, and in subsequent years it was zero.

The carbon stocks on the land before conversion were determined from above- and below-ground biomass data provided in the relevant land category sections. The biomass stocks immediately after conversion were assumed to be zero, as it is assumed all land is cleared before being converted to cropland. A default period of 20 years is applied to carbon stock increases for perennial crops (i.e. it was assumed the carbon stock will increase from the initial carbon stock to the final carbon stock over a period of 20 years). For annual crops, in the previous inventory 1 years' worth of growth was included for the converted area, but this growth was removed due to the assumption of equivalence. This was checked against the IPCC 2006 software. This was also the case for losses in annual crops.

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All carbon losses were assumed to occur within the year of conversion. For perennial crop the loss occurred across the total converted land area instead of the annual converted area.

6.7.2.5 *Litter*

The DOM pool for *Croplands* was not identified as a key category in the previous inventory, so a Tier 1 methodology was applied. The Tier 1 assumption for the litter pool in *Cropland remaining cropland* was that the stocks are not changing over time, therefore litter changes are reported to be zero. This was applied to areas where the crop type did not change, however, there were conversions between the various crops and these were treated as converted land areas.

Changes in the DOM pool in converted land was estimated using IPCC 2006 Guidelines equation 2.23. The initial DOM is given in the relevant land category section, and the final DOM for the cropland types is shown in Table 6.39. The litter data was sourced from the NTCSA (DEA, 2015) which provides spatial carbon density maps. These maps were intersected with the SANLC data to provide an area averaged estimate of the litter for each crop type. If there was a gain in DOM this was assumed to occur over the 20-year default period, while losses were assumed to occur within the year of conversion (Tier 1).

Table 6.39: Litter data for *Croplands*

Crop category	Litter (t C/ha)	Reference
Annual non-pivot crops	1.36	NTCSA (DEA, 2015)
Annual pivot crops	1.09	
Subsistence crops	0.54	
Orchards	3.20	
Vineyards	4.60	

6.7.2.6 *Soil carbon*

6.7.2.6.1 *Mineral soils*

Soil carbon changes were estimated for all *Cropland* categories as described in sections 6.3.4.1 and 6.4.3.

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For perennial crops (orchards and vines) the IPCC 2019 Refinement default stock change factors of 0.72, 1 (full till) and 1 (medium input) were applied for land use, management and input respectively. This was based on information provided in Moeletsi et al. (2015).

For annual crops (pivot, non-pivot) the land use stock change factor of 0.76 was applied (IPCC 2019 Refinement, Table 5.5, Long-term cultivation in warm temperate dry conditions). There was also a small area of cropland on inland wetland mineral soil and for this area the land use stock change factor was 0.71 (IPCC 2013 Wetland Supplement, Chapter 5, Table 5.3). The stock change factors for management, input and land use were determined from data reported in literature (Moeletsi, et al., 2015; Tongwane, et al., 2016). The management and input data for each crop type was combined with the IPCC 2019 Refinement default stock change factors and climate data to determine the stock change factors for each crop type. The IPCC 2019 Refinement data was selected as it has greater disaggregation than the 2006 Guidelines. These factors were assumed to remain constant throughout the time-period due to a lack of annual management data. A weighted average based on crop area was then determined for annual crops. Crop areas were obtained from DALRRD, national statistics (Statistics SA), Crop Estimates Committee, and FAO. The weighted average did not vary significantly across the years and the values in 2024 were 0.76, 1 and 0.96 for land use, management and input respectively.

The combined stock change factor of 0.58 was utilised for subsistence crops (DEFF, 2020).

6.7.2.6.2 Organic soils

The determination of the organic soil area in *Croplands* is described in section 6.4.3.2. The CO_2 emissions from drained organic soils is however not reported in this category (4.B) but under emissions from drainage and rewetting of mineral and organic soils in croplands (4(II).B). This category is therefore reported as included elsewhere (IE).

6.7.2.7 Direct and indirect N_2O from N inputs

All direct and indirect emissions of N_2O from nitrogen fertiliser inputs to *Croplands* are not included in the LULUCF sector, but rather in the Agriculture sector (3.D.1 & 3.D.2). These are therefore reported as IE in this section.

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6.7.2.8 *Emissions and removals from drainage and rewetting*

Drained organic soil area for *Croplands* was obtained from FAOSTAT (Table 6.40). The IPCC 2013 Wetland Supplement methodology for CO_2 emissions (equations 2.3 – 2.5) and CH_4 emissions (equation 2.6) were utilised to estimate emissions from drained soils.

Table 6.40: Drained organic soil area (ha) for *Croplands*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Cropland drained organic soil	3 391	3 391	3 391	3 391	3 391	3 382	3 385	3 390	3 456
	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cropland drained organic soil	3 582	3 645	3 667	3 883	4 205	4 272	4 281	4 281	4 276
	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cropland drained organic soil	4 283	4 286	4 290	4 290	4 290	4 296	4 317	4 317	4 317
	2017	2018	2019	2020	2021	2022	2023	2024	
Cropland drained organic soil	4 317	4 323	4 175	4 175	4 173	4 173	4 173	4 173	

CO_2 emissions from drained soil included on-site and off-site emissions on drained soils (IPCC 2013 Wetland Supplement, equation 2.2). A Tier 1 approach for on-site CO_2 emissions (equation 2.3) involved combining the drained organic soil area with an emission factor of 5.3 t C/ha/yr (IPCC 2013 Wetland Supplement, Table 2.1). Off-site emissions (equation 2.4) used an emission factor of 0.31 t C/ha/yr (IPCC 2013 Wetland Supplement, Table 2.2). CO_2 emissions from fires on drained soils were not included as burnt area for drained soils could not be separated from the total cropland burnt. The CO_2 emissions will therefore be slightly underestimated. Emission factors were selected based on a temperate, dry climate.

CH_4 emissions from drained soils were estimated with IPCC 2013 Wetland Supplement equation 2.6. The area of ditches is not known so an average fraction of 0.5 is assumed for ditches (IPCC 2013 Wetland Supplement, Table 2.4). The drained area was combined with this fraction and default emission factors for drained organic soils (0 kg CH_4/ha/yr) and drained ditches (1 165 kg CH_4/ha/yr) from the IPCC 2013 Wetland Supplement Tables 2.3 and 2.4 respectively. Emission factors were selected based on a temperate, dry climate.

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N_2O emissions from drained organic soils were not included in this sector but rather in the Agriculture sector (3.D.1.f).

6.7.2.9 Direct and indirect N_2O from N mineralisation/immobilisation

Direct N_2O from N mineralisation/immobilisation associated with loss of soil carbon from soil organic matter as a result of changes to land use were incorporated through the application of the IPCC 2006 Guidelines equations 11.1 and 11.8. The annual loss of carbon due to land use change comes from analysis described in section 6.6.2.6.1 and C:N ratios were obtained from IPCC 2006 Guidelines. The C:N ratio of 15 was applied for *Forest land* or *Grassland* to *Cropland* conversions and 12.5 for all other land use changes. The IPCC 2019 Refinement emission factor was 0.01 kg N_2O-N/kg N.

Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

6.7.2.10 Non-CO_2 emissions from biomass burning

Biomass burning emissions were identified as a key category in the previous inventory and therefore a Tier 2 approach is, according to IPCC decision tree, recommended. In this inventory, even though the emission factors were taken from the IPCC 2006 Guidelines, more specific fuel loads and combustion factors were applied (Tier 2). This section only includes emissions for perennial crops (orchards and vines) as the burning that occurs in annual crops is assumed to be due to crop residue burning and these emissions are included in the Agriculture sector (3.F). The CO_2 emissions from biomass burning were incorporated as disturbance losses in the gain-loss method described above. This category therefore only includes the emissions of CH_4 and N_2O emissions. Emissions were also estimated for CO, NO_x and NMVOCs but these are not reported here but rather under the section on Indirect emissions (Chapter 8).

Emissions were estimated with IPCC 2006 Guidelines equation 2.27. Burnt areas are provided in Table 6.38. Emission factors from IPCC 2006 Guidelines Table 2.5 were applied (Agricultural residues) along with a NMVOC emission factor of 7.6 g/kg dm burnt (Andreae, 2019). The biomass consumption for perennial crops was 7 t dm/ha (DAFF, 2010).

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6.7.3 Uncertainty

Uncertainties were provided for individual factors, based on literature and the IPCC 2006/2019 Refinement Guideline default values, and are combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

6.7.3.1 Activity data uncertainty

Uncertainty for the land areas were provided by the SANLC data accuracy assessments (DFFE, 2021). Cropland areas are determined from crop boundary data so uncertainty is low (±2-9%). An additional 2% was added to this for uncertainty on the mapped area corrections. This uncertainty is lower than *Forest lands* and *Grasslands* as minimal corrections were made to land use areas. The uncertainty for converted areas was taken to be the combined uncertainty (applying the propagation of errors as indicated in IPCC 2006 Guidelines) for the two land areas. The results of this approach indicate the converted lands had a higher uncertainty than the individual land types as was to be expected. Mapped areas for land converted to Cropland had an estimated uncertainty of 39.2%.

The burnt area data determined from MODIS collection 6 has an uncertainty of <6% (Boschetti et al., 2021) and the soil maps were estimated to have an uncertainty of ±10%. The overall activity data uncertainty for cropland remaining cropland was estimated at ±21.7%. For land converted to cropland the uncertainty was estimated at ±40.9%.

6.7.3.2 Emission factor uncertainty

Biomass data was determined from actual yield and production data from commercial crops so has a small uncertainty for the individual crops (estimates at ±5%) but the average value over all crops had a slightly higher uncertainty (±10%). Disturbance losses in industrialised countries have a default uncertainty of ±15%, so a ±20% uncertainty was assumed. Root to shoot ratios have a ±30% uncertainty and carbon fraction uncertainty is ±6% (IPCC, 2006). Litter and SOC data have greater uncertainty than the biomass data, particularly since they were derived from the NTCSA overlay, and therefore an uncertainty of ±20% was assumed for these categories. The CO_2 emission factor uncertainty for *Croplands* was estimated at ±40.3%, while for land converted to grasslands it was ±53.2%.

For CH_4 and N_2O biomass burning emission factors have uncertainties of ±40% and ±47% respectively for Croplands. Direct emission factors for inputs (of N and FSOM) to managed soils have, based on defaults from 2019 Refinement, uncertainties of -90% and

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+80%, while indirect emissions for volatilisation and leaching are ±80% and -100% to +82% respectively. Drainage and rewetting CH_4 and N_2O emission factors have an uncertainty of +71.2% and +58.1%.

6.7.4 Time-series consistency

The land change maps had some inconsistency in that there was a switch from Landsat to Sentinel data between 2014 and 2018, however some corrections were made to bring these two datasets into alignment. All other datasets were consistent through the time-series, using the same methodology and data sources. The calculations are consistent over time and complete for the entire reporting period (1990-2024).

6.7.5 Category specific QA/QC and verification

There were no category specific QA/QC checks over and above what was described in section 6.1.5.

6.7.6 Category-specific recalculations

The following main improvements led to a recalculation of the *Cropland* emission estimates:

- Inclusion 2020-2022 land change map.
- Updated land change matrix corrections for change in technology between 2014 and 2018, and wet and dry season variations.
- Removal of error from 2014 onwards (mentioned in last inventory) relating to a correction for land conversions on already converted land.
- Updated methodology for estimating burnt area per land class.
- Incorporation of soil type map overlay with 2014-2018, 2018-2020 and 2020-2022 land cover maps.
- Updated biomass, deadwood and litter carbon data.
- Inclusion of drained organic soils and their emissions.
- Removal of one years' worth of growth and losses for converted annual crops.

The recalculated emission estimates for *Croplands* show an increase in the emissions across the time-series. The 2021 and 2022 estimates have doubled (increased by 4 626 Gg CO_2e and 4 163 Gg CO_2e respectively) compared to the previous submission.

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6.7.7 Category-specific planned improvements

There are no planned improvements for *Croplands* beside the improvements that will come through the development of the overarching land mapping system (see section 6.1.6.

6.8 Grasslands (CRT 4.C)

6.8.1 Category description

The *Grassland* category is subdivided into *Grassland remaining Grassland* (4.C.1) and *Land converted to Grassland* (4.C.2). Calculations are carried out based on a 20-year transition period in that once a land area is converted it remains in the converted land category for 20 years. Both sub-categories are key categories for CO_2 emissions and removals in terms of the level and trend assessment.

Emissions in *Grasslands* include CO_2 emissions/removals from above- and below-ground biomass, litter, mineral and organic soils. It also includes CH_4 emissions from drained organic soils and direct and indirect N_2O emissions from mineralisation in mineral soils. In keeping with the IPCC 2006 Guidelines (IPCC, 2006) direct and indirect N_2O emissions from drained organic soils are reported under Agriculture (CRT 3.D.1) and are listed as "IE" in the LULUCF sector. There was insufficient data to include N_2O emissions from nitrogen inputs. Finally, it includes CH_4 and N_2O emissions from wildfires. Indirect emissions from wildfires are also estimated but these are reported under indirect CO_2 and N_2O in Chapter 8 of this report.

The *Grassland* category covers grasslands (which includes pastures and rangelands), low shrublands, eroded land as well as the newly added subantarctic tundra.

The *Grassland* category emitted 3 918 Gg CO_2e in 2024, which is up from the 1 404 Gg CO_2e in 1990 (Table 6.41). DOM is the dominant pool but soils are also an important sink. *Grasslands remaining grasslands* are a large sink while the *Land converted to Grasslands* is an almost equal source. *Forest land converted to Grasslands* is responsible for the source, while conversions of *Croplands* and *Other lands to Grasslands* are sinks (Figure 6.14). The annual variation across the times-series is relatively small because of the Tier 1 assumption of equivalence in grasslands remaining grasslands. This reduces the annual variation which is usually brought about by biomass burning. There are large increases

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in the sources and sinks between the land change mapping periods and this is due to changes in the annual land conversions.

Table 6.41: *Grassland* emissions for 1990 and 2024

Category	Pool	Gas	1990	2024	Change between 1990-2024 (%)
			Emissions (Gg CO_2e)	Emissions (Gg CO_2e)	
Grassland	All	All	1 404	3 918	179.0
Grassland	All	CO_2	575	3 048	430.1
Grassland	All	CH_4	489	519	6.1
Grassland	All	N_2O	340	351	3.3
Grassland remaining Grassland	All	All	-5 963	-14 683	146.2
Land converted to Grassland	All	All	7 368	18 601	152.5
Grassland	Biomass	All	619	978	58.0
Grassland	DOM	All	2 869	4 492	56.6
Grassland	Mineral soil	All	-2 913	-2 423	-16.8

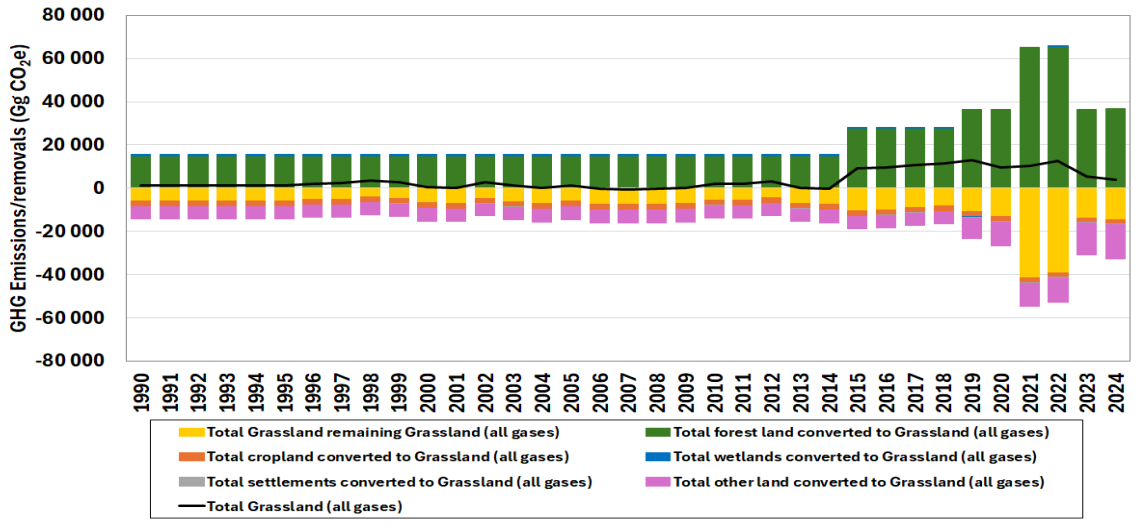


Figure 6.14: *Grassland* emission trends, 1990-2024

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6.8.2 Methodological issues

The methodologies and emission factors applied for *Grasslands* are provided in Table 6.42. In the previous inventory *Grassland remaining Grassland* (biomass) and *Land converted to Grasslands* (all carbon pools) were identified as key categories. Land conversions were calculated with a Tier 2 approach which is consistent with the IPCC decision tree (IPCC 2006 Guidelines, Figure 2.2), however only Tier 1 approach could be used for *Grassland remaining Grassland* due to a lack of data. As the land map data gets improved sources of additional data for disaggregation of *Grasslands* will be considered.

Table 6.42: Methodologies and EF applied for estimating emissions from *Grasslands*

Category	Gas	Method used	Source of activity data	Emission factor used
Grassland remaining Grassland	CO_2	Tier 1/Tier 2	CS	D/CS
Grassland remaining Grassland	CH_4	Tier 1/Tier 2	CS	D
Grassland remaining Grassland	N_2O	Tier 1/Tier 2	CS	D
Land converted to Grassland	CO_2	Tier 2	CS	D/CS
Land converted to Grassland	CH_4	Tier 1/Tier 2	CS	D
Land converted to Grassland	N_2O	Tier 1/Tier 2	CS	D

(NO = Not occurring; NA = Not applicable; CS = Country specific; D = IPCC default)

6.8.2.1 Land area activity data

The activity data was country specific land area data determined as outlined in section 6.3 with an Approach 2 methodology and included areas for both *Grassland remaining Grassland* and *Land converted to Grassland* (Table 6.43).

Table 6.43: Country specific land areas (kha) (including 20-year transition period) for *Grasslands*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Grassland remaining Grassland	60 439	60 389	60 338	60 288	60 238	60 187	60 137	60 087	60 036
Land converted to Grassland	8 926	8 926	8 926	8 926	8 926	8 926	8 926	8 926	8 926

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	1999	2000	2001	2002	2003	2004	2005	2006	2007
Grassland remaining Grassland	59 986	59 935	59 885	59 835	59 784	59 734	59 683	59 633	59 583
Land converted to Grassland	8 926	8 926	8 926	8 926	8 926	8 926	8 926	8 926	8 926
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Grassland remaining Grassland	59 532	59 482	59 432	59 381	59 331	59 280	59 230	59 196	59 162
Land converted to Grassland	8 926	8 926	8 926	8 926	8 926	8 926	8 926	9 041	9 156
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Grassland remaining Grassland	59 128	59 095	57 038	54 982	53 781	52 581	50 676	48 771	
Land converted to Grassland	9 271	9 386	10 510	11 634	13 023	14 413	15 529	16 644	

6.8.2.2 Biomass gains

6.8.2.2.1 Grasslands, Eroded land and Subantarctic tundra

A Tier 1 assumption of equivalence was applied to the grassland, eroded land and subantarctic tundra classes within the *Grassland* category as these have no woody components. Where there was conversion between the *Grassland* categories these biomass changes were calculated as described for land conversions, but the emissions were reported under *Grasslands remaining grasslands*.

6.8.2.2.2 Low shrublands

The low shrubland class includes a woody component as it includes the fynbos and karoo vegetation. The karoo vegetation has very small growth rates and so it was suggested in in a UNFCCC review that these could be considered in equilibrium but the fynbos has a higher growth rate. As *Grasslands remaining grasslands* were identified as a key category in the previous inventory more data was sought for this vegetation class. The SANLC data showed the area of fynbos, succulent karoo and nama karoo in this low shrubland category. The fraction of the total low shrubland area covered by these classes was determined from the SANLC maps (1990, 2014, 2018, 2020, 2022) and then linearly extrapolated between these points to complete the time series. This was used to estimate the area of each subclass.

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Using scientific literature as a source, biomass data was split into woody and herbaceous component and area weighted biomass, root to shoot ratios, growth rates, etc were determined for the low shrubland class (Table 6.44). Biomass gains for low shrublands were estimated with IPCC 2006 Guidelines equation 2.9 and 2.10.

Table 6.44: Biomass factors for grassland categories

	Woody AGB (t dm/ha)	Herbaceous biomass (t dm/ha)	Woody AGB growth (t dm/ha)	Ratio of BGB to AGB (woody)	Ratio of BGB to AGB (herbaceous)	Litter (t C/ha)	Deadwood (t C/ha)
Low shrubland[#]	7.07 (18.22)	0.35 (0.18)	0.72 (2.5)	0.26	1.19 (1.68)	0.35	2.1
IPCC 2019 Refinement (Shrubland)	48.4	NA	0.2-1.6	NA	2.8	NA	NA
Grasslands	NA	2.0	NA	NA	2.6	0.73	NA
IPCC 2006 (Semi-arid grasslands)	NA	1.6	NA	NA	2.8	NA	NA

[#] *The weighted average is shown with the Fynbos value in brackets.*

6.8.2.3 Biomass losses

6.8.2.3.1 Grasslands, eroded lands and subantarctic tundra

As no gains were included for *Grasslands remaining grasslands* no losses were included either. If there were conversions between different grassland categories, then these losses were determined as described for converted lands and included here.

6.8.2.3.2 Low shrublands

Biomass losses for low shrublands are determined using IPCC 2006 Guidelines equation 2.14, with the burnt area data (Table 6.45) coming from MODIS (see section 6.4.7). No burnt area data was available for the Subantarctic tundra as there are no land cover maps for the overseas territories. Burnt area and biomass data was combined with a *fd* of 0.91 and a carbon fraction of 0.47.

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Table 6.45: Burnt area (ha) data for *Grasslands*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Grasslands	2 260 677	2 260 677	2 260 677	2 260 677	2 260 677	2 260 677	1 992 544	1 816 147	2 125 663
Eroded land	3 435	3 435	3 435	3 435	3 435	3 435	3 027	2 759	3 229
Low shrublands	207 219	207 219	207 219	207 219	207 219	207 219	264 832	284 092	359 112
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Grasslands	2 002 241	2 211 087	2 531 164	2 611 302	2 097 613	1 777 414	2 762 240	3 039 324	2 871 773
Eroded land	3 042	4 767	4 315	4 969	1 462	4 391	5 379	6 504	989
Low shrublands	317 429	135 861	108 708	308 469	188 215	110 258	185 802	65 620	57 571
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Grasslands	2 667 606	2 761 543	2 375 424	2 413 849	2 013 447	2 427 910	2 153 523	1 525 175	855 746
Eroded land	4 629	3 005	4 044	6 822	2 899	2 891	2 513	1 766	387
Low shrublands	70 038	97 548	244 729	234 960	332 804	120 579	83 302	116 318	157 802
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Grasslands	1 659 196	1 857 947	1 583 629	1 870 800	2 907 928	1 709 207	2 869 169	2 394 056	
Eroded land	2 241	2 507	2 228	2 730	7 984	1 785	4 437	4 266	
Low shrublands	216 942	246 259	99 491	46 956	222 887	453 421	48 284	145 389	

6.8.2.4 Gains and losses due to land conversions

Land converted to grassland was identified as a key category in the previous inventory with the level and trend assessment and therefore a Tier 2 approach (IPCC 2006 Guidelines equations 2.15 and 2.16) was applied. For *land converted to grasslands* carbon gains and losses were only calculated for the woody low shrubland component., while in annual grasslands carbon stocks were assumed to be in balance and not included in the annual gain calculation.

The carbon stock change due to the removal of biomass from the initial land use (i.e. $\Delta C_{CONVERSION}$) was only calculated for the area of lands undergoing a conversion in a given year, and in subsequent years it was zero. The biomass values for the initial land types are given in the relevant land category sections, while biomass data for the grassland categories are provided in Table 6.44. It was assumed that only croplands and forest

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plantations were cleared before being converted to a grassland, while all other conversions were slow transitions and not abrupt changes. Converted lands remain in the converted category for a period of 20 years.

6.8.2.5 *Litter and deadwood*

The DOM pool for *Grasslands remaining grasslands* was identified as a key category in the previous inventory, however there is a lack of data to allow for movement to a Tier 2. A Tier 1 methodology was therefore applied and the collection of DOM data for Grasslands was included in the improvement list.

The Tier 1 assumption for the DOM pool was that the stocks in *Grasslands remaining grasslands* were not changing over time, therefore litter changes were reported to be zero. This was applied to areas where the grassland category did not change, however, there were conversions between the various grassland categories, and these were treated as converted lands.

Changes in the DOM pool in converted land was estimated using IPCC 2006 Guidelines equation 2.23. The initial DOM is given in the relevant land category section, and the final DOM for the grassland types is shown in Table 6.46. The litter data for grasslands was sourced from the NTCSA (DEA, 2015) which provides spatial carbon density maps. These maps were intersected with the SANLC data to provide an area averaged estimate of the litter for the grassland category. The Low shrubland category included fynbos which has a woody component, therefore deadwood was included in this DOM pool. Litter and deadwood values for Low shrublands were derived from IPCC 2019 refinement data for the various ecozones and an area based weighted average was determined based on the percentage area in each ecozone (methodology described in section 6.3.4.3. If there was a gain in DOM this is assumed to occur over the 20-year default period, while losses are assumed to occur within the year of conversion (Tier 1).

Table 6.46: DOM data for *Grasslands*

Grassland category	Litter (t C/ha)	Deadwood (t C/ha)	Reference
Grasslands	0.73		NTCSA (DEA, 2015)
Low shrublands	0.35	2.10	Weighted average IPCC 2019 Refinement values
Eroded land	0		Assumed to be zero

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6.8.2.6 Soil carbon

6.8.2.6.1 Mineral soils

Soil carbon changes were estimated for all grassland categories as described in sections 6.3.4.1 and 6.4.3. The IPCC 2006 Guidelines default stock change factor of 1 for grasslands and low shrublands, and 0.7 (IPCC 2006 Guidelines, Chapter 6, Table 6.2) for eroded lands were applied.

6.8.2.6.2 Organic soils

The determination of the organic soil area in *Grasslands* is described in section 6.4.3.2. The CO_2 emissions from drained organic soils is however not reported in this category (4.C) but under emissions from drainage and rewetting of mineral and organic soils in *Grasslands* (4(II).C). This category is therefore reported as included elsewhere (IE).

6.8.2.7 Direct and indirect N_2O from N inputs

All direct and indirect emissions of N_2O from nitrogen fertiliser inputs to *Grasslands* are not included in the LULUCF sector, but rather in the Agriculture sector (3.D.1 & 3.D.2). It should be noted that there is no known data source for nitrogen inputs to *Grasslands*. There may be some inputs to pastures and rangelands, but there is no input to natural grasslands, low shrublands or eroded lands. These emissions are therefore not estimated.

6.8.2.8 Emissions and removals from drainage and rewetting

Drained organic soil area for *Grasslands* was obtained from FAOSTAT (Table 6.47). The IPCC 2013 Wetland Supplement methodology for CO_2 emissions (equations 2.3 – 2.5) and CH_4 emissions (equation 2.6) were utilised to estimate emissions from drained soils.

Table 6.47: Drained organic soil area (ha) for *Grasslands*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Grassland drained organic soil	13 198	13 198	13 198	13 198	13 198	13 348	13 484	13 666	14 112
	1999	2000	2001	2002	2003	2004	2005	2006	2007
Grassland drained organic soil	14 823	14 947	15 001	15 216	15 696	15 737	15 772	15 784	15 801
	2008	2009	2010	2011	2012	2013	2014	2015	2016

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Grassland drained organic soil	15 830	15 832	15 830	15 835	15 835	15 835	15 809	15 807	15 795
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Grassland drained organic soil	15 795	15 796	15 691	15 680	15 670	15 678	15 678	15 678	

CO_2 emissions from drained soil includes on-site and off-site emissions (IPCC 2013 Wetland Supplement, equation 2.2). A Tier 1 approach for on-site CO_2 emissions (equation 2.3) included combining the drained organic soil area with an emission factor of 5.3 t C/ha/yr (IPCC 2013 Wetland Supplement, Table 2.1). Off-site emissions (equation 2.4) used an emission factor of 0.31 t C/ha/yr (2013 WS, Table 2.2). CO_2 emissions from fires on drained soils were not included as burnt area for drained soils could not be separated from the total grassland burnt area. The CO_2 emissions will therefore be slightly underestimated. Emission factors were selected based on a temperate, dry climate and nutrient poor grasslands. The nutrient status of the drained soil is not known so the nutrient poor value was chosen as it is an average value for grasslands in temperate climates.

CH_4 emissions from drained soils are estimated with the IPCC 2013 Wetland Supplement equation 2.6. The area of ditches is not known so an average fraction of 0.5 is assumed for ditches (IPCC 2013 Wetland Supplement, Table 2.4). The drained area was combined with this fraction and default emission factors for drained organic soils (1.8 kg CH_4/ha/yr) and drained ditches (527 kg CH_4/ha/yr) from the IPCC 2013 Wetland Supplement Tables 2.3 and 2.4 respectively.

N_2O emissions from drained organic soils were not included in this sector but rather in the Agriculture sector (3.D.1.f).

6.8.2.9 Direct and indirect N_2O from N mineralisation/immobilisation

Direct N_2O from N mineralisation/immobilisation associated with loss of soil carbon from soil organic matter as a result of changes to land use were incorporated through the application of the IPCC 2006 Guidelines equations 11.1 and 11.8. The annual loss of carbon due to land use change comes from analysis described in section 6.6.2.6.1 and the C:N ratio of 12.5 was obtained from IPCC 2006 Guidelines (average of 10 and 15). The IPCC 2019 Refinement emission factor was 0.01 kg N_2O-N/kg N.

Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

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6.8.2.10 Non-CO_2 emissions from biomass burning

Biomass burning emissions were identified as a key category in the previous inventory and therefore a Tier 2 approach is, according to IPCC decision tree, recommended. In this inventory, even though the emission factors were taken from the IPCC 2006 Guidelines, more specific fuel loads and combustion factors were applied (Tier 2). This section only included emissions for grasslands and low shrublands as there was no burnt area available for the small subantarctic area. The CO_2 emissions from biomass burning were incorporated as disturbance losses in the gain-loss method described above. This category therefore only includes the emissions of CH_4 and N_2O emissions. Emissions were also estimated for CO, NO_x and NMVOCs but these are not reported here but rather under the section on Indirect emissions (Chapter 8).

Emissions were estimated with IPCC 2006 Guidelines equation 2.27. Burnt areas are provided in Table 6.45. Emission factors from IPCC 2006 Guidelines Table 2.5 were applied (Savanna and grassland) along with a NMVOC emission factor of 3.4 g/kg dm burnt (Sinha, et al., 2003). An area weighted average fuel consumption value of 2.72 t dm/ha was determined for low shrublands based on the fuel consumption values for the different low shrubland (fynbos, succulent karoo, nama karoo) classes. These varied from 0.6 t dm/ha for Succulent karoo to 12.9 t dm/ha for fynbos (IPCC, 2006; DEAT, 2009; DEA, 1999). The grassland fuel load was 2.8 t dm/ha. Combustion factors for grasslands and low shrublands were 0.88 and 0.91 respectively (IPCC, 2006; Hely, et al., 2003).

6.8.3 Uncertainty

Uncertainties were provided for individual factors, based on literature and the IPCC 2006/2019 Refinement Guideline default values, and were combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

6.8.3.1 Activity data uncertainty

Uncertainty for the land areas were provided by the SANLC data accuracy assessments (DFFE, 2021). Grasslands have the highest uncertainty (52%) followed by shrublands (36%) and eroded land (16%). An additional 15% for land remaining and 20% for land conversions was added to this for uncertainty on the mapped area corrections. The uncertainty for converted areas was taken to be the combined uncertainty (applying the propagation of errors as indicated in IPCC 2006 Guidelines) for the two land areas. The results of this approach indicate the converted lands have a higher uncertainty than the individual land types as is to be expected. Mapped areas for land converted to Grasslands had an estimated uncertainty of ±60.7%.

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The burnt area data determined from MODIS collection 6 has an uncertainty of <6% (Boschetti et al., 2021) and the soil maps are estimated to have an uncertainty of ±10%. The overall activity data uncertainty for grassland remaining grassland was estimated at ±41.2%. For land converted to cropland the uncertainty was estimated at ±61.8%.

6.8.3.2 Emission factor uncertainty

The uncertainty on biomass gains was estimated from uncertainties and data ranges provided in the scientific literature, IPCC 2006 Guidelines and IPCC 2019 Refinement. Uncertainty on growing stock (±12%) was taken from the literature. Disturbance losses in industrialised countries have a default uncertainty of ±15%, so a ±20% uncertainty is assumed. Root to shoot ratios have a ±30% uncertainty and carbon fraction uncertainty is ±6% (IPCC, 2006). Since the DOM and SOC data have greater uncertainty than the biomass data an uncertainty of ±20% is assigned to these categories. The CO_2 emission factor uncertainty for *Grasslands* was estimated at ±40.3%, while for land converted to grasslands it was ±53.2%.

For CH_4 and N_2O biomass burning emission factors have uncertainties of ±40% and ±47% respectively for *Grasslands*. Direct emission factors for inputs (of N and FSOM) to managed soils have, based on defaults from 2019 Refinement, uncertainties of -90% and +80%, while indirect emissions for volatilisation and leaching are ±80% and -100% to +82% respectively. Drainage and rewetting CH_4 and N_2O emission factors have an uncertainty of +71.2% and +58.1%.

6.8.4 Time-series consistency

The land change maps had some inconsistency in that there was a switch from Landsat to Sentinel data between 2014 and 2018, however some corrections were made to bring these two datasets into alignment. All other datasets were consistent through the time-series, using the same methodology and data sources. The calculations are consistent over time and complete for the entire reporting period (1990-2024).

6.8.5 Category specific QA/QC and verification

There were no category specific QA/QC checks over and above the checks described in section 6.1.5.

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6.8.6 Category-specific recalculations

The following main improvements led to a recalculation of the *Grassland* emissions:

- Inclusion of 2020-2022 land change maps
- Updated land change matrix corrections for change in technology between 2014 and 2018, and wet and dry season variations.
- Removal of error from 2014 onwards (mentioned in last inventory) relating to a correction for land conversions on already converted land.
- Updated methodology for estimating burnt area per land class.
- Incorporation of soil type map overlay with 2014-2018, 2018-2020 and 2020-2022 land cover maps.
- Updated biomass, deadwood and litter carbon data.
- Inclusion of drained organic soils and their emissions.

The improvements led to an increase in emissions in the *Grasslands* category. The 2021 emission estimates were reduced by 2 279 Gg CO_2e (18.1%) and the 2022 estimates increased by 1 166 Gg CO_2e (10.3%) since the previous submission.

6.8.7 Category-specific planned improvements

The only planned improvement for *Grasslands* is the collection of more DOM data as this was listed as a key category in the previous inventory.

6.9 Wetlands (CRT 4.D)

6.9.1 Category description

The *Wetlands* category is split into *Wetlands remaining Wetlands* (4.D.1) and *Land converted to Wetlands* (4.D.2). These two divisions are, in the IPCC guidelines, further divided into 3 types of wetlands, namely peat extraction, flooded land and other wetlands. There is a "land remaining" and a "land converted" category for each of these wetland types. In this inventory flooded lands are what are classified as waterbodies in the SANLC and the class called wetlands is incorporated into the CRTs under "other wetlands". The SANLC does not separate out coastal wetlands, so these are included under "other wetlands" and are listed as "IE" in the CRTs. South Africa does have peatlands, but the area is very small (Grundling & Grobler, 2005; Grundling, et al., 2017; Grundling, et al.,

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2021). These are also not separated out from "other wetlands" in the SANLC. Due to the small peatland area peat extraction is limited and is primarily done by small-scale landowners. It is discouraged because peatlands provide vital ecosystem services. For this reason, peat extraction data is virtually non-existent and therefore emissions from this sub-category are not estimated.

All land conversion calculations are carried out based on a 20-year transition period in that once a land area is converted it remains in the converted land category for 20 years.

Emissions in *Wetlands* include CO_2 emissions/removals from above- and below-ground biomass, litter, deadwood, and mineral soils. Organic soil area is small and is not separated out from mineral soils, so for *Wetlands* all soil is treated as mineral and organic emissions from organic soils are indicated as "IE". *Wetland* emissions also include CO_2 and CH_4 from rewetting in mineral soils, and direct and indirect N_2O emissions from mineralisation in mineral soils. N_2O emissions from nitrogen inputs do not occur. Finally, it includes CH_4 and N_2O emissions from wildfires. Indirect emissions from wildfires are also estimated but these are reported under indirect CO_2 and N_2O in Chapter 8 of this report.

The *Wetland* category increased its emissions from 503 Gg CO_2e in 1990 to 2 105 Gg CO_2e 2024 (Table 6.48). This increase is mainly due to increased CH_4 emissions from rewetting as land is converted to flooded lands. Biomass is the dominant *Wetlands* pool and this source of emissions has increased by 74.8% since 1990. DOM is the main sink with a 20.0% increase since 1990. There is a large increase in conversion to flooded land in 2021 and 2022 (Figure 6.15) but this could be related to the fact that 2022 was a wet year so there was an increase in *Wetland* area.

Table 6.48: *Wetland* emissions for 1990 and 2024

Category	Pool	Gas	1990	2024	Change between 1990-2024 (%)
			Emissions (Gg CO_2e)	Emissions (Gg CO_2e)	
Wetlands	All	All	503	2 105	318.4
Wetlands	All	CO_2	-147	107	*
Wetlands	All	CH_4	582	1 932	232.1
Wetlands	All	N_2O	68	67	-2.0
Wetlands remaining Wetlands	All	All	217	309	42.6

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Land converted to Wetlands	All	All	286	1 796	527.4
Wetlands	Biomass	All	337	629	86.5
Wetlands	DOM	All	-405	-466	15.0
Wetlands	Mineral soil	All	-78	-55	-29.3

**Cannot be calculated due to positive and negative numbers. Sink changes to a source.*

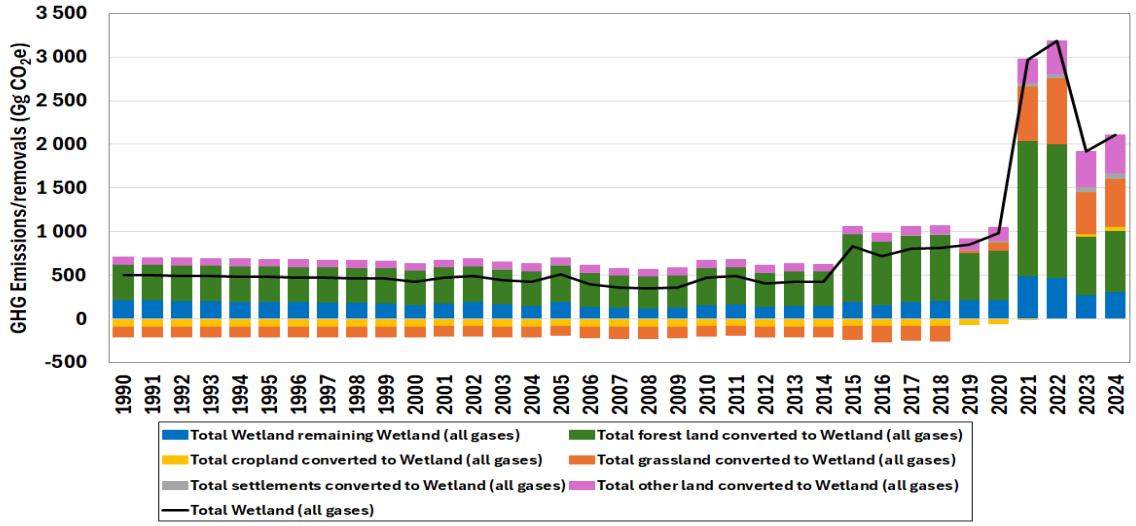


Figure 6.15: *Wetland* emission trends, 1990-2024

6.9.2 Methodological issues

Methodologies and emission factors applied for *Wetlands* are provided in Table 6.49. In the previous inventory *Wetlands remaining wetlands* and *Land converted to Wetlands* were identified as key categories for CH_4 emissions due to drainage and rewetting. In this inventory these emissions estimates were reassessed, and methodologies were revised to align with IPCC 2013 Wetland Supplement and IPCC 2019 Refinement methodologies. The *Wetlands* emissions were determined following the Inland Wetland Mineral Soils methodology provided in the IPCC 2013 Wetland Supplement. The methodology for flooded lands was taken from IPCC 2006 Guidelines, vol 4., Chapter 7 (as indicated in the decision tree in the IPCC 2013 Wetland Supplement (Chapter 1, Figure 1.1)).

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Table 6.49: Methodologies and EF applied for estimating emissions from *Wetlands*

Category	Gas	Method used	Source of activity data	Emission factor used
Wetlands remaining Wetlands	CO_2	Tier 1/Tier 2	CS	D/CS
Wetlands remaining Wetlands	CH_4	Tier 1/Tier 2	CS	D
Wetlands remaining Wetlands	N_2O	Tier 1/Tier 2	CS	D
Land converted to Wetlands	CO_2	Tier 2	CS	D/CS
Land converted to Wetlands	CH_4	Tier 1/Tier 2	CS	D
Land converted to Wetlands	N_2O	Tier 1/Tier 2	CS	D

(NO = Not occurring; NA = Not applicable; CS = Country specific; D = IPCC default)

6.9.2.1 Land area activity data

The activity data was country specific land area data determined as outlined in section 6.3**Error! Reference source not found.** with an Approach 2 methodology and included areas for both *Wetlands remaining Wetlands* and *Land converted to Wetlands* (Table 6.50).

Table 6.50: Country specific land areas (kha) (including 20-year transition period) for Wetlands.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Flooded land remaining flooded land	520	514	508	501	495	489	482	476	469
Land converted to flooded land	87	87	87	87	87	87	87	87	87
Other wetlands remaining other wetlands	1 271	1 250	1 229	1 209	1 188	1 168	1 147	1 126	1 106
Land converted to other wetlands	250	250	250	250	250	250	250	250	250
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Flooded land remaining flooded land	463	457	450	444	437	431	425	418	412
Land converted to flooded land	87	87	87	87	87	87	87	87	87
Other wetlands remaining other wetlands	1 085	1 065	1 044	1 023	1 003	982	962	941	920
Land converted to other wetlands	250	250	250	250	250	250	250	250	250

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	2008	2009	2010	2011	2012	2013	2014	2015	2016
Flooded land remaining flooded land	406	399	393	386	380	374	367	369	370
Land converted to flooded land	87	87	87	87	87	87	87	92	96
Other wetlands remaining other wetlands	900	879	859	838	817	797	776	771	765
Land converted to other wetlands	250	250	250	250	250	250	250	258	266
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Flooded land remaining flooded land	371	372	336	299	300	302	265	229	
Land converted to flooded land	101	105	133	161	282	403	436	468	
Other wetlands remaining other wetlands	759	753	756	760	752	745	751	757	
Land converted to other wetlands	275	283	284	285	286	288	289	290	

6.9.2.2 Biomass gains

6.9.2.2.1 Flooded lands (waterbodies)

There is no methodology for estimating CO_2 from *Flooded land remaining Flooded land*, but there was a small area that was converted from another wetland to flooded land. This area was treated as *Flooded land remaining flooded land* and the losses were calculated as described for land conversions.

6.9.2.2.2 Other wetlands

As the other wetlands do not contain woody vegetation they are considered annual and a Tier 1 assumption of equivalence was applied. As with flooded lands there was a small area that was converted from flooded land to wetlands and emissions from this area were estimated as described for converted land, but the emissions were reported under *Other wetlands remaining other wetlands*.

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6.9.2.3 Biomass losses

6.9.2.3.1 Flooded lands (waterbodies)

As with biomass gains there is no methodology for *Flooded lands remaining flooded lands*, but losses were estimated for the area of wetlands converted to flooded lands as described under the land conversion section. These losses were included here.

6.9.2.3.2 Other wetlands

As no gains were included for *Other wetlands remaining other wetlands* no losses were included either. If there were conversions between different wetland categories, then these losses were determined as described for converted lands and included here.

6.9.2.4 Gains and losses due to land conversion

For land conversions a Tier 2 approach (IPCC 2006 Guidelines equations 2.15 and 2.16) was applied. As the vegetation in wetlands is annual the only losses that occurred were the losses due to abrupt changes (i.e. $\Delta C_{CONVERSION}$), there were no additional gains or losses due to the assumption of equivalence. The losses were estimated for the area of lands undergoing a conversion in a given year, and in subsequent years it was zero. Converted lands remained in the converted category for a period of 20 years.

The biomass values for the initial land types are given in the relevant land category sections. Wetland biomass data was sourced from the literature and a weighted average determined based on the area of the various wetland types provided in the SANLC maps (DFFE, 2021). The above ground biomass was 15.0 t dm/ha and this was combined with a root to shoot ratio of 0.96 (IPCC, 2014a). It was assumed that only croplands and forest plantations were cleared before being converted to a grassland, while all other conversions were slow transitions and not abrupt changes.

6.9.2.5 Litter

The DOM pool for *Wetlands* was not identified as a key category in the previous inventory, so a Tier 1 methodology was applied. The Tier 1 assumption for the litter pool is that the stocks in *Wetlands remaining wetlands* are not changing over time, therefore litter changes are reported to be zero. This was applied to areas where the *Wetland category* did not change, however, there were conversions between wetlands and flooded lands so changes in litter in these areas was estimated as for converted land.

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Changes in the DOM pool in converted land was estimated using IPCC 2006 Guidelines equation 2.23. The initial DOM is given in the relevant land category section, and the final DOM for the other wetlands was 9.8 t C/ha (Glenday, 2007) and assumed zero for flooded lands. If there was a gain in DOM this was assumed to occur over the 20-year default period, while losses were assumed to occur within the year of conversion (Tier 1).

6.9.2.6 Soil carbon

6.9.2.6.1 Mineral soils

Soil carbon changes were estimated for other wetlands as described in sections 6.3.4.1 and 6.4.3. The IPCC 2006 Guidelines default stock change factor of 1 was applied. There is no methodology for *Flooded lands remaining flooded lands* or land converted to Flooded lands so these emissions were listed as not applicable.

6.9.2.6.2 Organic soils

Organic soils were not separated from mineral soils for *Wetlands*, therefore all soils were included under mineral soils.

6.9.2.7 Direct and indirect N_2O from N inputs

There are no know inputs of nitrogen to *Wetlands* so these emissions were allocated the notation key "NO".

6.9.2.8 Emissions and removals from drainage and rewetting

6.9.2.8.1 Flooded lands (waterbodies)

There is insufficient data to include drainage and rewetting of soils under flooded lands, but the IPCC 2019 Refinement provides methods for estimating annual reservoir surface CH_4 emissions (equation 7.10 B and 7.15 B). There is no place for these emissions to be reported in the CRTs as reporting with 2019 Refinement is not a requirement. For this reason, these emissions are, for the moment, reported under drainage and rewetting.

Total CH_4 for reservoirs >20 years, i.e. flooded land remaining flooded land, were estimated using IPCC 2019 Refinement equation 7.10. The reservoir surface area was estimated from the fraction of the flooded land area occupied by artificial waterbodies (reservoirs are the dominant man-made waterbodies) in the SANLC maps. An average fraction (0.6) was applied across the time-series. A Tier 1 method was applied so the

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emission factor adjustment for trophic state in the reservoirs was set at 1. The ratio of total downstream flux of CH_4 to the flux of the CH_4 from a reservoir surface to the atmosphere (0.09) and the CH_4 emission factor (150.9 kg CH_4/ha/yr) were sources from IPCC 2019 Refinement, chapter 7, Table 7.9 and 7.10.

Similarly, CH_4 emissions were estimated for land converted to reservoirs by applying the IPCC 2019 Refinement equation 7.15. All the factors were the same as the method for *Flooded land remaining flooded land* except the emission factor which was 195.6 kg CH4/ha/yr (IPCC 2019 Refinement, chapter 7, Table 7.15).

6.9.2.8.2 Other wetlands

For *lands converted to other wetlands* it was assumed the water level increases constitutes rewetted soil. The IPCC 2013 Wetland Supplement (IPCC, 2014a) provides a methodology to estimate CH_4 emissions from rewetted wetlands on Inland Wetland Mineral Soils (IPCC 2013 Wetland Supplement, Chapter 5, equation 5.1). Section 6.3.4.1 describes the estimation of the inland wetland mineral soil areas which was combined with the emission factor of 235 kg CH_4/ha/yr (IPCC 2013 Wetland Supplement, chapter 5, Table 5.4).

IPCC does not provide a method for estimating N_2O emissions from *Wetlands* so these emissions were not included.

6.9.2.9 Direct and indirect N_2O from N mineralisation/immobilisation

Direct N_2O from N mineralisation/immobilisation associated with loss of soil carbon from soil organic matter as a result of changes to land use were incorporated through the application of the IPCC 2006 Guidelines equations 11.1 and 11.8. The annual loss of carbon due to land use change comes from analysis described in section 6.6.2.6.1 and the C:N ratio of 12.5 was obtained from IPCC 2006 Guidelines (average of 10 and 15). The IPCC 2019 Refinement emission factor was 0.01 kg N_2O-N/kg N.

Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

6.9.2.10 Non-CO_2 emissions from biomass burning

This section includes only non-CO_2 emissions (CH_4, N_2O) for *Wetlands*. The CO_2 emissions from biomass burning were incorporated as disturbance losses in the gain-loss method

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described above. Emissions were also estimated for CO, NO_x and NMVOCs but these are not reported here but rather under the section on Indirect emissions.

Emissions were estimated with IPCC 2006 Guidelines equation 2.27. Burnt areas are provided in Table 6.51. Emission factors from IPCC 2006 Guidelines Table 2.5 were applied (Savanna and grassland) along with a NMVOC emission factor of 3.4 g/kg dm burnt (Sinha, et al., 2003). A fuel load and combustion factor of 2.8 t dm/ha and 0.7 (IPCC, 2006) respectively were incorporated into the equation.

Table 6.51: Burnt area (ha) data for other wetlands

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Wetlands	92 482	91 229	89 976	88 723	87 470	86 218	84 965	83 712	82 459
	1999	2000	2001	2002	2003	2004	2005	2006	2007
Wetlands	81 206	69 554	83 761	94 341	76 709	65 282	97 399	65 912	58 861
	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wetlands	53 240	59 934	77 350	85 212	69 151	81 508	77 274	73 853	39 414
	2017	2018	2019	2020	2021	2022	2023	2024	
Wetlands	64 334	62 951	65 981	67 098	72 623	41 063	59 384	90 674	

6.9.3 Uncertainty

Uncertainties were provided for individual factors, based on literature and the IPCC 2006/2019 Refinement Guideline default values, and were combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

6.9.3.1 Activity data uncertainty

Uncertainty for the land areas were provided by the SANLC data accuracy assessments (DFFE, 2021). Wetlands have a higher uncertainty than flooded lands. An additional 5% was added to this for uncertainty on the mapped area corrections. The uncertainty for converted areas was taken to be the combined uncertainty (applying the propagation of errors as indicated in IPCC 2006 Guidelines) for the two land areas. The results of this approach indicate the converted lands have a higher uncertainty than the individual land types as is to be expected. Mapped areas for land converted to Wetlands had an estimated uncertainty of ±42.8%.

The burnt area data determined from MODIS collection 6 has an uncertainty of <6% (Boschetti et al., 2021) and the soil maps are estimated to have an uncertainty of ±10%.

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The overall activity data uncertainty for wetlands remaining wetlands was estimated at ±17.7%. For land converted to cropland the uncertainty was estimated at ±44.4%.

6.9.3.2 Emission factor uncertainty

The uncertainty on biomass gains was estimated from uncertainties and data ranges provided in the scientific literature, IPCC 2006 Guidelines and IPCC 2019 Refinement Guidelines.

The uncertainty for biomass was estimated to be similar to *Grasslands*. Disturbance losses in industrialised countries have a default uncertainty of ±15%, so a ±20% uncertainty is assumed. Root to shoot ratios have a ±30% uncertainty and carbon fraction uncertainty is ±6% (IPCC, 2006). Since the DOM and SOC data have greater uncertainty than the biomass data an uncertainty of ±20% is assigned to these categories. The CO_2 emission factor uncertainty for *Wetlands* was estimated at ±40.3%, while for land converted to wetlands it was ±53.2%.

For CH_4 and N_2O biomass burning emission factors have uncertainties of ±40% and ±47% respectively for Wetlands. Direct emission factors for inputs (of N and FSOM) to managed soils have, based on defaults from 2019 Refinement, uncertainties of -90% and +80%, while indirect emissions for volatilisation and leaching are ±80% and -100% to +82% respectively. Drainage and rewetting CH_4 and N_2O emission factors have an uncertainty of +71.2% and +58.1%.

6.9.4 Time-series consistency

The land change maps had some inconsistency in that there was a switch from Landsat to Sentinel data between 2014 and 2018, however some corrections were made to bring these two datasets into alignment. All other datasets were consistent through the time-series, using the same methodology and data sources. The calculations were therefore consistent over time and complete for the entire reporting period (1990-2024).

6.9.5 Category specific QA/QC and verification

There were no category specific QA/QC checks over and above the checks described in section 6.1.5.

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6.9.6 Category-specific recalculations

Recalculations were necessary as several updates and improvements were made to the *Wetland* category. In the previous submission the estimation method for CH_4 emissions was not completely in alignment with IPCC methodologies, so this was addressed in this inventory. The following improvements were the main reasons for recalculations in the *Wetland* category:

- Inclusion of 2020-2022 land change map.
- Updated land change matrix corrections for change in technology between 2014 and 2018, and wet and dry season variations.
- Removal of error from 2014 onwards (mentioned in last inventory) relating to a correction for land conversions on already converted land.
- Updated methodology for estimating burnt area per land class.
- Incorporation of soil type map overlay with 2014-2018, 2018-2020 and 2020-2022 land cover maps.
- Updated biomass, deadwood and litter carbon data.
- Correction to the CH_4 emissions from rewetted soils methodology to bring it not alignment with IPCC 2013 Wetland Supplement and CRT tables.
    - In the previous submission the emission factor was applied to the whole wetland area, but this has been corrected to only the rewetted inland mineral soil area.

The improvements, particularly in terms of the CH_4 methodology, caused a large reduction (67% for 2022) in the *Wetland* overall emissions, with emissions being reduced by 6 490 Gg CO_2e (2022) compared to the last submission. The CH_4 emission estimates were reduced by 6 520 Gg CO_2e in this submission for 2022, CO_2 emissions were reduced by half and N_2O emissions were increased by 1 971 Gg CO_2e. The N_2O emissions changes were due to increased emissions from fires which were affected by land area, burnt area and biomass factor improvements.

6.9.7 Category-specific planned improvements

As the land mapping system is developed so the inclusion of organic soils (for all land categories) will be improved. It is therefore planned that organic soil emissions will be incorporated into Wetlands in the future.

During the updating of this inventory further data on peatlands was found. Peatlands are not separated out in the SANLC maps but the literature (Grundling & Grobler, 2005;

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Grundling, et al., 2017; Grundling, et al., 2021) indicates that some spatial data may be available. In the next inventory the aim is to try and include some information on peatlands.

Lastly, in this inventory reservoirs were separated out in the *Flooded land* subcategory, and the IPCC 2019 Refinement provides a methodology for estimating on-site CO2 emissions from reservoirs (IPCC 2019 Refinement, Equation 7.13). It is unclear at this stage where in the CRTs this data would be accommodated, so the inclusion of this data will be explored in the next inventory.

6.10 Settlements (CRT 4.E)

6.10.1 Category description

The *Settlement* category is subdivided into *Settlements remaining Settlements* (4.E.1) and *Land converted to Settlements* (4.E.2). Calculations are carried out based on a 20-year transition period in that once a land area is converted it remains in the converted land category for 20 years. *Settlements remaining settlements* or a key category in terms of biomass CO2 emissions and removals.

Emissions in *Settlements* include CO_2 emissions/removals from above- and below-ground biomass, litter and mineral soils. Organic soils could not be separated out so all soils were assumed to be mineral and organic soils are reported as "IE". It also includes direct and indirect N_2O emissions from nitrogen inputs and mineralisation in mineral soils. Lastly, it includes CH_4 and N_2O emissions from wildfires. Indirect emissions from wildfires are also estimated but these are reported under indirect CO_2 and N_2O in Chapter 8.

The *Settlement* category covers residential areas, smallholdings, commercial and industrial spaces, as well as mines.

The *Settlement* category increased its sink by 74.5% to 1 326 Gg CO_2e in 2024 (Table 6.52). *Settlements remaining Settlements* were a sink due to the growth of woody areas within settlement zones, while *Land converted to Settlements* is a source of emissions. Biomass is therefore the dominant pool. From 2015 onwards there has been an increase in the conversion of *Forest Land to Settlements* which reduced the sink (Figure 6.16), and an increase in conversion of *Cropland to Settlements* between 2020 and 2024.

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Table 6.52: *Settlement* emissions for 1990 and 2024

Category	Pool	Gas	1990	2024	Change between 1990-2024 (%)
			Emissions (Gg CO_2e)	Emissions (Gg CO_2e)	
Settlements	All	All	-760	-1 326	74.5
Settlements	All	CO_2	-810	-1 453	79.4
Settlements	All	CH_4	16	21	28.0
Settlements	All	N_2O	34	107	213.1
Settlements remaining Settlements	All	All	-1 287	-2 981	131.7
Land converted to Settlements	All	All	527	1 656	214.0
Settlements	Biomass	All	-796	-1 327	66.7
Settlements	DOM	All	162	154	-5.1
Settlements	Mineral soil	All	-175	-279	59.3

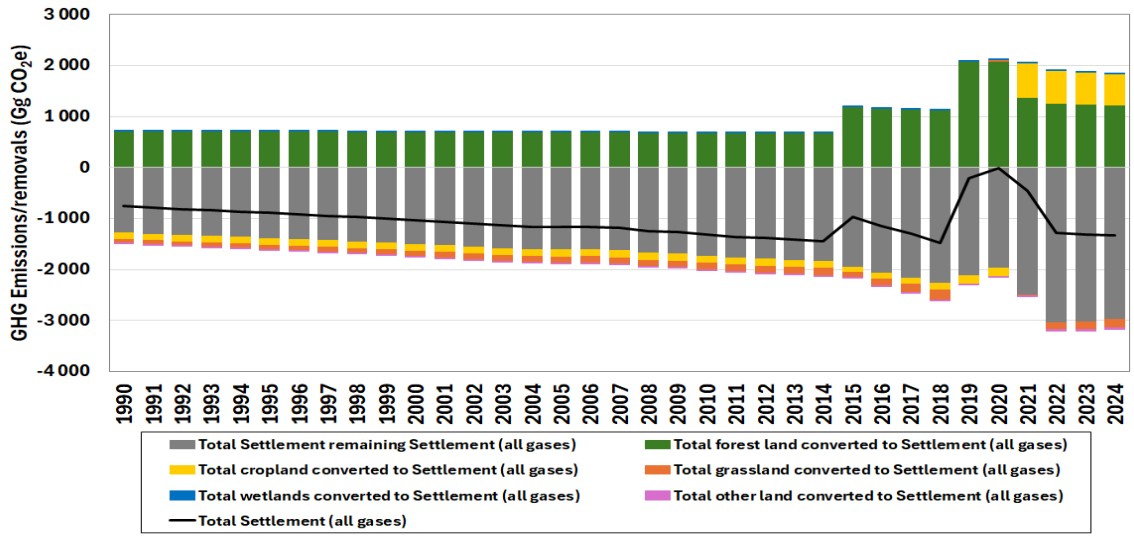


Figure 6.16: *Settlement* emission trends, 1990-2024

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6.10.2 Methodological issues

The methodologies and emission factors applied to *Settlements* are provided in Table 6.53. In the previous inventory *Settlements remaining Settlements* (all carbon pools) and *Forest land converted to Settlements* (all carbon pools) were identified as key categories. *Settlements remaining Settlements* which contained perennial growth were identified and a Tier 2 approach applied. Land conversions were calculated with a Tier 2 approach which is consistent with the IPCC decision tree (IPCC 2006 Guidelines, Figure 2.2).

Table 6.53: Methodologies and EF applied for estimating emissions from *Settlements*

Category	Gas	Method used	Source of activity data	Emission factor used
Settlements remaining Settlements	CO_2	Tier 1/Tier 2	CS	D/CS
Settlements remaining Settlements	CH_4	Tier 1/Tier 2	CS	D
Settlements remaining Settlements	N_2O	Tier 1/Tier 2	CS	D
Land converted to Settlements	CO_2	Tier 2	CS	D/CS
Land converted to Settlements	CH_4	Tier 1/Tier 2	CS	D
Land converted to Settlements	N_2O	Tier 1/Tier 2	CS	D

(NO = Not occurring; NA = Not applicable; CS = Country specific; D = IPCC default)

6.10.2.1 Land area activity data

The activity data was country specific land area data determined as outlined in section 6.3 with an Approach 2 methodology and included areas for both *Settlements remaining Settlements* and *Land converted to Settlements* (Table 6.54).

Table 6.54: Country specific land areas (kha) (including 20-year transition period) for *Settlements*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Settlements remaining Settlements	2 493	2 505	2 517	2 528	2 540	2 552	2 563	2 575	2 586
Land converted to Settlements	524	524	524	524	524	524	524	524	524
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**

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Settlements remaining Settlements	2 598	2 610	2 621	2 633	2 645	2 656	2 668	2 680	2 691
Land converted to Settlements	524	524	524	524	524	524	524	524	524
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Settlements remaining Settlements	2 703	2 714	2 726	2 738	2 749	2 761	2 773	2 786	2 799
Land converted to Settlements	524	524	524	524	524	524	524	535	545
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Settlements remaining Settlements	2 813	2 826	2 806	2 786	2 739	2 693	2 646	2 599	
Land converted to Settlements	555	566	600	634	676	719	762	805	

6.10.2.2 Biomass gains

6.10.2.2.1 Industrial, commercial and mines

The detailed SANL maps provide detailed separation of the *Settlement* category. It provides information on the area covered grass, shrubs and trees within each Settlement class. The industrial and commercial classes are not indicated to have woody vegetation and therefore no gain are included for these classes. Mines are also only shown to have infrastructure, pits and quarries, salt mines, tailings and resource dumps, therefore biomass gains were also not included for this class.

6.10.2.2.2 Residential and smallholdings

The percentage area covered by grass, shrubs and trees in each of these categories was determined from the SANLC data and the woody vegetation area estimated. For biomass gains IPCC 2006 Guidelines Equation 8.2 is applied. Only growth for perennial vegetation is included as the rest is assumed to be in equilibrium. As per the guidelines, trees over 20yrs age also assumed to be at equilibrium. Crown area was assumed to be the tree component from the SANLC residential area, but since the age of the vegetation was not known it was assumed that 50% of the tree crown cover area for "land remaining land" was >20yrs. Growth therefore was only included for half the tree area. The IPCC default accumulation rate of 2.8 t C/ha crown cover (IPCC 2019 Refinement, Chapter 8, Table 8.1) was applied.

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6.10.2.3 Biomass losses

6.10.2.3.1 Industrial, commercial and mines

Since gains are not included for these classes, losses are also not included.

6.10.2.3.2 Residential and smallholdings

The carbon losses from fire disturbance in *Settlements* was estimated with IPCC 2006 Guidelines equation 2.14. Where there was land-use change between the *Settlement* categories, carbon stock changes were reported under Settlements remaining settlements. The only disturbance losses that were included are those from fires. There was insufficient data to separate out controlled and wildfire burns so all emissions were included under wildfires.

Losses were estimated from burnt area data (Table 6.55), biomass data and a fraction of vegetation that was burnt (*fd*). A weighted average biomass was determined for residential (2.77 t dm/ha) and smallholdings (3.63 t dm/ha) by using biomass data for grasslands, shrublands and woodlands and weighting it by percentage area. These were combined with a root to shoot ratio of 0.26, a *fd* value of 0.74 (which is an average of fraction lost for grasslands and woodlands) and carbon fraction of 0.47.

Table 6.55: Burnt area data (ha) for *Settlements*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Residential	42 966	43 134	43 302	43 470	43 638	43 806	43 974	44 142	44 310
Smallholdings	6 158	6 165	6 172	6 179	6 186	6 193	6 200	6 207	6 214
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Residential	44 478	33 404	36 995	27 692	23 889	18 631	42 185	72 769	80 485
Smallholdings	6 221	5 738	6 355	4 379	3 778	2 946	6 671	9 127	10 094
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Residential	49 688	59 795	44 716	31 968	31 133	33 475	35 002	20 882	8 569
Smallholdings	6 232	7 499	5 608	3 050	2 970	3 194	3 340	4 414	1 106
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Residential	14 062	12 022	21 081	26 478	29 948	12 378	25 076	58 439	
Smallholdings	3 003	1 644	3 608	2 774	2 106	1 682	2 120	4 596	

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6.10.2.4 Carbon gains and losses for land conversions

Land converted to Settlements was estimated using a Tier 2 approach (IPCC 2006 Guidelines equations 2.15 and 2.16). For *land converted to settlements* the biomass gains and losses on total converted area were estimated as described above. The initial carbon stock change due to the removal of biomass (i.e. $\Delta C_{CONVERSION}$) was only calculated for the area of land undergoing a conversion in a given year, and in subsequent years it was zero. Converted lands remain in the converted category for a period of 20 years.

The biomass values for the initial land types are given in the relevant land category sections, while biomass data for the settlement categories are provided above (6.10.2.3). It was assumed that only croplands and forest plantations were cleared before being converted to a settlement, while all other conversions were slow transitions and not abrupt changes.

6.10.2.5 Litter

The DOM pool for *Settlements* was not identified as a key category in the previous inventory, so a Tier 1 methodology was applied. The Tier 1 assumption for the litter pool in *Settlements remaining settlements* is that the stocks are not changing over time, therefore litter changes are reported to be zero. This was applied to areas where the crop type did not change, however, there were conversions between the various settlement types, and these were treated as converted land areas.

Changes in the DOM pool in converted land was estimated using IPCC 2006 Guidelines equation 2.23. The initial DOM is given in the relevant land category section, and the final DOM for the settlement types is shown in Table 6.56. The litter data was sourced from the NTCSA (DEA, 2015) which provides spatial carbon density maps. These maps were intersected with the SANLC data to provide an area averaged estimate of the litter for each settlement type. If there is a gain in DOM this is assumed to occur over the 20-year default period, while losses are assumed to occur within the year of conversion (Tier 1).

Table 6.56: Litter data for Settlement categories

Settlement type	Litter (t C/ha)	Reference
Residential	1.39	NTCSA (DEA, 2015)
Smallholdings	1.13	
Commercial	1.11	
Industrial	2.02	

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6.10.2.6 Soil carbon

6.10.2.6.1 Mineral soils

Soil carbon changes were estimated for all settlement categories as described in sections 6.3.4.1 and 6.4.3. The IPCC 2006 Guidelines default stock change factor of 1 was applied.

6.10.2.6.2 Organic soils

Organic soils were not separated from mineral soils for *Settlements*, therefore all soils were included under mineral soils.

6.10.2.7 Direct and indirect N_2O from N inputs

There are nitrogen inputs to settlements as this category includes residential gardens and recreational areas that are often fertilised. A data source for the amount of nitrogen applied to residential gardens is lacking and so these emissions still need to be estimated. As a start this inventory includes an estimate of emissions for fertilisers added to golf courses. These emissions were included under the Residential category. In the 72 class SANLC data there is class 63 which is called "Urban recreational fields (grass)" which includes grassy urban sports fields and golf courses. The fraction of this relative to the total Residential category was determined for each land map (1990, 2014, 2018, 2020, 2022). Linear extrapolation was used to extrapolate for the years in between. This enabled the determination the golf course area across the time-series. A nitrogen application rate of 263.4 kg N/ha was applied to this area to determine total N application. This rate was based on 84 kg N/ha three times a year for turf, 40 kg N/ha once a month for green, and the assumption of greens occupying 5% of the area.[34] This is an initial start to incorporating N input data and will be improved as more data becomes available.

Direct N_2O emissions were estimated by combining the amount of nitrogen applied was combined with the IPCC 2019 Refinement default average emission factor for synthetic fertilisers (0.01 kg N_2O-N/kg N) in IPCC 2006 Guidelines equation 11.1. Indirect emissions from atmospheric deposition of N volatilised from managed soils were determined with equation 11.9, a $Frac_{GASF}$ of 0.11 kg N volatilised/kg N applied (IPCC 2019 Refinement, Chapter 11, Table 11.3) and an emission factor of 0.01 kg N_2O-N/(kg NH_3-N + NO_x -N volatilised) (IPCC 2019 Refinement, Chapter 11, Table 11.3). Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines

[34] *Fertplan – Fertilizer for greens*

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equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

6.10.2.8 Emissions and removals from drainage and rewetting

There is no data on the area of drained or rewetted *Settlement* soils, therefore these emissions were not estimated.

6.10.2.9 Direct and indirect N_2O from N mineralisation/immobilisation

Direct N_2O from N mineralisation/immobilisation associated with loss of soil carbon from soil organic matter as a result of changes to land use were incorporated through the application of the IPCC 2006 Guidelines equations 11.1 and 11.8. The annual loss of carbon due to land use change comes from analysis described in section 6.6.2.6.1 and the C:N ratio of 12.5 was obtained from IPCC 2006 Guidelines (average of 10 and 15). The IPCC 2019 Refinement emission factor was 0.01 kg N_2O-N/kg N.

Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

6.10.2.10 Non-CO_2 emissions from biomass burning

Biomass burning emissions were identified as a key category in the previous inventory and therefore a Tier 2 approach is, according to IPCC decision tree, recommended. In this inventory, even though the emission factors were taken from the IPCC 2006 Guidelines, more specific fuel loads and combustion factors were applied (Tier 2). This section only included emissions for residential and small holdings as commercial, industrial and mines were assumed not to burn as there is minimal biomass at these locations. The CO_2 emissions from biomass burning were incorporated as disturbance losses in the gain-loss method described above. This category therefore only includes the emissions of CH_4 and N_2O emissions. Emissions were also estimated for CO, NO_x and NMVOCs but these are not reported here but rather under the section on Indirect emissions.

Emissions were estimated with IPCC 2006 Guidelines equation 2.27. Burnt areas are provided in Table 6.55. Emission factors from IPCC 2006 Guidelines Table 2.5 were applied (Savanna and grassland) along with a NMVOC emission factor of 3.4 g/kg dm burnt (Sinha, et al., 2003). A fuel load of 5.73 t dm/ha and 6.03 t dm/ha was determined for residential and smallholdings respectively. Combustion fraction of 0.88 from *Grasslands* (IPCC, 2006; Hely, et al., 2003) was applied.

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6.10.3 Uncertainty

Uncertainties were provided for individual factors, based on literature and the IPCC 2006/2019 Refinement Guideline default values, and were combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

6.10.3.1 Activity data uncertainty

Uncertainty for the land areas were provided by the SANLC data accuracy assessments (DFFE, 2021). *Settlements remaining settlements* have a lower uncertainty than the other land categories as it is land use data for which there is a lot more detail and thus accuracy. An additional 2% was added to this for uncertainty on the mapped area corrections. The uncertainty for converted areas was taken to be the combined uncertainty (applying the propagation of errors as indicated in IPCC 2006 Guidelines) for the two land areas. The results of this approach indicate the converted lands have a higher uncertainty than the individual land types as is to be expected. Mapped areas for land converted to Settlements had an estimated uncertainty of ±47.8%.

The burnt area data determined from MODIS collection 6 has an uncertainty of <6% (Boschetti et al., 2021) and the soil maps are estimated to have an uncertainty of ±10%. The overall activity data uncertainty for *Settlements remaining settlements* was estimated at ±18.3%. For land converted to *Settlements* the uncertainty was estimated at ±49.2%.

6.10.3.2 Emission factor uncertainty

The uncertainty on biomass gains was estimated from uncertainties and data ranges provided in the scientific literature, IPCC 2006 Guidelines and IPCC 2019 Refinement. Growing stock or gains were indicated to have a ±30% uncertainty for non-industrialised countries. Disturbance losses in industrialised countries have a default uncertainty of ±15%, so a ±20% uncertainty is assumed. Root to shoot ratios have a ±30% uncertainty and carbon fraction uncertainty is ±6% (IPCC, 2006). Since the DOM and SOC data have greater uncertainty than the biomass data an uncertainty of ±20% is assigned to these categories. The CO_2 emission factor uncertainty for *Settlements* was estimated at ±40.3%, while for land converted to settlements it was ±53.2%.

For CH_4 and N_2O biomass burning emission factors have uncertainties of ±40% and ±47% respectively for Settlements. Direct emission factors for inputs (of N and FSOM) to managed soils have, based on defaults from 2019 Refinement, uncertainties of -90% and +80%, while indirect emissions for volatilisation and leaching are ±80% and -100% to +82% respectively.

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6.10.4 Time-series consistency

The land change maps had some inconsistency in that there was a switch from Landsat to Sentinel data between 2014 and 2018, however some corrections were made to bring these two datasets into alignment. All other datasets were consistent through the time-series, using the same methodology and data sources. The calculations are therefore consistent over time and complete for the entire reporting period (1990-2024).

6.10.5 Category specific QA/QC and verification

No category specific quality checks were completed for *Settlements*.

6.10.6 Category-specific recalculations

The main improvements for the *Settlement* category that led to recalculations for the time series were:

- Inclusion of 2020-2022 land change map.
- Updated land change matrix corrections for change in technology between 2014 and 2018, and wet and dry season variations.
- Removal of error from 2014 onwards (mentioned in last inventory) relating to a correction for land conversions on already converted land.
- Updated methodology for estimating burnt area per land class.
- Incorporation of soil type map overlay with 2014-2018, 2018-2020 and 2020-2022 land cover maps.
- Updated biomass, deadwood and litter carbon data.
- Update of carbon accumulation rate for tree from IPCC 2006 Guidelines default to IPCC 2019 Refinement default.

The improvements caused the *Settlements* sink to decline by 1 084 Gg CO_2e (45%) in 2022 relative to the previous submission. Most of the change is due to adjustments in the land change areas.

6.10.7 Category-specific planned improvements

There are no specific planned improvements for this category.

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6.11 Other lands (CRT 4.F)

6.11.1 Category description

The *Other land* category is subdivided into *Other land remaining Other land* (4.F.1) and *Land converted to Other land* (4.F.2). Calculations are carried out based on a 20-year transition period in that once a land area is converted it remains in the converted land category for 20 years.

Emissions in *Other land* include CO_2 emissions/removals from above- and below-ground biomass, litter and mineral soils. Organic soils could not be separated out so all soils were assumed to be mineral and organic soils are reported as "IE". It also includes direct and indirect N_2O emissions from mineralisation in mineral soils. No nitrogen is input into the *Other land* category, therefore direct and indirect N_2O emissions from N input are reported as "NO". There is also no vegetation in *Other lands* so no biomass burning emissions are included.

The *Other land* category includes bare ground and the newly added polar desert.

There are no emissions from *Other land remaining Other land* so the emissions of 10 335 Gg CO_2e in 2024 are from Lands converted to Other lands (Table 6.57). These emissions have increased by 67.8% since 1990, with an almost doubling occurring from 2015 (Figure 6.17). This increase was due to an increase in the conversion of *Forest land to Other land* between 2015 and 2020 and a further increase in the conversion of *Grassland to Other land* between 2020 and 2024.

Table 6.57: *Other land* emissions for 1990 and 2024

Category	Pool	Gas	1990	2024	Change between 1990-2024 (%)
			Emissions (Gg CO_2e)	Emissions (Gg CO_2e)	
Other lands	All	All	6 159	10 335	67.8
Other lands	All	CO_2	5 981	10 093	68.7
Other lands	All	CH_4	0	0	0.0
Other lands	All	N_2O	178	241	35.8
Other lands remaining Other lands	All	All	0	0	0.0
Land converted to Other land	All	All	6 159	10 335	67.8

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Other lands	Biomass	All	2 393	5 176	116.3
Other lands	DOM	All	622	1 287	107.0
Other lands	Mineral soil	All	2 967	3 631	22.4

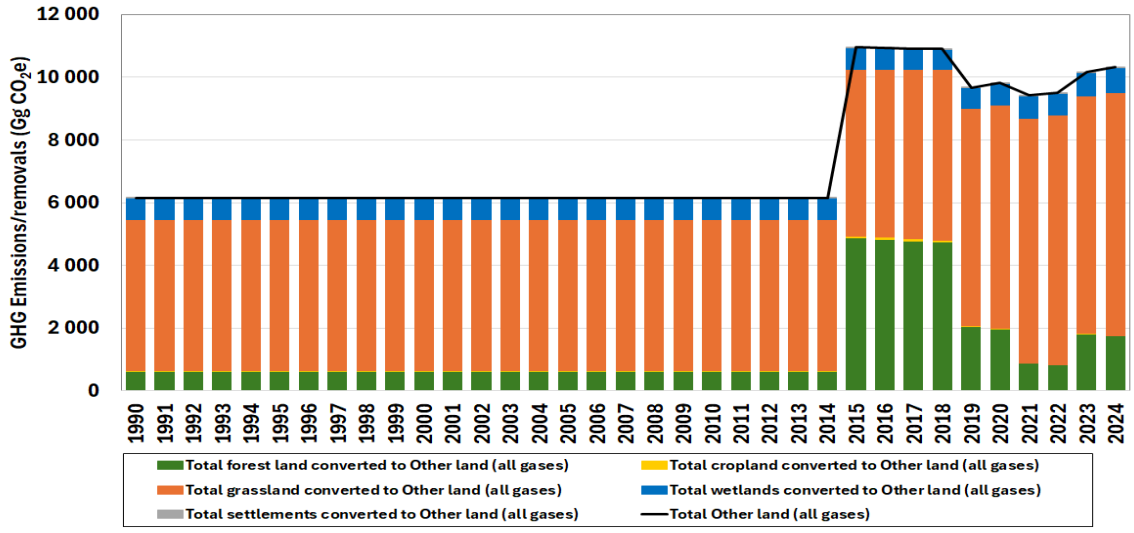


Figure 6.17: *Other land* emission trends, 1990-2024

6.11.2 Methodological issues

Methodologies and emission factors applied for *Other land* emission estimation are provided in Table 6.58. *Other lands* were not a key category in the previous inventory, so a Tier 1 approach is suitable.

Table 6.58: Methodologies and EF applied for estimating emissions from *Other land*

Category	Gas	Method used	Source of activity data	Emission factor used
Other lands remaining Other lands	CO_2	Tier 1	CS	D/CS
Other lands remaining Other lands	CH_4	NO	NA	NA
Other lands remaining Other lands	N_2O	Tier 1	CS	D

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Land converted to Other land	CO_2	Tier 2	CS	CS
Land converted to Other land	CH_4	NO	NA	NA
Land converted to Other land	N_2O	Tier 1	CS	D

(NO = Not occurring; NA = Not applicable; CS = Country specific; D = IPCC default)

6.11.2.1 Land area activity data

The activity data was country specific land area data determined as outlined in section 6.3 with an Approach 2 methodology and included areas for both *Other land remaining Other land* and *Land converted to Other land* (Table 6.59).

Table 6.59: Country specific land areas (kha) (including the 20-year transition period) for *Other land*

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Other land remaining Other land	10 982	10 937	10 893	10 849	10 804	10 760	10 715	10 671	10 627
Land converted to Other land	2 539	2 539	2 539	2 539	2 539	2 539	2 539	2 539	2 539
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Other land remaining Other land	10 582	10 538	10 494	10 449	10 405	10 361	10 316	10 272	10 228
Land converted to Other land	2 539	2 539	2 539	2 539	2 539	2 539	2 539	2 539	2 539
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Other land remaining Other land	10 183	10 139	10 094	10 050	10 006	9 961	9 917	9 887	9 857
Land converted to Other land	2 539	2 539	2 539	2 539	2 539	2 539	2 539	2 582	2 625
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	
Other land remaining Other land	9 826	9 796	8 863	7 931	7 158	6 385	5 459	4 532	
Land converted to Other land	2 667	2 710	2 856	3 003	3 166	3 330	3 476	3 623	

6.11.2.2 Biomass gains

Other lands do not have vegetation, therefore there were no gains for *Other lands remaining other lands*.

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6.11.2.3 Biomass losses

No gains were included for *Other lands remaining other lands*, and therefore, due to equivalence, no losses were included either.

6.11.2.4 Carbon gains and losses for land conversions

Land converted to Other lands biomass gains were estimated using a Tier 2 approach (IPCC 2006 Guideline equations 2.15 and 2.16). For *land converted to other lands* the only biomass losses were the initial carbon losses due to the removal of biomass (i.e. $\Delta C_{CONVERSION}$). This was calculated for the area of land undergoing a conversion in a given year, and in subsequent years it was zero. Converted lands remain in the converted category for a period of 20 years.

The biomass values for the initial land types are given in the relevant land category sections, while biomass data for *Other lands* is zero. It was assumed that only croplands and forest plantations were cleared before being converted to other lands, while all other conversions were slow transitions and not abrupt changes.

6.11.2.5 Litter

The DOM pool for *Other lands* was not identified as a key category in the previous inventory, so a Tier 1 methodology was applied. As there is no vegetation there is also no litter in *Other lands remaining other lands*. Changes in the DOM pool in converted land was estimated using IPCC 2006 Guidelines equation 2.23. The initial DOM is given in the relevant land category section, and the final DOM for *Other lands* is zero. All losses are assumed to occur within the year of conversion (Tier 1).

6.11.2.6 Soil carbon

6.11.2.6.1 Mineral soils

Soil carbon changes in *Other lands* were estimated as described in sections 6.3.4.1 and 6.4.3. The IPCC 2006 Guidelines Tier 1 methodology assumes that soil carbon stocks will decline to zero after conversion. In the inventory, however, the land conversion matrixes show large areas of conversion between bare ground (*Other land*) and other land categories such as low shrubland and grasslands. This suggests that some of the bare ground area may only be temporarily bare but can have vegetation growing on them. These conversions could be associated with seasonal variation (i.e. whether the land cover maps are for dry or wet years). In addition, this *Other land* category includes deserts and even deserts are shown to still have carbon in the soil (DEA, 2015). The soil

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carbon in all the *Other land* area is therefore unlikely to have a soil carbon value of zero. For this reason, a Tier 2 approach for SOC estimation for land converted to *Other land* was applied where the reference carbon stock at the end of the 20 year default transition period was not assumed to be zero and country specific reference carbon stocks at the end of the 20 year period are applied with stock change values set at 0.7.

6.11.2.6.2 Organic soils

Organic soils were not separated from mineral soils for *Other lands*, therefore all soils were included under mineral soils.

6.11.2.7 Direct and indirect N_2O from N inputs

There are no nitrogen inputs to *Other lands* so these emissions were indicated to not occur (NO).

6.11.2.8 Emissions and removals from drainage and rewetting

This is not included in this inventory for *Other lands*.

6.11.2.9 Direct and indirect N_2O from N mineralisation/immobilisation

Direct N_2O from N mineralisation/immobilisation associated with loss of soil carbon from soil organic matter as a result of changes to land use were incorporated through the application of the IPCC 2006 Guidelines equations 11.1 and 11.8. The annual loss of carbon due to land use change comes from analysis described in section 6.6.2.6.1 and the C:N ratio of 12.5 was obtained from IPCC 2006 Guidelines (average of 10 and 15). The IPCC 2019 Refinement emission factor was 0.01 kg N_2O-N/kg N.

Indirect emissions from N leaching and runoff were estimated with IPCC 2006 Guidelines equation 11.10 with a $Frac_{LEACH}$ of 0.24 kg N/kg N additions and an emission factor of 0.01 kg N_2O-N/kg N leached/runoff (IPCC 2019 Refinement, Chapter 11, Table 11.3).

6.11.2.10 Non-CO_2 emissions from biomass burning

As there is no biomass on bare ground it is assumed that there is no biomass burning occurring on these lands.

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6.11.3 Uncertainty

Uncertainties were provided for individual factors, based on literature and the IPCC 2006/2019 Refinement Guideline default values, and were combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

6.11.3.1 Activity data uncertainty

Uncertainty for the land areas were provided by the SANLC data accuracy assessments (DFFE, 2021). *Other lands* have a high uncertainty and there are numerous conversions with natural land cover classes. An additional 20% was added to this for uncertainty on the mapped area corrections. The uncertainty for converted areas was taken to be the combined uncertainty (applying the propagation of errors as indicated in IPCC 2006 Guidelines) for the two land areas. The results of this approach indicate the converted lands have a higher uncertainty than the individual land types as is to be expected. Mapped areas for land converted to Other lands had an estimated uncertainty of ±60.6%.

The soil maps are estimated to have an uncertainty of ±10%. The overall activity data uncertainty for *Other lands remaining other lands* was estimated at ±30.2%. For land converted to *Other lands* the uncertainty was estimated at ±61.8%.

6.11.3.2 Emission factor uncertainty

There is no growth or DOM stock on *Other lands*, but there are uncertainties associated with SOC changes. The CO_2 emission factor uncertainty for *Other lands* was estimated at ±35%, while for land converted to settlements it was ±40%. There is no biomass burning, nitrogen inputs or drainage and rewetting emissions.

6.11.4 Time-series consistency

The land change maps had some inconsistency in that there was a switch from Landsat to Sentinel data between 2014 and 2018, however some corrections were made to bring these two datasets into alignment. All other datasets were consistent through the time-series, using the same methodology and data sources. The calculations are consistent over time and complete for the entire reporting period (1990-2024).

6.11.5 Category specific QA/QC and verification

Part of the quality control process was to check methodologies and outputs against the IPCC software. It was noted that the final SOC reference value for conversion to *Other land*

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is set at zero and cannot be changed. The IPCC software does not allow for a Tier 2 approach as used in this inventory and this was queried during an IPCC software training course. It was indicated that there may need to be a more detailed assessment of the bare ground so that the area which potentially still has soil carbon (such as deserts) can be reclassified into a vegetation class in the *Grassland* category. If the IPCC software is going to be used in the future this reclassification would be required.

6.11.6 Category specific recalculations

The main improvements that led to recalculations in this *Other land* category are:

- Inclusion of 2020-2022 land change map.
- Updated land change matrix corrections for change in technology between 2014 and 2018, and wet and dry season variations.
- Removal of error from 2014 onwards (mentioned in last inventory) relating to a correction for land conversions on already converted land.
- Incorporation of soil type map overlay with 2014-2018, 2018-2020 and 2020-2022 land cover maps.

The recalculations due to these improvements led to a 50% reduction (9 506 Gg CO_2e) in the emissions from *Other lands* in 2022 compared to the previous submission.

6.11.7 Category specific planned improvements

The soil carbon levels in *Other lands* will be investigated further in the next inventory to ensure that the most appropriate data (final soil carbon, stock change factors) and methodology is being applied correctly for lands converted to *Other lands*. The classification of *Other lands* will also be studied in more detail to determine if changes need to be made in future. The *Other land* category is very large, and it may be more appropriate to shift some of the area to another subcategory of *Grasslands*. This may improve transparency.

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6.12 Harvested wood products (CRT 4.G)

6.12.1 Category description

Much of the wood that is harvested from *Forest lands* remains in products for differing lengths of time. This section of the report estimates the contribution of these harvested wood products (HWPs) to annual CO_2 emissions or removals. *HWPs* include all wood material that leaves harvest sites from forest plantations. Wood that is collected from woodlands for household use for cooking is not included in this category. HWP in Solid Waste Disposal Sites (SWDS) are also not included.

HWP's are a net sink for the full time-series and the sink shows an increasing trend since 1990. The sink increased by 65.9% between 1990 and 2024 (Table 6.60). The trend in emissions between 1990 and 2024 are provided in Figure 6.18.

Table 6.60: HWP emissions and removals between 1990 and 2024.

Category	Gas	1990	2024	Change between 1990-2024 (%)
		Emissions (Gg CO_2e)	Emissions (Gg CO_2e)	
HWP	CO_2	-1 036	-1 718	65.9

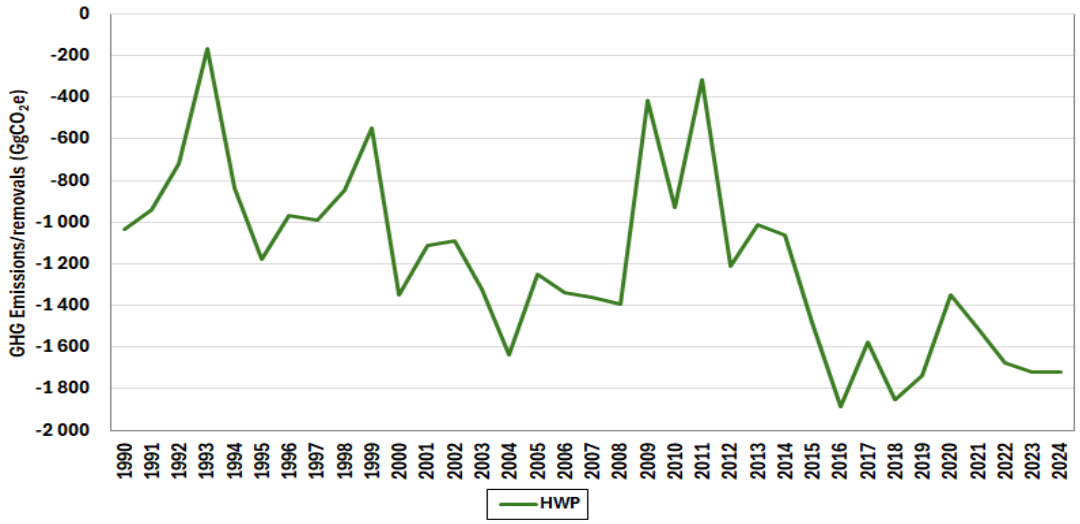


Figure 6.18: Trend in *HWP* CO_2 removals, 1990-2024

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6.12.2 Methodological issues

Emissions and removals arising from HWP were estimated following the guidance provided in the IPCC 2019 Refinement (Chapter 12). A Tier 1 First Order Decay approach was implemented (equations 12.1-12.3), and the CO_2 inflow was determined following the Production Approach (equations 12.7-12.10). In the previous submission the IPCC 2006 Guidelines methodology was applied, but the 2019 Refinement was selected for this submission. The methodological approaches are very similar but the refinement was selected as it considers new relevant scientific information and provides clearer guidance for completing the emission estimates.

HWP from forest plantations are included in this section and it does not include fuelwood harvested from woodlands for domestic purposes. It also does not include wood disposed of in SWDS.

6.12.2.1 Activity data

Activity data is required for 1960 onwards for HWP estimation, however country specific data from Forestry SA (collected annually) is only available for 1980 onwards. FAOSTAT data was therefore used to extend the timeline back to 1960 (as well as for filling data gaps). If FAO data had gaps in the time-series the IPCC interpolation technique was used to fill these gaps. If the gaps were at the beginning of the time-series, then production data was extended with linear extrapolation and import/export data were assigned a value of zero. In addition, Forestry SA data is only available until 2019 so additional data was sought to complete the time-series to 2024. The data sources are provided in Table 6.61 and the activity data is provided in Table 6.62 and Table 6.63.

Table 6.61: HWP activity data sources

Data type		Details of data source
Industrial round wood	Production	Forestry SA statistics (South African Forestry & Forest Products Industry Facts 1980-2019); extrapolation for 2020-2024 as described in section 6.6.2.2.3). FAO data matches very well with this data set so FAO data used for 1961-1979.
	Imports and exports	FAOSTAT 1960-2024
Sawnwood	Production	Forestry SA statistics (South African Forestry & Forest Products Industry Facts 1980-2017, Sales data in table 20 (https://forestry.co.za/industry-info/statistical-data/) for 1980-2017.

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Data type		Details of data source
		FSA and FAO data match very well so FAO data used for 1961-1979 and 2018-2024.
	Imports and exports	FAOSTAT 1960-2024
Wood panels	Production	Forestry SA statistics (South African Forestry & Forest Products Industry Facts 1980-2017, Sales data in table 20 (https://forestry.co.za/industry-info/statistical-data/) for 2000-2017. FSA and FAO data match quite well so FAO data used for 1961-1979 and 2018-2024.
	Imports and exports	FAOSTAT 1960-2024
Paper and paperboard	Production	PAMSA Reports for 2001-2024. Data matches very well with FAO so FAO data applied for years 1961-2000.
	Imports and exports	FAO data was slightly lower than the FSA data so the IPCC overlap splicing technique was used to adjust the FAO data for 1961-2000 and 2019-2020.
Wood pulp	Production	Forestry SA statistics (South African Forestry & Forest Products Industry Facts 1980-2017, Sales data in table 20 (https://forestry.co.za/industry-info/statistical-data/) for 1980-2000; PAMSA Reports for 2008 onwards. FAO data matches will with FSA data therefore FAO data used for 1961-1979.
	Imports and exports	FAO data was slightly lower than the FSA data so the IPCC overlap splicing technique was used to adjust the FAO data for 1961-2000 and 2016-2020.
Recovered paper	Production	PAMSA Reports; PRASA Paper recycling statistics reports for 2010 onwards. Data the same as FAO so FAO data used for 1961-2009
	Imports and exports	FAOSTAT 1960-2024

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Table 6.62: Activity data for estimating *HWP* emissions and removals

Year	Industrial roundwood			Sawnwood			Wood panels		
	Production	Imports	Exports	Production	Imports	Exports	Production	Imports	Exports
	(m^3/yr)								
1990	17 650 820	6 051	18 198	1 796 196	80 202	106 946	283 700	5 407	74 725
1991	17 545 290	9 921	79 762	1 793 063	80 202	106 946	274 000	5 407	74 725
1992	17 794 081	105 266	64 756	1 644 136	530 869	94 863	392 000	65 056	60 557
1993	17 645 533	66 145	419 821	1 315 022	60 943	63 801	189 000	9 456	33 192
1994	19 127 778	82 078	462 371	1 498 437	542 100	66 778	545 000	22 970	61 019
1995	19 060 473	102 830	231 311	1 574 424	413 000	57 000	618 000	93 400	42 900
1996	20 076 766	84 298	433 920	1 430 005	466 200	47 500	618 000	99 000	17 100
1997	20 504 985	10 961	277 302	1 319 902	438 000	73 600	618 000	49 100	16 100
1998	17 090 998	17 628	234 362	1 556 243	384 300	91 000	401 000	52 800	21 200
1999	17 434 523	14 690	340 130	1 378 935	510 200	134 100	401 000	52 700	24 000
2000	18 660 619	14 690	340 130	1 446 303	510 200	134 100	706 210	52 700	24 000
2001	18 494 152	13 355	156 244	1 716 031	427 000	107 800	767 058	49 584	79 500
2002	18 521 086	18 080	435 969	1 689 628	380 000	110 000	685 985	75 100	82 600
2003	21 459 013	24 502	343 280	2 006 044	480 000	123 306	733 389	119 547	67 664
2004	22 652 164	42 933	419 096	2 183 847	360 349	84 279	692 196	166 969	76 670
2005	24 537 662	42 367	285 867	2 243 209	464 350	63 971	512 802	231 514	82 249
2006	25 465 815	57 306	216 211	2 016 053	487 200	62 782	726 213	330 280	50 770
2007	22 628 073	57 306	216 211	1 892 171	535 300	78 500	820 289	319 800	35 300
2008	22 450 035	68 319	242 666	2 051 769	487 690	55 323	891 817	156 109	37 316
2009	20 990 015	39 961	237 021	1 908 347	297 000	14 726	625 228	148 192	77 678
2010	19 473 611	9 161	201 167	1 880 498	350 904	22 976	540 526	179 428	69 647
2011	20 585 783	3 102	179 446	1 568 004	302 030	18 338	551 564	277 954	99 396
2012	20 217 222	1 742	147 754	1 443 105	153 000	119 500	1 228 421	130 644	101 958
2013	19 880 460	14 593	222 935	1 588 558	341 343	123 353	1 153 878	167 659	88 912
2014	18 757 273	7 244	342 015	1 918 244	318 509	165 796	1 013 112	275 241	133 885
2015	19 941 125	43 697	301 710	2 012 515	258 620	150 720	1 227 663	208 252	169 400
2016	18 298 167	32 215	269 687	2 144 045	186 440	214 740	1 446 535	245 994	179 836
2017	20 424 180	44 353	718 414	2 141 199	267 905	264 510	1 466 502	241 688	220 796
2018	20 859 735	18 970	706 250	2 259 317	216 134	287 440	1 513 031	197 335	242 494
2019	18 510 348	49 852	514 673	2 259 317	318 225	219 000	1 513 431	254 044	276 587
2020	15 913 711	24 661	340 272	2 105 000	328 000	205 755	1 546 431	229 987	250 374
2021	17 984 503	56 418	510 915	2 105 000	250 000	301 430	1 546 431	280 314	223 163
2022	19 100 828	100 808	868 929	2 105 000	234 000	288 991	1 546 431	279 335	224 273
2023	18 280 463	53 847	955 980	2 105 000	158 000	177 470	1 546 431	241 494	323 909

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Year	Industrial roundwood			Sawnwood			Wood panels		
	Production	Imports	Exports	Production	Imports	Exports	Production	Imports	Exports
	(m^3/yr)								
2024	18 280 463	53 847	955 980	2 105 000	158 000	177 470	1 546 431	241 494	323 909

Table 6.63: Activity data for estimating *HWP* emissions and removals

Year	Paper and paperboard			Wood pulp			Recovered paper		
	Production	Imports	Exports	Production	Imports	Exports	Production	Imports	Exports
	(t/yr)								
1990	1 904 000	178 717	146 927	1 774 494	150 807	377 177	510 000	7 984	6 396
1991	1 904 000	178 717	146 927	1 846 988	150 807	377 177	525 000	7 984	6 396
1992	1 800 000	293 890	417 128	1 866 177	55 238	465 077	598 000	19 939	6 918
1993	1 710 000	283 105	404 188	1 828 397	78 886	429 062	590 000	39 602	2 002
1994	1 684 000	311 895	698 185	2 106 973	83 993	525 171	590 000	18 264	5 970
1995	1 871 000	352 338	642 663	2 206 892	84 800	615 853	590 000	21 000	15 000
1996	1 871 000	357 132	575 709	2 902 476	131 449	886 708	590 000	6 400	1 000
1997	2 047 000	312 310	388 532	2 919 634	131 449	616 076	590 000	6 400	1 000
1998	2 105 000	303 614	680 641	2 215 322	105 878	654 261	590 000	10 000	22 000
1999	2 041 000	316 545	701 479	2 115 588	96 755	862 439	590 000	2 700	13 200
2000	2 426 000	316 545	707 631	2 126 641	96 755	862 439	690 000	2 700	13 200
2001	2 258 000	254 000	933 606	2 138 000	53 000	659 382	770 000	3 200	13 200
2002	2 332 000	265 000	784 956	2 183 000	64 000	711 259	770 000	4 800	12 900
2003	2 337 000	371 000	1 098 978	2 317 000	71 000	918 666	923 000	11 721	20 620
2004	2 522 000	399 000	1 160 892	2 073 000	71 000	1 009 721	923 000	2 803	18 555
2005	2 483 000	449 000	1 101 895	2 193 000	70 000	839 955	923 000	8 500	48 448
2006	2 610 000	670 000	921 939	2 222 000	127 000	845 794	923 000	20 519	39 300
2007	2 727 000	708 000	1 115 054	2 311 000	82 000	815 469	923 000	20 519	39 300
2008	2 726 000	645 000	1 084 000	2 572 000	114 000	849 000	1 030 000	31 800	23 893
2009	2 244 000	706 000	794 000	2 130 000	99 000	1 008 000	1 129 955	31 064	14 863
2010	2 497 000	708 000	735 000	2 307 000	77 000	985 000	1 090 198	30 752	50 572
2011	2 261 000	738 000	547 000	2 321 000	79 000	1 113 000	1 064 509	32 876	71 541
2012	2 427 000	805 000	565 000	2 259 000	88 000	998 000	1 151 315	35 156	103 092
2013	2 318 183	824 629	610 568	1 985 000	144 000	1 047 000	1 169 296	45 252	98 699
2014	2 261 790	761 128	732 474	1 967 000	230 000	1 165 000	1 063 129	72 060	55 398
2015	2 289 109	791 601	665 753	1 982 000	214 000	1 128 000	1 196 026	69 244	49 069
2016	2 352 989	747 879	719 426	2 221 547	228 758	1 151 566	1 399 039	57 645	105 620
2017	2 180 061	715 471	640 456	2 250 857	228 664	1 267 317	1 282 120	57 895	120 920

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Year	Paper and paperboard			Wood pulp			Recovered paper		
	Production	Imports	Exports	Production	Imports	Exports	Production	Imports	Exports
	(t/yr)								
2018	2 223 213	785 719	664 257	2 139 000	283 769	1 254 761	1 285 250	53 928	155 086
2019	2 159 000	791 307	529 885	1 937 000	244 035	1 269 692	1 201 909	49 312	95 472
2020	1 891 000	679 712	606 583	1 721 000	204 155	1 176 910	1 101 356	40 912	99 392
2021	1 909 000	761 000	540 000	1 591 000	199 000	1 160 000	1 149 346	53 614	144 836
2022	2 018 000	1 026 000	460 000	1 682 000	274 000	1 340 000	1 251 319	51 906	156 238
2023	2 120 000	752 302	500 777	1 700 000	168 831	1 270 000	1 200 000	40 138	167 683
2024	2 120 000	752 302	500 777	1 900 000	168 831	1 270 000	1 166 830	40 138	167 683

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6.12.2.2 *Emission factors*

IPCC default factors (IPCC 2019 Refinement, Table 12.2 & 12.3) incorporated into the emission calculations are shown in Table 6.64.

Table 6.64: Parameters applied in the HWP equations

	Half life	Average lifetime	Decay rate	Conversion factors (t C/m³ or t C/adt)
Sawn Wood	35	50.5	0.02	0.229
Wood panels	25	36.1	0.028	0.269
Paper & paperboard	2	2.9	0.347	0.386

6.12.3 Uncertainty

Uncertainties for activity data and parameters associated with HWP variables are provided in the IPCC Guidelines (IPCC 2006 Guidelines, Volume 4, p. 12.22). Production and trade data have an uncertainty of ±50% since 1961, while the product volume to product weight factors and oven-dry product weight to carbon weight have uncertainties of ±25% and ±10%, respectively. There was also a ±50% uncertainty on the half-life values.

6.12.4 Time-series consistency

Data from FAO and Forestry SA were combined, but splicing techniques were used to ensure the time-series is consistent. There were also some additional data sources for the country specific data between 2020 and 2024, but consistencies were checked by looking at data overlaps to ensure time-series consistency.

6.12.5 Category specific QA/QC and verification

Forestry SA production, import and export data was compared to FAOSTAT for all products (see example in Figure 6.19). The emissions from *HWP* were also estimated using the IPCC software (version 2.980.9306.14596) and compared (Figure 6.20). It is noted that there are some differences between the two data sets, particularly for 2003 and 2004. Some small difference may be expected since IPCC software applies IPCC 2006

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Guidelines methodology, but the large differences in 2003 and 2004 will need to be investigated further.

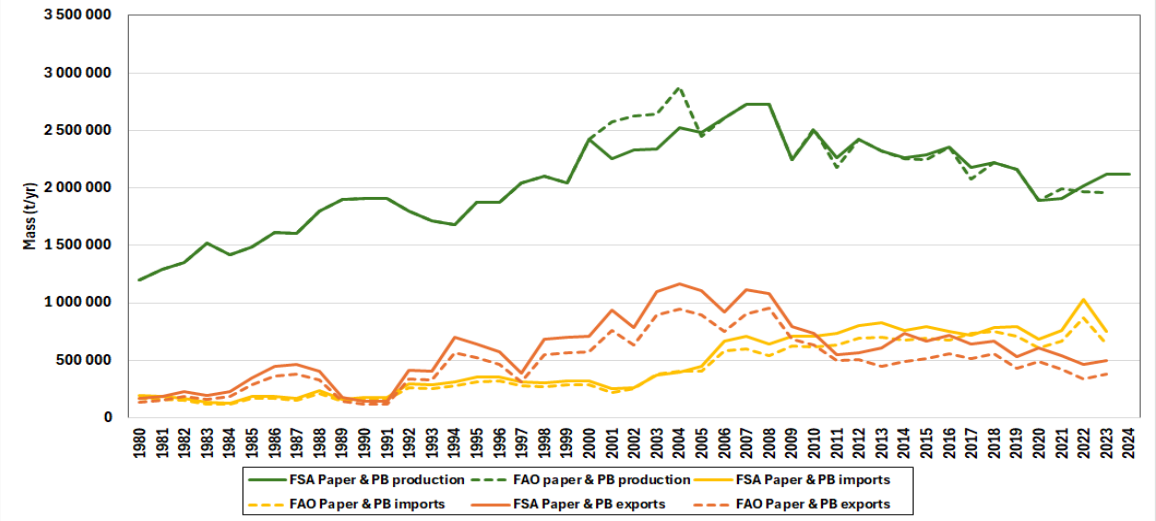


Figure 6.19: Example comparison between Forestry SA and FAO data

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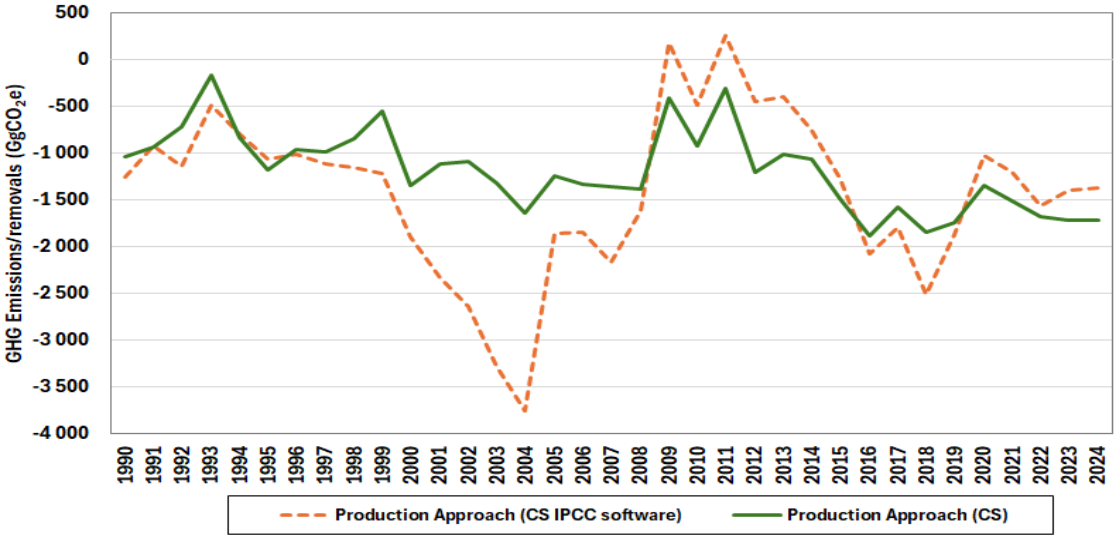


Figure 6.20: Comparison of inventory HWP emissions with emissions estimated with IPCC software

The IPCC software was used to compare the outputs from the production approach with the other IPCC 2006 Guidelines methodologies (Figure 6.21), namely Stock change, Atmospheric Flow and Simple Decay Approach. All the approaches had a similar trend, but the Atmospheric flow approach produced a much larger sink than the Production approach. The Production, Simple decay and Stock change approaches were more closely aligned. Unfortunately, due to a lack of time a comparison of the different approaches using the IPCC 2019 Refinement methodology used in this inventory was not completed. This will provide a more direct comparison, so will be completed for the next inventory.

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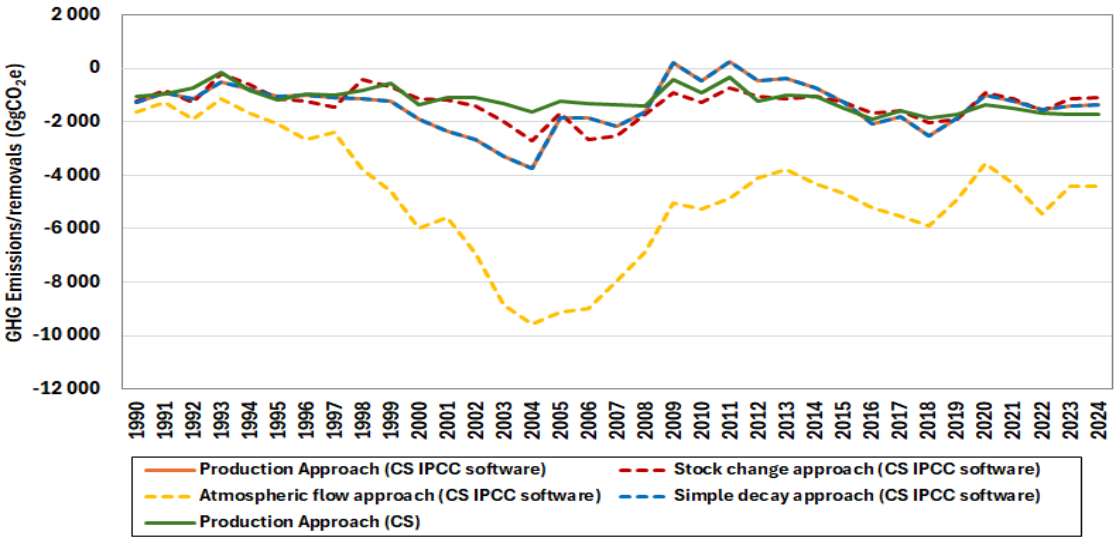


Figure 6.21: Comparison of production approach with other IPCC approaches

6.12.6 Category specific recalculations

Recalculations were performed for the full time-series due to the change in methodology and the improvement of the activity data time-series. There were only small differences (<20%) between the current inventory and the previous inventory for the years between 2009 and 2020, while the sink was reduced by about 3-fold between 1990 and 2009 (Figure 6.22). There were also slightly larger differences in 2021 and 2022 where the sink was reduced by 31% (468 Gg CO_2e) and 40% (671 Gg CO_2e) respectively compared to the previous submission. The differences are due to the use of country specific data from 1980 and the improved activity data. The resultant sink shows less variation than the previous submission.

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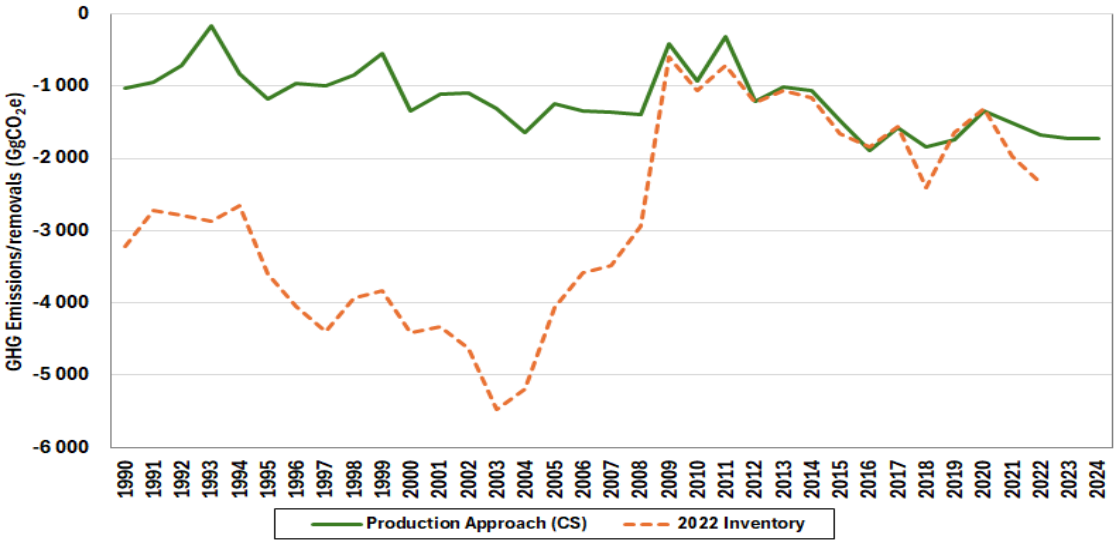


Figure 6.22: Recalculations of the *HWP* CO_2 removals compared to the previous submission

6.12.7 Category specific planned improvements

As was stated in the previous inventory a more detailed assessment of *HWP* is required to include a wider range of products and improve data collection. This was highlighted in the TERT review (FCCC/ETF/TERR.1/2024/ZAF/Add.1; ID# 6.L_CBN.2) but has not yet been done as funds would need to be made available for such a study.

6.13 Other (CRT 4.H)

South Africa does not have any additional emissions, so nothing was included under this category.

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Government Gazette
Staatskoerant

REPUBLIC OF SOUTH AFRICA
REPUBLIEK VAN SUID AFRIKA

Vol. 731 29 May Mei 2026 No. 54758

PART 5 OF 7

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ISSN 1682-5845

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Chapter 7: Waste (CRT sector 5)

7.1 Sector overview

The waste sector covers GHG emissions from the following sources:

- *Solid Waste Disposal;*
- *Biological Treatment of Solid Waste;*
- *Open Burning of Waste (including pyrolysis);* and
- *Wastewater Treatment and Discharge.*

7.1.1 Overview of shares and trends in emissions

The total emissions from the Waste sector in 2024 is 19 245 Gg CO_{2e} as shown in Table 7.1. The majority of Waste sector emissions are from wastewater treatment and discharge accounting for 47% of the emissions, followed by *Solid waste disposal* accounting for 38%. Emissions from *Biological treatment of solid waste* and *Open burning of waste* only contribute 14% and 1% respectively.

An overview of the Waste emissions trends for the period 1990-2024 can be seen in Figure 7.1. Waste sector emissions have increased by 69.6% since 1990.

Table 7.1: Summary of the change in Waste sector emissions between 1990 and 2024

Source Categories	Emissions (Gg CO2e)		Change (%)	Contribution (%)
	1990	2024	1990-2024	
5 - Waste	**11 346**	**19 245**	**69.6**	
5A - Solid Waste Disposal	**2 822**	**7 377**	**161.4**	**38.3**
5B - Biological Treatment of Solid Waste	**1 346**	**2 620**	**94.7**	**13.6**
5C - Incineration and Open Burning of Waste	**156**	**260**	**66.7**	**1.3**
5C1 - Waste Incineration	*NE*	*NE*	*NE*	
5C2 - Open Burning of Waste	*156*	*241*	*54.7*	***1.3***
5D - Wastewater Treatment and Discharge	**7 022**	**9 007**	**28.3**	**46.8**
5D1 - Domestic Wastewater Treatment and Discharge	*2 772*	*4 287*	*54.7*	***22.3***
5D2 - Industrial Wastewater Treatment and Discharge	*4 251*	*4 720*	*11.0*	***24.5***
5E-Other (please specify)	**NE**	**NE**	**NE**	

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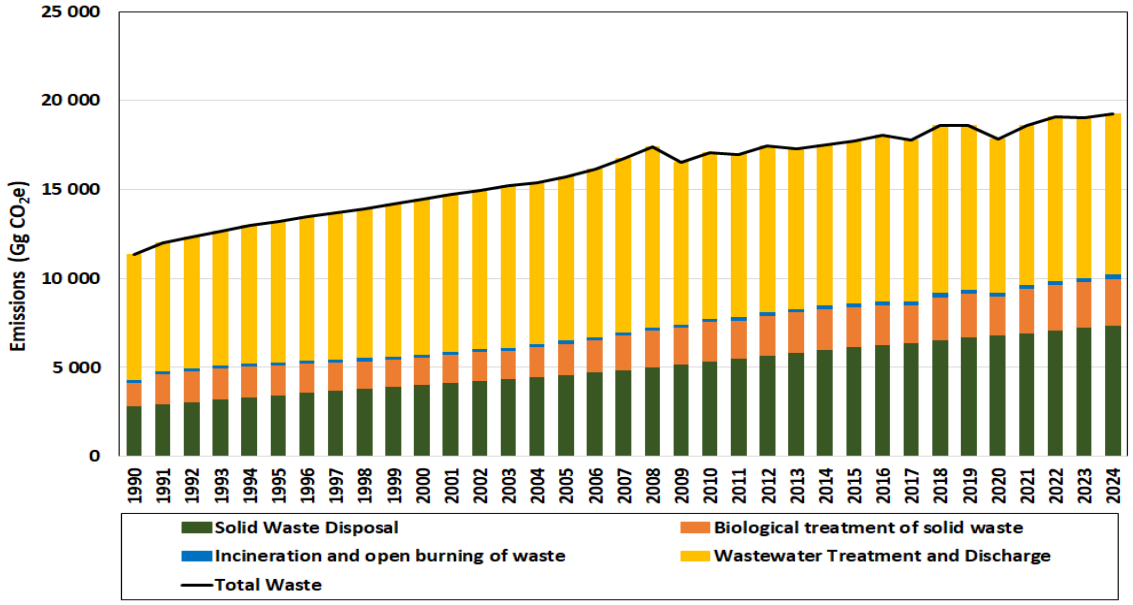


Figure 7.1: Trend in emissions from Waste sector, 1990-2024

Emissions from all waste categories have increased since 1990 (Table 7.1). However, comparing the current (2024) and the previous GHG inventory (2022) emissions from *Solid waste disposal*, *Biological treatment of solid waste*, and *Open burning of waste* have increased since 2024. The *Wastewater treatment and discharge* experienced a decreased in emissions by 2.5%, the decrease came from the industrial wastewater treatment and discharge as seen in Table 7.2.

Table 7.2: Summary of the change in emissions from South Africa's Waste sector between 2022 and 2024

Source Categories	Emissions (Gg CO2e)		Change (%)
	2022	2024	2022-2024
5 - Waste	**19 107**	**19 245**	**0.7**
5A - Solid Waste Disposal	**7 105**	**7 377**	**3.8**
5B - Biological Treatment of Solid Waste	**2530**	**2 620**	**3.5**
5C - Incineration and Open Burning of Waste	**237**	**241**	**1.6**
5C1 - Waste Incineration	*NE*	*NE*	*NE*
5C2 - Open Burning of Waste	*237*	*241*	*1.6*

5D - Wastewater Treatment and Discharge	**9 235**	**9 007**	**-2.5**
5D1 - Domestic Wastewater Treatment and Discharge	*4 219*	*4 287*	*1.6*
5D2 - Industrial Wastewater Treatment and Discharge	*5 016*	*4 720*	*-5.9*
5E-Other (please specify)	**NE**	**NE**	**NE**

7.1.2 Overview of methodology and completeness

Table 7.3 shows a summary of methods and tier levels used for the waste inventory.

Table 7.3: Summary of methods and emission factors for the Waste sector and an assessment of the completeness of the Waste sector emissions

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	
A	Solid waste disposal	NA	NA	T1	DF	NA	NA	Tier 1 FOD model was used.
B	Biological treatment of solid waste	NA	NA	T1	DF	T1	DF	IPCC 2006 Guidelines
C	Incineration and open burning of waste	T1	DF	T1	DF	T1	DF	IPCC 2006 Guidelines
D	Wastewater treatment and discharge	NA	NA	T1	DF, CS	T1	DF	IPCC 2006 Guidelines

7.1.3 Improvements and recalculations

Recalculations were performed for the Waste sector because of the following reasons:

- Updated the Methane correction factors (2019 State of waste report).
- Updated the waste generation rate (2019 State of waste report).
- Updated the waste composition (2019 State of waste report).
- Removed the Methane recovery data on the Solid waste results (reliable information gathering is ongoing to include this information in the NID).

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The recalculations show a change in the trend throughout the time series (Figure 7.2). The emissions are lower after the recalculations compared to the previous inventory.

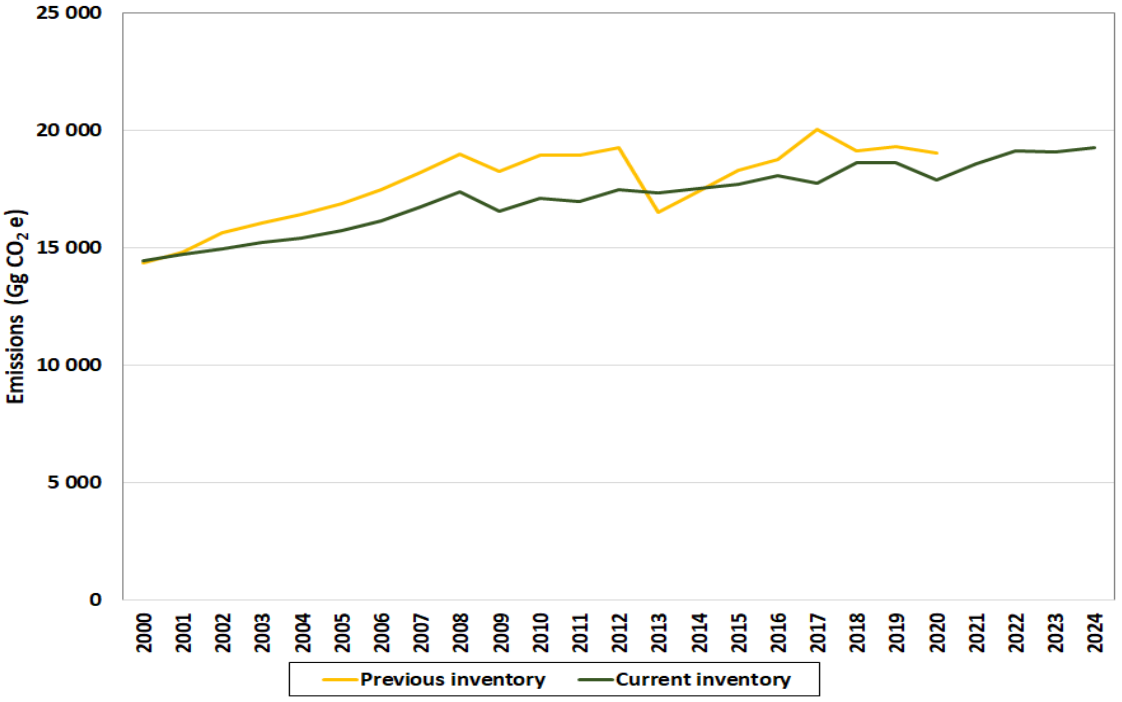


Figure 7.2: Change in Waste emission estimates due to recalculations since 2022 submission.

7.1.4 Key categories in the Waste sector

The key categories for the Waste sector as determined by level (L) and trend (T) assessment are shown in Table 7.4.

Table 7.4: Key categories in the Waste sector

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IPCC Code	Category	GHG	Criteria
5D	Wastewater Treatment and Discharge	CH_4, N_2O	L, T
5A	Solid Waste Disposal	CH_4	L, T
5B	Biological treatment of waste	CH4	L,T

7.1.5 QA/QC process and verification

QA/QC measures in Table 7.5 below were used for the waste sector calculation files.

Table 7.5: General QA/QC checks completed for the Waste sector

QA/QC principle	Check
Accuracy	Activity data source
Accuracy	Correct units
Accuracy	Unit carry through
Accuracy	Method validity
Accuracy	Calculations check
Accuracy	Uncertainties
Accuracy	Double counting
Accuracy	Correct GWP
Accuracy	Notation keys
Accuracy, Completeness, Consistency, Transparency	Trend check
Accuracy, Transparency	Emission factor applicability
Accuracy, Transparency, Consistency, Completeness	Recalculations
Completeness, Comparability	Sub-category completeness
Consistency	Time series consistency
Transparency	Documentation
Transparency, Completeness, Consistency, Accuracy	Colour coding
Accuracy, Comparability	Cross check data
Accuracy	Spot checks
Transparency, Consistency	Data source referencing
Transparency	Links to source data
Transparency	Raw primary data
Accuracy	QA review

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7.1.6 Planned improvements.

The most challenging task in estimating GHG emissions in South Africa was the lack of specific-activity and emissions factor data. As a result, estimations of GHG emissions from both *Solid waste* and *Wastewater* sources were largely computed using default values suggested in IPCC 2006 Guidelines and, therefore, margins of error were large. No specific improvements are planned; however, South Africa has identified the following areas to be considered in the improvement plan:

- Obtain data on the quantities of waste disposed of into managed and unmanaged landfills including its composition.
- Improve the reporting of economic data (e.g., annual growth) to include different population groups. The assumption that GDP growth is evenly distributed (using a computed mean) across all the population groups is highly misleading and leads to exacerbated margins of error.
- Obtain information on population distribution trends between rural and urban settlements as a function of income; and
- Conduct a study to trace waste streams and obtain more information on the bucket system which is still widely used in South Africa.
- Collect data on CH_4 recovery at SWDS based on metering data.

7.2 Solid Waste Disposal (CRT 5.A)

7.2.1 Category description

Waste streams deposited into managed landfills in South Africa comprise waste from households, commercial businesses, institutions, and industry. In this report only the organic fraction of the waste in solid disposal sites was considered as other waste stream components were assumed to generate insignificant quantities in landfills. The types of waste included are municipal waste, industrial waste, and sewage sludge waste. Furthermore, GHG's generated from managed and unmanaged disposal landfills in South Africa were included.

According to the IPCC 2006 Guidelines, emissions from flaring are however not significant, as the CO_2 emissions are of biogenic origin and the CH_4 and N_2O emissions are very small, so good practice in the waste sector does not require their estimation. In addition, according to the guidelines, it is good practice to only estimate and report CH_4 recovery when references documenting the amount of CH_4 recovery are available.

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Reporting based on metering of all gas recovered for energy and flaring or reporting of gas recovery based on the monitoring of produced amount of electricity from the gas (considering the availability of load factors, heating value and corresponding heat rate, and other factors impacting the amount of gas used to produce the monitored amount of electricity) is consistent with good practice.

7.2.2 Methodological issues

The methodology for calculating GHG emissions from *Solid waste* is consistent with the IPCC Tier 1 FOD Model (IPCC, 2006). This method utilizes a dynamic model driven by landfill data. It assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH_4 and CO2 are formed. If conditions are constant, the rate of CH_4 production depends solely on the amount of carbon remaining in the waste. As a result, emissions of CH_4 from waste deposited in a disposal site are highest in the first few years after deposition, then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

7.2.2.1 Activity data

Input data includes population data (StatsSA, 2025), waste generation rates, GDP (World bank), annual waste generation, population growth rates, emission rates, waste composition, rate constants, Methane correction factor (MCF), degradable carbon fraction (DCF), as well as other factors described in the IPPC Guidelines, Volume 5, Chapter (IPPC, 2006). Notably, due to a lack of published specific-activity data for many of these parameters in South Africa, the default values suggested in the IPCC 2006 Guidelines were applied (Table 7.6).

The FOD method requires data to be collected or estimated for historical disposals of waste over a period of 3 to 5 half-lives in order to achieve an acceptably accurate result. It is therefore good practice to use disposal data for at least 50 years as this time frame provides an acceptably accurate result for most typical disposal practices and conditions. Therefore, the activity data used comprised waste quantities disposed of into managed landfills from 1950 to 2022, covering a period of about 75 years (satisfying the condition for a period of five half-lives). Population data for the period 1950 to 2001 was sourced from United Nations population statistics (UN, 2012). Statistics South Africa population data was used for the period 2002 to 2022 (StatsSA, 2023). Waste generation rates for industrial waste were estimated using GDP values sourced from the World Bank for period 1990 to 2024.

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7.2.2.2 *Emission factors*

The emission factors for the FOD model are provided in Table 7.6.

Table 7.6: IPCC default factors utilized in the FOD Model to determine emissions from solid waste disposal.

Factor	Sub-category	Value	Unit
DOC (degradable organic carbon)	Bulk MSW	0.2	Weight fraction (wet basis)
	Industrial waste	0.15	
	Sludge waste	0.05	
DOCf (fraction of DOC dissimilated)		0.05	Fraction
Methane generation rate constant	Bulk MSW	0.05	$Years^{-1}$
	Industrial waste	0.05	
	Sewage sludge	0.06	
Methane correction factor (MCF)	Unmanaged, shallow	0.4	Unitless
	Unmanaged, deep	0.8	
	Managed	1	
	Managed, semi-aerobic	0.5	
	Uncategorized	0.6	
Fraction of methane in generated landfill gas (F)		0.5	Fraction
Oxidation factor (OF)		0	Unitless

7.2.3 Uncertainty

Among the chief limitations of the FOD methodology is that even if activity data improved considerably, the limitations of the data, or lack thereof, of previous years will still introduce a considerable degree of uncertainty. On the other hand, the estimated waste generations derived from previous years, back to 1950, will remain useful in future estimations of GHGs as they will aid in taking into account half-lives.

Uncertainty in this category (Table 7.7) is due mainly to the lack of data on the characterization of landfills, as well as of the quantities of waste disposed in them over the medium to long term. An uncertainty of ±30% is typical for countries that collect waste-generation data on a regular basis (IPCC 2006 Guidelines, Table 3.5).

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Table 7.7: Uncertainties associated with emissions from South Africa's solid waste disposal

Gas	Activity data and emission factors	Uncertainty	
		%	Source
CH_4	Total municipal solid waste	±30	IPCC 2006
	Fraction of MSW sent to SWDS	More than a factor of two	
	Total uncertainty of waste composition	More than a factor of two	
	DOC	±20	
	DOC_f	±20	
	MCF	±10	
	Fraction of CH_4 in generated landfill gas	±5	
	Methane recovery	±50	

7.2.4 Time series consistency

The FOD methodology for estimating methane emissions from solid waste requires a minimum of 48 years' worth of historical waste disposal data. However, in South Africa, waste disposal statistics are not available. In addition, periodic waste baseline studies do not build time-series data. Hence, population statistics sourced from the (StatsSA; 2025) provided consistent time-series activity data for solid waste disposal.

Time series consistency is ensured by use of consistent model parameters and datasets for the calculations of emissions estimates. Where changes in datasets or model parameters occur, a full time series recalculation is undertaken.

7.2.5 Category specific QA/QC and verification

General QA/QC measures in Table 7.5 were used for this category.

7.2.6 Category specific recalculations

The population data was updated from 2002 -2024 with the latest data from Statistics South Africa. The updated data led a slight reduction in emissions.

7.2.7 Category specific planned improvements

Planned improvements include:

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- Collection of actual quantities of waste disposed into landfill sites for period 1990 – 2024.
- Conducting a detailed analysis of methane recovery from the National Climate Change Response Database, which captures valuable data from mitigation and adaptation projects for future GHG estimates from landfills.

7.3 Biological Treatment of Solid Waste (CRT 5.B)

7.3.1 Category description

Biological treatment of solid waste considers waste treated through composting and anaerobic digestion of organic waste. In this inventory only the emissions from *biological treatment of Industrial Solid Waste* have been taken into account. *Biological treatment of Municipal Solid Waste* has been excluded due to lack of information.

7.3.2 Methodological issues

A tier 1 method, with default emission factors from the IPCC 2006 Guidelines was applied to calculate emissions for this category.

7.3.2.1 Activity data

The amount of waste treated by biological treatment of solid waste was obtained from a study that was done to by DFFE (Wastewater Treatment Pathways Study;2018)). Extrapolation was used to derive data for 2018-2024.

7.3.2.2 Emission factors

The default emission factors for composting and anaerobic treatment at biogas facilities are shown in Table 7.8.

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Table 7.8: Emission Factors for Biological Treatment of Solid Waste

	CH_4 Emission Factors (g CH_4/kg waste treated)	N_2O Emission Factors (g N_2O/kg waste treated)
Composting	10	0.6
Anaerobic Digestion at Biogas Facilities	2	Assumed negligible

7.3.3 Uncertainty

The estimation of the uncertainties of methane emissions from *biological treatment of solid waste* was carried out using the IPCC level 1 method (IPCC, 2006).

7.3.4 Time-series consistency

The time series for *biological treatment of solid waste* is complete and consistent from 1990-2024.

7.3.5 Category specific QA/QC and verification

General QA/QC measures in Table 7.5 were used for this category.

7.3.6 Category specific recalculations

No recalculations were performed for this category.

7.3.7 Category specific planned improvements

In future inventories, it is planned to improve data collection of waste treated by biological treatment.

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7.4 Incineration and open burning of waste (CRT 5.C)

7.4.1 Category description

According to the IPCC 2006 Guidelines, *Open burning of waste* can be defined as the combustion of unwanted combustible materials such as paper, wood, plastics, textiles, rubber, waste oils and other debris in nature (open-air) or in open dumps, where smoke and other emissions are released directly into the air without passing through a chimney or stack. Open burning can also include incineration devices that do not control the combustion air to maintain an adequate temperature and do not provide sufficient residence time for complete combustion.

In South Africa *Open burning of waste* is considered in two cases:

- Where population do not have access to formal waste collection services. It is assumed that this portion of the population burn its waste openly.
- Small percentage of formal landfill sites who practice open burning to manage waste volumes at SWDS.

In this source category only the emissions from *Open burning* have been included and emissions associated with *Incineration of waste* are not yet considered.

7.4.2 Methodological issues

A Tier 1 approach, with default IPCC 2006 Guidelines emission factors, was applied in the calculation of CO_2, CH_4 and N_2O emissions from open burning. The amount of MSW open-burned was determined using Equation 5.7 of the IPCC 2006 Guidelines (IPCC, 2006; vol 5, chapter. 5; pg. 5.16).

7.4.2.1 Activity data

The activity data for the calculation of MSW are described in section 7.2.2.1 The fraction of population carrying out open-burning was assumed to be at 9% since 91% of the waste is collected. CO2 emissions were calculated for the different waste types using the IPCC default breakdown.

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7.4.2.2 Emission factors

The emission factors for *Open burning of waste* are provided in Table 7.9.

Table 7.9: Emission factors for estimating emissions from open burning of waste.

Sub-category	Value	Unit	Source
Dry matter content			
Food	*0.4*	fraction	IPCC 2006
Garden	*0.4*		
Paper	*0.9*		
Wood	*0.85*		
Textile	*0.8*		
Nappies	*0.4*		
Plastics, other inert	*0.9*		
Fraction of carbon in dry matter			
Food	*0.38*	fraction	IPCC 2006
Garden	*0.49*		
Paper	*0.46*		
Wood	*0.5*		
Textile	*0.5*		
Nappies	*0.7*		
Plastics, other inert	*0.03*		
Fraction of fossil C in total carbon			
Food	*0*	fraction	IPCC 2006
Garden	*0*		
Paper	*0.01*		
Wood	*0*		
Textile	*0.2*		
Nappies	*0.1*		
Plastics, other inert	*1.0*		
Oxidation factor	0.58	fraction	IPCC 2006
CH_4 emission factor	6500	g/t MSW	IPCC 2006
N_2O emission factor	150	G N_2O/t waste	IPCC 2006

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7.4.3 Uncertainty

7.4.3.1 Activity data uncertainty

Uncertainties associated with CO_2 emission factors for *Open burning of waste* depend on uncertainties related to fraction of dry matter in waste open-burned, fraction of carbon in the dry matter, fraction of fossil carbon in the total carbon, combustion efficiency, and fraction of carbon oxidized and emitted as CO_2. A default value of ±40% is suggested by IPCC 2006 Guidelines.

7.4.3.2 Emission factor uncertainty

Uncertainties on default N2O and CH4 emission factors have been estimated to be ±100%.

7.4.4 Time series consistency

The time series is consistent as the activity data source is the same throughout the time series.

7.4.5 Category specific QA/QC and verification

General QA/QC measures in Table 7.5 were used for this category.

7.4.6 Category specific recalculations

Recalculations for this category were done due to change in data source for the population data. The recalculations resulted in a decrease in emissions compared to the previous inventory.

7.4.7 Category specific planned improvements

An improvement planned for this category is collection of activity data on amounts of waste incinerated, by category of waste and the technologies used to incinerate waste in South Africa.

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7.5 Wastewater Treatment and Discharge (CRT 5.D)

7.5.1 Domestic wastewater treatments and discharge (CRT 5.D.1)

7.5.1.1 Category description

Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on site (uncollected), sewered to a centralised plant (collected) or disposed untreated nearby or via an outfall. Domestic wastewater is defined as wastewater from household water use.

Wastewater treatment contributes to anthropogenic emissions, mainly CH_4 and N_2O. The generation of CH_4 is due to anaerobic degradation of organic matter in wastewater from domestic, commercial, and industrial sources. The organic matter can be quantified using biological oxygen demand (BOD) values.

Unlike solid waste, organic carbon in wastewater sources generates comparatively low quantities of CH_4. This is because even at very low concentrations, oxygen considerably inhibits the functioning of the anaerobic bacteria responsible for the generation of CH_4.

N_2O is produced from nitrification and denitrification of sewage nitrogen, which results from human protein consumption and discharge.

7.5.1.2 Methodological issues

In South Africa, most of the wastewater generated from domestic and commercial sources is treated through municipal wastewater treatment systems (MWTPs).

Domestic and commercial wastewater CH_4 emissions mainly originate from septic systems and centralised treatment systems such as MWTPs. Because of the lack of national statistics on the quantities of Biological Oxygen Demand (BOD) generated from domestic and commercial sources in South Africa annually, the yearly estimates were determined using the IPPC 2006 default Tier 1 method.

7.5.1.2.1 Activity data

The activity data for this category which is total amount of organically degradable material in the wastewater was calculated using population data from Statistics South Africa (Stats SA,2023) and IPCC 2006 Guidelines default BOD.

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IPCC 2006 Guidelines default correction factor of 1 was used for the factor *I*.

7.5.1.2.2 Emission factors

Methane emissions from Domestic Wastewater Treatment

Default population distribution trends between rural and urban settlements as a function of income was sourced from the IPCC 2006 Guidelines. Generally, it is good practice to express BOD product as a function of income, however, this information is not readily available in South Africa.

The emissions factors for different wastewater treatment and discharge systems were taken from the IPCC 2006 Guidelines (Table 7.10) as was the data on distribution and utilization of different treatment and discharge systems (Table 7.11).

Table 7.10: Emission factors for different wastewater treatment and discharge systems

Type of treatment or discharge	Maximum CH_4 producing capacity (BOD)	CH_4 correction factor for each treatment system	Emission factor
	(kg CH_4/kg BOD)	(MCF)	(kg CH_4/kg BOD)
Septic system	0.6	0.5	0.30
Latrine – rural	0.6	0.1	0.06
Latrine – urban low income	0.6	0.5	0.30
Stagnant sewer (open and warm)	0.6	0.5	0.30
Flowing sewer	0.6	0.0	0.00
Other	0.6	0.1	0.06
None	0.6	0.0	0.00

Table 7.11: Distribution and utilization of different treatment and discharge systems

Income group	Fraction of population income group	Type of treatment or discharge pathway	Degree of utilization
		(kg CH_4/kg BOD)	(Tij)
Rural	0.39	Septic tank	0.10
		Latrine – rural	0.28
		Sewer stagnant	0.10
		Other	0.04
		None	0.48
	0.12	Sewer closed	0.70

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Urban high-income		Septic tank	0.15
		Other	0.15
Urban low-income	0.49	Latrine – urban low income	0.24
		Septic tank	0.17
		Sewer (open and warm)	0.34
		Sewer (flowing)	0.20
		Other	0.05

Nitrous oxide emissions from Domestic Wastewater Treatment

The default values provided by the IPCC 2006 Guidelines were used in estimating the potential growing trends of N_2O emissions from the wastewater treatment systems. This was due to the lack of specific-activity data for South Africa.

For the per capita protein consumption, a value of 27.96 kg/person/yr was applied throughout the time series (FAO, 2017).

7.5.1.3 Uncertainty

An analysis of the results for methane emissions suggest that the likely sources of uncertainties may be due to the input data. These include uncertainties associated with South African population estimates provided by Statistics South Africa (StatsSA, 2023), the presumed constant country BOD production of about 37 g person-1 day-1 from 2001 to 2022, and the lack of data on the distribution of wastewater treatment systems in South Africa. It is recommended that, in future inventories, a detailed study on the input parameters merits careful consideration to minimize the uncertainty level. In turn, this approach would improve the reliability of the projected methane estimates from wastewater sources.

7.5.1.4 Time series consistency

The time series is complete and consistent from 2000-2022.

7.5.1.5 Category specific QA/QC and verification

General QA/QC measures in Table 7.5 were used for this category.

7.5.1.6 Category specific recalculations

Recalculations were performed for this category due to the following changes:

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- change in data source for the population data. The recalculations were done for the entire time series.
- The factor was changed from 1.25 to 1 due to industrial wastewater being estimated separately therefore there is no commercial and industrial wastewater co discharged to domestic wastewater.

The recalculations resulted in a decrease in emissions compared to the previous inventory.

7.5.1.7 Category specific planned improvements

The following improvement is planned for this category:

- Collection of wastewater related activity data for period 2000 – 2022 taking into account different wastewater treatment pathways in South Africa.

7.5.2 Industrial wastewater treatment and discharge (CRT 5.D.2)

7.5.2.1 Category description

In South Africa, it is common practice for major industrial facilities to have comprehensive in-plant or on-site wastewater treatment systems for purposes of compliance with regulatory standards for wastewater treatment and discharge.

Industrial and commercial wastewater treated anaerobically on-site (uncollected) or sewered (co-discharged) to a centralized plant (collected) or disposed untreated nearby waterbodies, generates and is a source of methane (CH_4) (IPCC 2006).

7.5.2.2 Methodological issues

The tier 1 default IPCC 2006 Guidelines methodology was used to estimate CH_4 emissions from industrial wastewater treatment using national parameters on production tonnage per sector; wastewater generated per ton of production; average concentration of Chemical Oxygen Demand (COD); and discharge pathways for the period 2000-2017 (IPCC, 2006, equation 6.4). Emissions of methane from wastewater and their sludge generated in treatment systems were considered.

A waste improvement study implemented in the year 2019, collected actual activity data for the period 2000-2017 for all the sectors of wastewater and biological solid waste,

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followed by developing a forecasting model for the period 2018-2035 for industrial wastewater.

7.5.2.2.1 Activity data

The collected data for the industrial wastewater sectors included the following parameters:

- Production tonnage per sector.
- Wastewater generated per ton of production.
- Average concentration of COD; and
- Discharge pathways

The production tonnage per sector data for the period 2000 – 2017 was obtained from a study done by DFFE on the Sanitation Pathways for industrial wastewater.

For the period 2018-2022 the activity data was then extrapolated for the following sectors:

- Alcohol Refining;
- Starch Production;
- Beer and Malt;
- Vegetable Oils;
- Dairy Products;
- Fish Processing;
- Vegetables Fruits and Juices;
- Meat and Poultry;
- Organic Chemicals;
- Petroleum Refining;
- Plastic and Resins;
- Soap and Detergents; and
- Wine and Vinegar.

For the dairy products sector, data for the period 2018-2022 was obtained from Milk SA Lacto data report (Milk SA, 2023) which is published yearly. For the sugar industry, data for the period 2018-2022 was obtained from South Africa Sugar Association (SASA, 2023) and South African Sugar Technologists` Association (SASTA, 2023) on their production reports which are published yearly. For the Pulp and paper industry, data for the 2000-

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2015 and period 2019-2022 was obtained from the Paper Manufacturers Association of South Africa (PAMSA, 2023) and for the period 2016-2018 data was interpolated.

The COD data is a combination of IPCC 2006 Guidelines defaults and country specific from the Sanitation Pathways study.

Methane recovery in the calculation was not taken into account in view of the lack of information on projects for the collection and utilization of methane in facilities for the treatment of industrial wastewater.

The maximum methane producing capacity of CH_4 (Bo)

The calculation used the value of B_0 by default 0.25 g CH_4 / g COD (IPCC, 2006).

Methane Correction Factor

The MCF values and emission factors applied are given in Table 7.12, while the COD values are provided in Table 7.13.

Table 7.12: MCF values and emission factors

Type of treatment or discharge	CH_4 correction factor for each treatment system	Emission factor
	(MCF)	(kg CH_4/kg BOD)
Aerobic treatment plant	0.1	0,025
Sea River	0.1	0,025
Anaerobic Lagoon (shallow)	0.2	0,05
Aerobic Lagoon (ATP not well managed)	0.3	0,075
Sea River Untreated	0.1	0,025
Anaerobic Reactor	0.8	0,2
Anaerobic Lagoon	0.2	0,05

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Table 7.13: Average COD values used to estimate CH_4 emissions from industrial wastewater.

Industry Type	Chemical Oxygen Demand (COD)
Alcohol Refining	11
Starch Production	10
Beer and Malt	2.9
Vegetable Oils	1
Dairy Products	2.7
Fish Processing	2.5
Vegetables Fruits and Juices	5
Meat and Poultry	4.1
Organic Chemicals	3
Petroleum Refining	1
Plastic and Resins	1.45
Soap and Detergents	0.85
Pulp and Paper	9
Sugar	6
Wine & vinegar	1.5

7.5.2.2.2 Emission factors

These are given in Table 7.12.

7.5.2.3 Uncertainty

The estimation of the uncertainties of methane emissions from industrial wastewater was carried out using the IPCC level 1 method (IPCC, 2006).

7.5.2.4 Time series consistency

The time series is complete and consistent from 2000-2022.

7.5.2.5 Category specific QA/QC and verification

General QA/QC measures in Table 7.5 were used for this category.

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7.5.2.6 Category specific recalculations

Recalculations were done for industrial wastewater treatment due change of COD for the following industries:

- Starch Production;
- Beer and Malt;
- Pulp and Paper;
- Vegetables Fruits and Juices; and
- Wine and Vinegar.

The COD was changed to revert to IPCC 2006 Guidelines defaults due to variability in the country specific COD.

The recalculations resulted in an increase on the emissions compared to the previous inventory.

7.5.2.7 Category specific planned improvements

In future inventories, it is planned to continue collecting more detailed data on the applied technologies of wastewater treatment in various industries the use of the mandatory GHG reporting regime. Work will also continue the analysis and assessment of the data reported through the SAGERS to enhance the accuracy of the emissions from this category.

7.6 Other (CRT 5.E)

No emissions data reported under this IPCC code.

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Chapter 8: Indirect CO_2 and N_2O emissions

The Agriculture and LULUCF sectors report on the following indirect N_2O emissions:

- Agriculture:
  - Manure Management: Indirect N_2O emissions resulting from both volatilization and from runoff and leaching. Indirect emissions of N_2O-N from manure can take place in two ways: i) volatilization of N as NH_3 and oxides of N, and ii) through runoff and leaching from land where N was applied. Emissions reported under 3.B.
  - Agricultural soils: Indirect emissions of N_2O-N from managed soils can take place in two ways: i) volatilization of N as NH_3 and oxides of N, and the deposition of these gases onto water surfaces, and ii) through runoff and leaching from land where N was applied. These emissions included are from fertiliser application, urine and dung in grazing fields, crop residue additions to soils and N mineralisation in mineral soils due to SOC losses from land use changes. In the Agriculture sector these are emissions from Croplands and Grasslands. Emissions reported under 3.D.
- LULUCF:
  - Indirect N_2O emissions through volatilisation and leaching/runoff from N fertiliser application and N mineralisation in mineral soils due to SOC losses from land use changes. As Croplands remaining Croplands and Grasslands remaining Grasslands emissions are included under Agriculture, the indirect emissions included in LULUCF sector are from other land classes and all land conversions. Emissions reported under 4(I).A. to 4(I).F. and 4(III).A. to 4(III).F.

These indirect N_2O emissions are detailed within the Agriculture and LULUCF chapters and are included within those sector emissions and so are therefore not included in this section.

The indirect emission of N_2O that are to be included here are those produced from atmospheric deposition of nitrogen in NO_x and NH_3, and the indirect CO_2 emissions are from the atmospheric oxidation of CH_4, CO and NMVOC. This is not a category that has

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been included in the inventory before, and so South Africa is in the process of identifying the emissions that would be included here.

The indirect CO_2 and N_2O emissions produced from the precursor gases (CO, NO_x and NMVOCs) which arise from biomass burning are currently being determined. These will be included in this section in the next version of the NID.

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Chapter 9: Recalculations and improvements

9.1 Explanation and justification for recalculations

A comprehensive recalculation of the Forest Land emission and removal estimates was undertaken to improve methodological consistency, data accuracy, and alignment with the most recent land representation and carbon stock information. These refinements were implemented in accordance with the principles of transparency, completeness, consistency, comparability, and accuracy as outlined in the Intergovernmental Panel on Climate Change guidelines.

The recalculation was driven by several key methodological and data improvements:

- Inclusion of updated land change maps for the period 2020–2022, enhancing temporal coverage and improving the representation of recent land-use dynamics.
- Corrections to the land-use change matrix to account for technological changes in land mapping between 2014 and 2018, as well as improved differentiation between wet and dry season classifications.
- Removal of a previously identified error (reported in the last inventory submission) affecting estimates from 2014 onwards, which related to double correction for land conversions on areas already converted.
- Revision of the methodology used to estimate burnt area per land class, improving the allocation of fire impacts across forest categories.
- Integration of soil type map overlays with the 2014–2018, 2018–2020 and 2020–2022 land cover datasets, enabling more accurate estimation of soil carbon stock changes.
- Updating of biomass, deadwood and litter carbon stock data to reflect improved emission factors and country-specific parameters.
- Refinement of assumptions used to distinguish between primary and secondary forest, improving representation of carbon density variations.

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Incorporation of updated household fuelwood consumption data to better reflect removals associated with forest degradation.

Inclusion of both direct and indirect N_2O emissions from nitrogen inputs and nitrogen mineralisation, enhancing completeness of non-CO_2 emissions reporting. Collectively, these improvements resulted in a structural revision of the Forest Land time series. The recalculated estimates indicate an average reduction in the net sink of 42.3% over the period 2000- 2022, although the magnitude of change varies by year due to interannual variability in land-use change, fire occurrence, and updated carbon parameters.

Recalculations were performed for the Energy sector due to methodological improvements, specifically the application of country-specific CO_2 emission factors for solid fuels in place of default IPCC values. These factors were derived from a Study, completed in 2022, consequently, emissions for the entire time series for where solid fuels are used were recalculated for the applicable fuel combustion activities to ensure methodological consistency and improved national representativeness.

For the most recent inventory years, the recalculated estimates show that the 2021 and 2022 net removals were reduced by 39.2% (25,095 Gg CO_2e) and 38.7% (31,884 Gg CO_2e), respectively, compared to the previous submission. These differences are primarily attributable to improved land representation, updated carbon stock data, methodological refinements in burnt area estimation, and correction of historical processing errors.

Overall, the recalculation enhances the robustness, internal consistency, and completeness of the Forest Land estimates, and ensures improved alignment with current methodological best practice and updated national datasets.

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9.2 Implications for emission and removal levels and trends

The Figure 9.1 presents a comparison between the current emission estimates and the previous submission, both excluding and including LULUCF, for the period 2000-2024.

The recalculations result in a structural downward revision of the net sink contribution from the land sector, particularly evident from 2014 onward. Consequently, total emissions including LULUCF in the current submission are higher relative to the previous submission in recent years, despite improvements in methodological accuracy.

The most significant differences occur in 2021 and 2022, where revised LULUCF estimates materially alter total national emissions. These changes are not indicative of real world emission increases but rather reflect improved data quality, methodological consistency, and correction of historical artefacts in the time series.

Overall, the recalculated time series improves consistency across the full 2000 - 2024 period, enhances transparency, and ensures alignment with updated national datasets and current good practice guidance.

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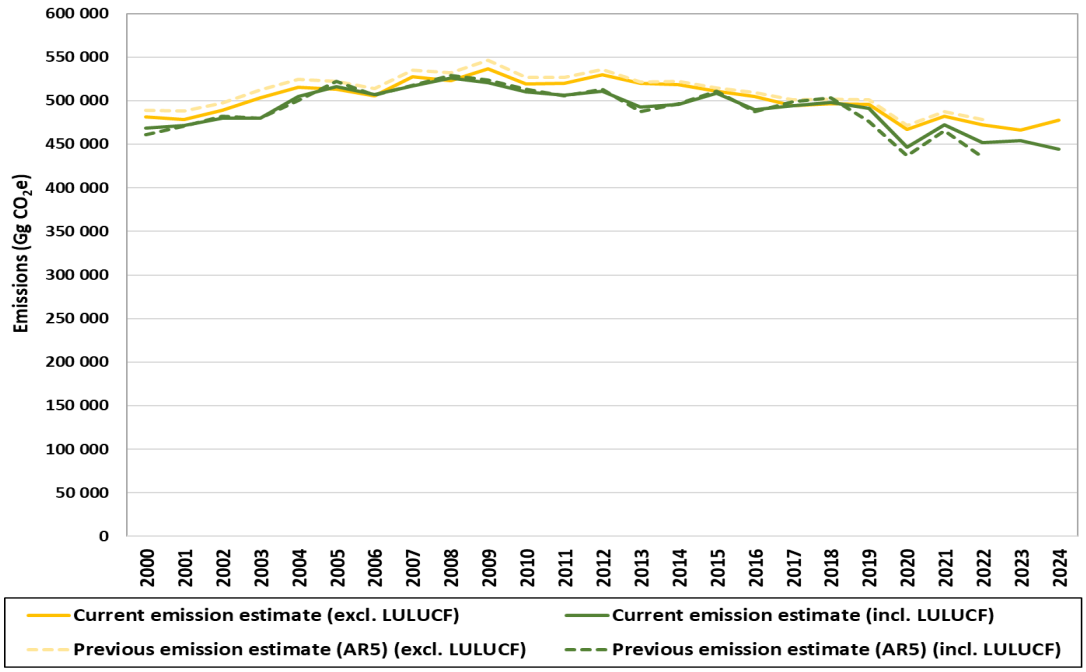


Figure 9.1: Impacts of recalculations on the overall emission estimates for South Africa.

9.3 Areas of improvement in response to review process

In response to the issues identified during the technical expert review of South Africa's first Biennial Transparency Report, a number of targeted improvements have been implemented in the current National Inventory compilation process. These include strengthened quality assurance and quality control procedures to improve consistency , systematic checks of data transfers from calculation files, and corrections to previously identified reporting inconsistencies.

Where feasible, recalculations have been undertaken to improve time-series consistency following methodological updates, while additional documentation has been provided to clarify assumptions, emission factors, activity data sources. Sector-specific enhancements were also introduced to address data gaps, improve methodological

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transparency. Collectively, these improvements enhance the transparency, accuracy, completeness, consistency, and comparability of the inventory and reflect South Africa's commitment to continuous improvement under the enhanced transparency framework.

9.4 Areas of improvement related to flexibility provisions applied

The list of improvements South Africa plans to implement in light of the flexibilities used in the 2022 inventory are as follows:

Time Series Reporting Improvements: Collect and report consistent annual data starting from 1990 to meet mandatory requirements, with completion targeted by BTR 2 in December 2026.

Assessment of Insignificant Emissions: Evaluate the significance of the following emissions sources that are not estimated in the current inventory:

- Abandoned underground mines (CH_4).
- Post-mining activities (CO_2, CH_4, N_2O).
- Various IPPU categories, including:
- Electronics industry (N_2O, HFCs, PFCs, SF_6).
- Solvents and electrical equipment (HFCs, PFCs, SF_6).
- PFCs from other product use.
- N_2O from product uses.

Incorporate these sources if emissions exceed thresholds (0.1% of total national emissions or 1,000 kt CO_2e). Assessments and updates are planned for BTR 3 in December 2028.

9.5 Improvement plan

Table 9.1 shows planned improvements and the timelines for the completion of these improvements.

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South Africa continues to strengthen its quality assurance and quality control (QA/QC) framework for the national greenhouse gas (GHG) inventory. In response to findings and recommendations arising from the external technical review process under the UNFCCC transparency framework, a structured and systematic approach has been adopted to address all identified issues.

All review comments are assessed, categorised according to significance (e.g., transparency, consistency, comparability, completeness and accuracy), and incorporated into the national inventory improvement plan. Priority is given to issues that materially affect emission estimates, methodological application, time-series consistency, or documentation. Corrective actions include recalculations where necessary, enhancement of methodological descriptions, improvement of activity data and emission factors, strengthening of institutional arrangements, and improved documentation of Tier 2 and Tier 3 methodologies.

Overall, South Africa's GHG inventory improvement plan reflects a balanced combination of completed actions, ongoing refinements and longer-term methodological developments. While significant progress has been achieved in improving transparency and sectoral detail, several improvements remain dependent on sustained funding, enhanced institutional capacity and improved collaboration with national data providers.

The inventory system will continue to apply a continuous improvement approach, prioritising actions that materially enhance transparency, accuracy and completeness in advance of future BTR submissions.

Constraints to the full and immediate resolution of all review findings include resource limitations, as well as dependency on external data providers for improved activity data and sector-specific information. Nevertheless, the continuous strengthening of the QA/QC system remains a high priority to ensure the credibility, robustness, and transparency of South Africa's national GHG inventory.

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Table 9.1: List of Completed, planned and proposed improvements for South Africa's GHG inventory.

Sector	Improvement	Priority	Reason	Status	Completeness timeframe	Barriers and constraints
Tasks in progress						
Cross-cutting	Improve uncertainty data for all sectors by incorporating more country specific uncertainty values	High	Improve transparency, accuracy and consistency in uncertainty analysis	Ongoing – more detailed uncertainty analysis included for LULUCF; further disaggregation required	Continuous improvement; phased incorporation as data becomes available (2025–2027)	Lack of uncertainty data constrains this activity. As data becomes available it will be incorporated. In this inventory a more detailed analysis of uncertainty for LULUCF sector was included but further disaggregation is required to improve the analysis.
	Improve QA/QC process by addressing all issues in external review	High	Strengthen transparency, consistency, accuracy and completeness of the national GHG inventory and ensure alignment with UNFCCC review recommendations	Ongoing- review findings are being systematically assessed and incorporated into the improvement plan	Continuous; priority issues to be addressed before next BTR submission	Resource and capacity constraints.

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	Incorporate NOx, CO, NMVOC, and SOx emissions	Medium	Improve completeness of inventory and align with reporting requirement	Partly resolved	Continuous improvement; phased incorporation as data becomes available (2025–2027)	Partly resolved.
	Update of the VKT study, including segregation of on-road/off-road	High	Improve accuracy of transport sector emissions	Planned	to be initiated before next BTR submission (2026)	Project to be initiated before next BTR
	Comparison of next VKT approach with fuel statistics	Medium	Improve QA/QC and consistency checks	Planned	to be initiated before next BTR submission (2026)	Project to be initiated before next BTR
Agriculture	Incorporate all background data and equations for the Tier 2 calculations of enteric fermentation	High	Improve transparency and methodological robustness	Partially completed - equations included; some parameters rely on average data	Full completion dependent on sustainable annual data source (2027-2029)	Partially completed. All background equations are included, but some factors still rely on average data rather than annual data due to the absence of a sustainable data source; although the investigation was conducted, no sustainable data source has been identified so far
LULUCF	Improve the uncertainty analysis for the Land sector to incorporate more detail.	High	Improve robustness of Land sector estimates	Partially completed - more detailed analysis included; further	2027-2029	A more detailed uncertainty analysis was included in this inventory but further disaggregation is required to improve the analysis.

				disaggregation needed		
	Improvement of land change data through detailed assessment of maps and tracking of land parcels	High	Improve accuracy of land representation and reduce misclassification	Ongoing - 2022 SANLC map incorporated; key categories identified; seasonality removal prioritised	Progressive improvement through next inventory cycles	This 2024 inventory incorporated a more detailed assessment of the land change data and identified the most important land change categories that need attention. The assessment also identified improvements that need to be done moving forward and the priority of these improvements. Removing changes due to seasonality is top priority and this will be improved as more land change maps are obtained. The 2022 SANLC map was used to make improvements. Tracking of land parcels over time still remains a critical process to undertake.
	Improve the biomass burning emissions	Medium	Improve representation of fire-related emissions	Analysis undertaken for 2024; assessment pending for replication in other years	Decision on expansion in next inventory.	An analysis of biomass burning was undertaken for 2024, and the resulting emission impacts need to be assessed to determine the value of conducting similar analyses for other years.
	Incorporate organic soils study to include emissions from organic soils	Medium	Improve completeness (CO_2 emissions	Initial estimates included using ISRIC, FAOSTAT and IPCC defaults	Further refinement required (2027 onwards)	Organic soil area was determined from ISRIC data. The area of drained organic soils for *Grasslands remaining grasslands* and *Croplands remaining*

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			from drained organic soils)			*Croplands* were obtained from FAOSTAT. These datasets were used, together with IPCC default factors to estimate CO_2 emissions from drained organic soils. Further organic soil studies are required to improve emission estimates.
	Move to a higher tier level for DOM in forest lands	Medium	Improve accuracy of forest carbon pool estimates	Partially addressed - disturbance matrix improved; some data gaps remain	To be completed in next inventory	This was considered in the 2022 inventory and more detailed disturbance matrix data was included to determine the amount of biomass entering the DOM pool, however there were still one or two pieces of data missing which requires further investigation. This will be completed and included in the next inventory.
Tasks outstanding						
Sector	**Improvement**	**Priority**	**Reason**	**Status**	**Completeness timeframe**	**Barriers and constraints**
	Use IPCC Software	Medium	Improve transparency, consistency and QA/QC of calculations	Planned - migration to IPCC Software to be initiated	2027-2028 inventory cycle	Use of the IPCC software to be initiated in future.

Improve completeness	Planned - research to be initiated	TBD	Improve completeness and accuracy of non-energy use emissions	Planned - research to be initiated	2027-2028 inventory cycle	Research to be initiated in future.
	Further disaggregation of 1A2	High	Improve sectoral resolution.	Ongoing - currently disaggregated to 1A2a, 1A2b, 1A2-ab; further breakdown required	Progressive improvement through next inventory cycles	Current inventory breaks down 1A2 into 1A2a, 1A2b and 1A2-ab. Further work is required to further disaggregate this sector and have emissions calculated per sub-sector
	Inclusion of methodology documentation/summary/approval process for tier 3 methods	Medium	Improve transparency	Planned - to be collated and included	2027-2028 inventory cycle	To be collated and included in future.
	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams	Medium	Improve completeness	Planned - research to be initiated	TBD, based on funding availability.	Funding to initiate study required
	CH_4 emissions from abandoned mines	Medium	Improve completeness	Planned - research to be initiated	TBD, based on funding availability.	Research to be initiated in future.
	CO_2 transport and storage	Medium	Anticipate CCS developments	Proposed	TBD	Proposed
	CO_2, CH_4 and N_2O emissions from combined heat and power (CHP) combustion systems	Medium	Improve completeness of combustion systems	Proposed	TBD	Proposed

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IPPU	Assess significance of emissions from electronics industry	Medium	Improve completeness of IPPU sector	Proposed	TBD,Proposed; not implemented due to funding constraints	Proposed
	Update the fluorinated gasses with higher accuracy figures from SARS	High	Improve accuracy of F-gas estimates	Ongoing	2027-2028 inventory cycle	Access to all data and ensuring that the data is accurate.
Agriculture	Update SOC reference data	Medium	Improve soil carbon stock accuracy	Proposed	TBD, Proposed; not implemented due to funding constraints	Proposed
	Improve manure management data, including biogas digesters as a management system	High	Improve accuracy of CH_4 and N_2O estimates	Proposed	Proposed; not implemented due to funding constraints	Proposed as a project due to the high variability in the dataset; however, it was not carried out because of insufficient funding.
LULUCF	Initiate data collection on controlled fires	High	Improve disaggregation biomass burning estimates	Proposed	TBD	Proposed
	Perform a more detailed assessment of HWP to include a wider range of products	Medium	Improve carbon stock change estimates	Proposed	TBD	Proposed project that could be considered under the GHGIP. For future evaluation.
	Collect data on other disturbances besides fire in forest lands	High	Accuracy - Improve	Proposed	TBD	This would require a study so will be recommended as a project under the GHGIP.

			forest carbon accounting			
Waste	Include information on population distribution in rural and urban areas as a function of income	Medium	Improve waste generation estimates	Proposed	TBD	Insufficient data.
	Include HWP in solid waste	Medium	Improve completeness	Proposed	TBD	Insufficient data.
	Obtain data on waste streams and the bucket system	Medium	Improve wastewater and solid waste estimates	Proposed	TBD	Insufficient data.
	CH_4, N_2O emissions from biological treatment of waste	Medium	Improve completeness	Proposed	TBD	Insufficient data.
	CO_2, CH_4 and N_2O from waste incineration	Medium	Improve completeness	Proposed	TBD	Insufficient data.
	Data collection on quantities of waste disposed of into managed and unmanaged landfills	Medium	Improve completeness	Proposed	TBD	Funding to initiate study.

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Annex I: Key category analysis

Table A I.1: Level assessment on emissions excluding LULUCF for South Africa (1990) with the key categories highlighted in green.

Code	Category Title	GHG	1990 Estimates	Level Assessment	Cumulative Total
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO2	137 910.7	0.341	34%
1.A.3.b	Road Transportation	CO2	41 755.4	0.103	44%
1.A.4	Other Sectors - Solid Fuels	CO2	33 356.7	0.083	53%
3.A.1.a.ii	Non-dairy Cattle	CH4	28 133.1	0.070	60%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO2	26 631.5	0.066	66%
1.B.3	Fugitive emissions from - Other emissions from energy production	CO2	25 903.1	0.064	73%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	12 921.6	0.032	76%
2.C.1	Iron and Steel Production	CO2	12 597.0	0.031	79%
3.A.2	Sheep	CH4	10 019.9	0.025	81%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO2	9 748.0	0.024	84%
3.D.1	Direct N2O Emissions From Managed Soils	N2O	7 914.1	0.020	86%
1.A.4	Other Sectors - Liquid Fuels	CO2	5 480.3	0.014	87%
2.A.1	Cement Production	CO2	4 252.5	0.011	88%
5.D	Wastewater Treatment and Discharge - Industrial	CH4	4 250.7	0.011	89%
1.A.3.a	Domestic Aviation	CO2	3 408.9	0.008	90%
3.A.1.a.i	Dairy Cattle	CH4	3 021.0	0.007	91%
1.B.3	Fugitive emissions from - Other emissions from energy production	CH4	2 905.1	0.007	92%

5.A	Solid Waste Disposal	CH4	2 821.7	0.007	92%
3.G	Liming	CO2	2 470.8	0.006	93%
5.D	Wastewater Treatment and Discharge - Domestic	CH4	2 297.1	0.006	93%
3.A.4	Goats	CH4	2 285.5	0.006	94%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO2	2 282.2	0.006	95%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	1 655.0	0.004	95%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CH4	1 495.4	0.004	95%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CO2	1 466.1	0.004	96%
2.B.2	Nitric Acid Production	N2O	C	C	C
2.C.2	Ferroalloys Production	CO2	1 186.9	0.003	96%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	1 079.8	0.003	97%
3.D.2	Indirect N2O Emissions From Managed Soils	N2O	1 008.9	0.002	97%
5.B	Biological Treatment of Solid Waste	CH4	858.5	0.002	97%
3.B.1.a.ii	Non-dairy Cattle	N2O	806.4	0.002	97%
1.B.2	Oil and Natural Gas	CO2	773.3	0.002	97%
3.B.1.a.ii	Non-dairy Cattle	CH4	703.2	0.002	98%
1.A.3.c	Railways	CO2	664.3	0.002	98%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	N2O	566.5	0.001	98%
1.A.3.b	Road Transportation	N2O	519.5	0.001	98%
2.A.2	Lime Production	CO2	488.0	0.001	98%
5.B	Biological Treatment of Solid Waste	N2O	487.5	0.001	98%
5.D	Wastewater Treatment and Discharge - Domestic	N2O	474.4	0.001	98%

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3.B.1.a.i	Dairy Cattle	CH4	466.0	0.001	99%
2.B.1	Ammonia Production	CO2	423.7	0.001	99%
1.A.4	Other Sectors - Solid Fuels	N2O	392.5	0.001	99%
1.A.3.d	Domestic Navigation - Liquid Fuels	CO2	389.7	0.001	99%
2.B.6	Titanium Dioxide Production	CO2	C	C	C
1.A.3.b	Road Transportation	CH4	368.5	0.001	99%
3.B.4	Poultry	N2O	367.6	0.001	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	N2O	285.8	0.001	99%
3.B.5	Indirect N2O Emissions From Manure Management	N2O	268.3	0.001	99%
2.C.3	Aluminium Production	CO2	254.0	0.001	99%
3.B.3	Swine	CH4	237.1	0.001	99%
1.A.4	Other Sectors - Solid Fuels	CH4	205.9	0.001	99%
3.B.2	Sheep	N2O	199.0	0.000	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CH4	192.7	0.000	99%
3.B.1.a.i	Dairy Cattle	N2O	178.9	0.000	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CO2	153.4	0.000	100%
3.B.2	Sheep	CH4	134.6	0.000	100%
2.C.6	Zinc Production	CO2	128.7	0.000	100%
2.B.8	Petrochemical and Carbon Black Production	CO2	C	C	C
3.A.4	Horses	CH4	115.9	0.000	100%
5.C	Incineration and Open Burning of Waste	CH4	108.1	0.000	100%
3.H	Urea Application	CO2	91.0	0.000	100%
2.A.3	Glass Production	CO2	85.0	0.000	100%

3.B.4	Poultry	CH4	79.2	0.000	100%
2.B.1	Ammonia Production	CH4	76.3	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	73.2	0.000	100%
1.A.3.e	Railways	N2O	67.5	0.000	100%
3.B.4	Goats	N2O	66.8	0.000	100%
3.A.4	Mules & Asses	CH4	62.7	0.000	100%
3.A.3	Swine	CH4	49.0	0.000	100%
3.F	Field burning of agricultural residues	CH4	47.2	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	44.6	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CH4	39.9	0.000	100%
3.B.4	Goats	CH4	38.5	0.000	100%
3.B.3	Swine	N2O	27.4	0.000	100%
1.A.3.a	Domestic Aviation	N2O	24.8	0.000	100%
5.C	Incineration and Open Burning of Waste	CO2	24.0	0.000	100%
5.C	Incineration and Open Burning of Waste	N2O	23.6	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CO2	20.4	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CH4	18.3	0.000	100%
2.C.5	Lead Production	CO2	16.0	0.000	100%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CO2	14.7	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CH4	13.0	0.000	100%
3.F	Field burning of agricultural residues	N2O	11.6	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	N2O	11.3	0.000	100%

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1.A.4	Other Sectors - Gaseous Fuels	CO2	11.2	0.000	100%
1.B.2	Oil and Natural Gas	CH4	10.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.3	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	CH4	6.1	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	N2O	4.7	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	N2O	3.6	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	2.6	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CH4	2.5	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	N2O	2.2	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	2.1	0.000	100%
2.B.5	Carbide Production	CO2	C	C	C
2.C.2	Ferroalloys Production	CH4	1.6	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	CH4	1.0	0.000	100%
1.A.3.e	Railways	CH4	1.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	0.9	0.000	100%
1.B.2	Oil and Natural Gas	N2O	0.8	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.7	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	N2O	0.7	0.000	100%
1.A.3.a	Domestic Aviation	CH4	0.7	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	N2O	0.3	0.000	100%
2.B.8	Petrochemical and Carbon Black Production	CH4	C	C	C

1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CH4	0.1	0.000	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	N2O	0.1	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	CH4	0.0	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	N2O	0.0	0.000	100%
2.A.4	Other Process Uses of Carbonates	CO2	0.0	0.000	100%
2.B.5	Carbide Production	CH4	0.0	0.000	100%
2.B.7	Soda Ash Production	CO2	0.0	0.000	100%
2.B.10	Other	CO2	0.0	0.000	100%
2.B.10	Other	CH4	0.0	0.000	100%
2.C.1	Iron and Steel Production	CH4	0.0	0.000	100%
2.C.3	Aluminium Production	Aggregate F-gases	0.0	0.000	100%
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases	0.0	0.000	100%
2.G	Other Product Manufacture and Use	CO2	0.0	0.000	100%
2.B.2	Nitric Acid Production	CO2	0.0	0.000	100%
2.B.2	Nitric Acid Production	CH4	0.0	0.000	100%
2.B.8	Hydrogen Production	CO2	0.0	0.000	100%
2.C.2	Ferroalloys Production	N2O	0.0	0.000	100%
2.D.1	Non-energy Products from Fuels and Solvent Use - Lubricant use	CO2	0.0	0.000	100%
2.D.2	Non-energy Products from Fuels and Solvent Use - Paraffin wax use	CO2	0.0	0.000	100%
2.F.1.a	Refrigeration and Air conditioning - refrigeration and stationary ACs	CO2e	0.0	0.000	100%
2.F.1.b	Refrigeration and Air conditioning - mobile ACs	CO2e	0.0	0.000	100%

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Table A.I.1: Level assessment on emissions including LULUCF for South Africa (1990) with the key categories highlighted in green.

Code	Category Title	GHG	1990 Estimates	Level Assessment	Cumulative Total
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO2	137 910.7	0.269	27%
1.A.3.b	Road Transportation	CO2	41 755.4	0.082	35%
1.A.4	Other Sectors - Solid Fuels	CO2	33 356.7	0.065	42%
4.A.2.b	Grassland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-29 846.3	0.058	47%
3.A.1.a.ii	Non-dairy Cattle	CH4	28 133.1	0.055	53%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO2	26 631.5	0.052	58%
1.B.3	Fugitive emissions from - Other emissions from energy production	CO2	25 903.1	0.051	63%
4.A.1.a	Forest land remaining forest land – biomass (above and below)	CO2	20 674.8	0.040	67%
4.C.2.a	Forest land converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	14 927.0	0.029	70%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	12 921.6	0.025	73%
2.C.1	Iron and Steel Production	CO2	12 597.0	0.025	75%
3.A.2	Sheep	CH4	10 019.9	0.020	77%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO2	9 748.0	0.019	79%
3.D.1	Direct N2O Emissions From Managed Soils	N2O	7 914.1	0.015	81%
4.C.1.a	Grassland remaining Grassland – biomass (above and below)	CO2	-5 937.9	0.012	82%
4.C.2.e	Other land converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-5 730.6	0.011	83%
1.A.4	Other Sectors - Liquid Fuels	CO2	5 480.3	0.011	84%
4.F.2.c	Grassland converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	4 685.3	0.009	85%
2.A.1	Cement Production	CO2	4 252.5	0.008	86%
5.D	Wastewater Treatment and Discharge - Industrial	CH4	4 250.7	0.008	86%
1.A.3.a	Domestic Aviation	CO2	3 408.9	0.007	87%
3.A.1.a.i	Dairy Cattle	CH4	3 021.0	0.006	88%
4.A.2.a	Cropland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-2 955.4	0.006	88%
1.B.3	Fugitive emissions from - Other emissions from energy production	CH4	2 905.1	0.006	89%
5.A	Solid Waste Disposal	CH4	2 821.7	0.006	89%

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4.B.2.b	Grassland converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	2 737.2	0.005	90%
4.B.2.a	Forest land converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	2 736.2	0.005	90%
4.C.2.b	Cropland converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-2 520.7	0.005	91%
3.G	Liming	CO2	2 470.8	0.005	91%
5.D	Wastewater Treatment and Discharge - Domestic	CH4	2 297.1	0.004	92%
3.A.4	Goats	CH4	2 285.5	0.004	92%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO2	2 282.2	0.004	93%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	1 655.0	0.003	93%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CH4	1 495.4	0.003	93%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CO2	1 466.1	0.003	94%
4.E.1.a	Settlements remaining Settlements – biomass (above and below)	CO2	-1 336.8	0.003	94%
2.B.2	Nitric Acid Production	N2O	C	C	C
2.C.2	Ferroalloys Production	CO2	1 186.9	0.002	94%
4.A.1.b	Forest land remaining forest land – dead organic matter (dead wood and litter)	CO2	-1 135.5	0.002	95%
4.A.2.e	Other land converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-1 127.6	0.002	95%
4.A.2.c	Wetland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-1 093.7	0.002	95%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	1 079.8	0.002	95%
4.G	Harvested Wood Products	CO2	-1 035.6	0.002	96%
3.D.2	Indirect N2O Emissions From Managed Soils	N2O	1 008.9	0.002	96%
4(V)	Biomass Burning	CH4	974.5	0.002	96%
5.B	Biological Treatment of Solid Waste	CH4	858.5	0.002	96%
3.B.1.a.ii	Non-dairy Cattle	N2O	806.4	0.002	96%
1.B.2	Oil and Natural Gas	CO2	773.3	0.002	96%
4.C.2.c	Wetland converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	720.2	0.001	97%
4.E.2.a	Forest land converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	716.6	0.001	97%

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4.B.1.a	Cropland remaining Cropland – biomass (above and below)	CO2	714.8	0.001	97%
3.B.1.a.ii	Non-dairy Cattle	CH4	703.2	0.001	97%
4.C.1.c	Grassland remaining Grassland – soil (mineral)	CO2	-695.6	0.001	97%
4(V)	Biomass Burning	N2O	689.6	0.001	97%
1.A.3.c	Railways	CO2	664.3	0.001	97%
4.A.2.d	Settlements converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-662.7	0.001	97%
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH4	656.2	0.001	98%
4.F.2.e	Other land converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	640.8	0.001	98%
4.F.2.a	Forest land converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	623.0	0.001	98%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	N2O	566.5	0.001	98%
1.A.3.b	Road Transportation	N2O	519.5	0.001	98%
2.A.2	Lime Production	CO2	488.0	0.001	98%
5.B	Biological Treatment of Solid Waste	N2O	487.5	0.001	98%
5.D	Wastewater Treatment and Discharge - Domestic	N2O	474.4	0.001	98%
3.B.1.a.i	Dairy Cattle	CH4	466.0	0.001	98%
2.B.1	Ammonia Production	CO2	C	C	C
1.A.4	Other Sectors - Solid Fuels	N2O	392.5	0.001	99%
1.A.3.d	Domestic Navigation - Liquid Fuels	CO2	389.7	0.001	99%
2.B.6	Titanium Dioxide Production	CO2	C	C	C
1.A.3.b	Road Transportation	CH4	368.5	0.001	99%
3.B.4	Poultry	N2O	367.6	0.001	99%
4(III)	Direct N2O emissions from N mineralization/immobilization	N2O	348.6	0.001	99%
4.D.2.c.iii	Grassland converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-303.0	0.001	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	N2O	285.8	0.001	99%
3.B.5	Indirect N2O Emissions From Manure Management	N2O	268.3	0.001	99%
2.C.3	Aluminium Production	CO2	254.0	0.000	99%
3.B.3	Swine	CH4	237.1	0.000	99%
1.A.4	Other Sectors - Solid Fuels	CH4	205.9	0.000	99%
3.B.2	Sheep	N2O	199.0	0.000	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CH4	192.7	0.000	99%

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4.B.2.c	Wetland converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	183.8	0.000	99%
3.B.1.a.i	Dairy Cattle	N2O	178.9	0.000	99%
4.D.2.c.i	Forest land converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	159.7	0.000	99%
4.D.2.b.i	Forest land converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	155.1	0.000	99%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CO2	153.4	0.000	99%
3.B.2	Sheep	CH4	134.6	0.000	100%
2.C.6	Zinc Production	CO2	128.7	0.000	100%
4.C.2.d	Settlements converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-127.4	0.000	100%
4.E.2.b	Cropland converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-126.2	0.000	100%
2.B.8	Petrochemical and Carbon Black Production	CO2	121.0	0.000	100%
4.D.2.c.ii	Cropland converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-116.8	0.000	100%
3.A.4	Horses	CH4	115.9	0.000	100%
5.C	Incineration and Open Burning of Waste	CH4	108.1	0.000	100%
4.D.1.c	Other Wetlands Remaining Other Wetlands	CO2	-100.3	0.000	100%
3.H	Urea Application	CO2	91.0	0.000	100%
2.A.3	Glass Production	CO2	85.0	0.000	100%
3.B.4	Poultry	CH4	79.2	0.000	100%
2.B.1	Ammonia Production	CH4	C	C	C
4.E.2.c	Grassland converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-75.7	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	73.2	0.000	100%
4.A.1.c	Forest land remaining forest land – soil (mineral)	CO2	71.6	0.000	100%
1.A.3.e	Railways	N2O	67.5	0.000	100%
3.B.4	Goats	N2O	66.8	0.000	100%
3.A.4	Mules & Asses	CH4	62.7	0.000	100%
3.A.3	Swine	CH4	49.0	0.000	100%
3.F	Field burning of agricultural residues	CH4	47.2	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	44.6	0.000	100%

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4.D.2.b.iii	Grassland converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	43.2	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CH4	39.9	0.000	100%
3.B.4	Goats	CH4	38.5	0.000	100%
4.C.1.b	Grassland remaining Grassland – dead organic matter (dead wood and litter)	CO2	-30.5	0.000	100%
4.C.1.e	Grassland remaining Grassland – drained organic soil	CO2	-29.6	0.000	100%
4.D.1.b	Flooded Land Remaining Flooded Land	CO2	28.6	0.000	100%
3.B.3	Swine	N2O	27.4	0.000	100%
1.A.3.a	Domestic Aviation	N2O	24.8	0.000	100%
5.C	Incineration and Open Burning of Waste	CO2	24.0	0.000	100%
5.C	Incineration and Open Burning of Waste	N2O	23.6	0.000	100%
4.B.1.c	Cropland remaining Cropland – soil (mineral)	CO2	-20.8	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CO2	20.4	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CH4	18.3	0.000	100%
4(IV)	Indirect N2O Emissions from Managed Soils	N2O	18.1	0.000	100%
4.F.2.d	Settlements converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	16.0	0.000	100%
2.C.5	Lead Production	CO2	16.0	0.000	100%
4.F.2.b	Cropland converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	16.0	0.000	100%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CO2	14.7	0.000	100%
4(I)	Direct N2O emissions from N inputs to managed soils	N2O	13.6	0.000	100%
4.E.2.d	Settlements converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	13.0	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CH4	13.0	0.000	100%
4.D.2.c.v	Other land converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-12.0	0.000	100%
3.F	Field burning of agricultural residues	N2O	11.6	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	N2O	11.3	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	CO2	11.2	0.000	100%
1.B.2	Oil and Natural Gas	CH4	10.0	0.000	100%
4.D.2.c.iv	Settlements converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-10.0	0.000	100%

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4.D.2.b.ii	Cropland converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	8.2	0.000	100%
4.B.1.e	Cropland remaining Cropland – drained organic soil	CO2	-7.6	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.3	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	CH4	6.1	0.000	100%
4.E.2.e	Other land converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-4.9	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	N2O	4.7	0.000	100%
4.E.1.b	Settlements remaining Settlements – dead organic matter (dead wood and litter)	CO2	4.2	0.000	100%
4.B.1.b	Cropland remaining Cropland – dead organic matter (dead wood and litter)	CO2	3.8	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	N2O	3.6	0.000	100%
4.B.2.d	Settlements converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	3.4	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	2.6	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CH4	2.5	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	N2O	2.2	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	2.1	0.000	100%
2.B.5	Carbide Production	CO2	C	C	C
2.C.2	Ferroalloys Production	CH4	1.6	0.000	100%
4.B.2.e	Other land converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	1.5	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	CH4	1.0	0.000	100%
1.A.3.e	Railways	CH4	1.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	0.9	0.000	100%
1.B.2	Oil and Natural Gas	N2O	0.8	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.7	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	N2O	0.7	0.000	100%
1.A.3.a	Domestic Aviation	CH4	0.7	0.000	100%
4.D.2.b.iv	Settlements converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	0.6	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	N2O	0.3	0.000	100%
2.B.8	Petrochemical and Carbon Black Production	CH4	0.1	0.000	100%

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1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CH4	0.1	0.000	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	N2O	0.1	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	CH4	0.0	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	N2O	0.0	0.000	100%
2.A.4	Other Process Uses of Carbonates	CO2	0.0	0.000	100%
2.B.5	Carbide Production	CH4	0.0	0.000	100%
2.B.7	Soda Ash Production	CO2	0.0	0.000	100%
2.B.10	Other	CO2	0.0	0.000	100%
2.B.10	Other	CH4	0.0	0.000	100%
2.C.1	Iron and Steel Production	CH4	0.0	0.000	100%
2.C.3	Aluminium Production	Aggregate F-gases	0.0	0.000	100%
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases	0.0	0.000	100%
2.G	Other Product Manufacture and Use	CO2	0.0	0.000	100%
2.B.2	Nitric Acid Production	CO2	0.0	0.000	100%
2.B.2	Nitric Acid Production	CH4	0.0	0.000	100%
2.B.8	Hydrogen Production	CO2	0.0	0.000	100%
2.C.2	Ferroalloys Production	N2O	0.0	0.000	100%
2.D.1	Non-energy Products from Fuels and Solvent Use - Lubricant use	CO2	0.0	0.000	100%
2.D.2	Non-energy Products from Fuels and Solvent Use - Paraffin wax use	CO2	0.0	0.000	100%
2.F.1.a	Refrigeration and Air conditioning - refrigeration and stationary ACs	CO2e	0.0	0.000	100%
2.F.1.b	Refrigeration and Air conditioning - mobile ACs	CO2e	0.0	0.000	100%
4.D.2.b.v	Other land converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	0.0	0.000	100%
4.E.1.c	Settlements remaining Settlements – soil (mineral)	CO2	0.0	0.000	100%
4.F.1.a	Other land remaining Other land – biomass (above and below)	CO2	0.0	0.000	100%
4.F.1.b	Other land remaining Other land – dead organic matter (dead wood and litter)	CO2	0.0	0.000	100%
4.F.1.c	Other land remaining Other land – soil (mineral)	CO2	0.0	0.000	100%
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO2	0.0	0.000	100%

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Table A.I.2: Level assessment on emissions excluding LULUCF for South Africa (2024) with the key categories highlighted in green.

Code	Category Title	GHG	2024 Estimates	Level Assessment	Cumulative Total
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO2	194 648.2	0.412	41%
1.A.3.b	Road Transportation	CO2	56 846.0	0.120	53%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO2	31 538.0	0.067	60%
3.A.1.a.ii	Non-dairy Cattle	CH4	24 291.0	0.051	65%
1.B.3	Fugitive emissions from - Other emissions from energy production	CO2	23 477.0	0.050	70%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO2	16 682.9	0.035	74%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	14 635.7	0.031	77%
1.A.4	Other Sectors - Liquid Fuels	CO2	14 134.1	0.030	80%
3.D.1	Direct N2O Emissions From Managed Soils	N2O	8 166.5	0.017	81%
5.A	Solid Waste Disposal	CH4	7 376.7	0.016	83%
2.C.2	Ferroalloys Production	CO2	6 942.5	0.015	84%
2.C.1	Iron and Steel Production	CO2	6 894.0	0.015	86%
3.A.2	Sheep	CH4	6 313.1	0.013	87%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	5 063.6	0.011	88%
5.D	Wastewater Treatment and Discharge - Industrial	CH4	4 720.4	0.010	89%
2.A.1	Cement Production	CO2	3 846.0	0.008	90%
1.A.4	Other Sectors - Solid Fuels	CO2	3 842.0	0.008	91%
3.A.1.a.i	Dairy Cattle	CH4	3 609.0	0.008	92%
5.D	Wastewater Treatment and Discharge - Domestic	CH4	3 552.8	0.008	93%
1.B.3	Fugitive emissions from - Other emissions from energy production	CH4	2 736.7	0.006	93%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	2 228.1	0.005	94%
3.G	Liming	CO2	1 890.9	0.004	94%
5.B	Biological Treatment of Solid Waste	CH4	1 793.2	0.004	94%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CH4	1 754.0	0.004	95%
3.A.4	Goats	CH4	1 577.1	0.003	95%
3.D.2	Indirect N2O Emissions From Managed Soils	N2O	1 513.7	0.003	95%
2.C.3	Aluminium Production	CO2	1 259.2	0.003	96%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO2	1 115.9	0.002	96%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CO2	986.5	0.002	96%

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3.B.4	Poultry	N2O	953.0	0.002	96%
3.B.1.a.ii	Non-dairy Cattle	N2O	922.6	0.002	96%
5.B	Biological Treatment of Solid Waste	N2O	826.9	0.002	97%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	N2O	808.2	0.002	97%
2.A.2	Lime Production	CO2	799.1	0.002	97%
1.A.3.a	Domestic Aviation	CO2	775.7	0.002	97%
5.D	Wastewater Treatment and Discharge - Domestic	N2O	733.8	0.002	97%
1.A.3.b	Road Transportation	N2O	733.3	0.002	97%
2.D.2	Non-energy Products from Fuels and Solvent Use - Paraffin wax use	CO2	715.8	0.002	98%
2.B.6	Titanium Dioxide Production	CO2	683.3	0.001	98%
3.B.1.a.ii	Non-dairy Cattle	CH4	676.6	0.001	98%
3.H	Urea Application	CO2	670.8	0.001	98%
1.A.3.d	Domestic Navigation - Liquid Fuels	CO2	562.0	0.001	98%
3.B.1.a.i	Dairy Cattle	CH4	556.7	0.001	98%
1.A.4	Other Sectors - Gaseous Fuels	CO2	526.0	0.001	98%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	N2O	503.6	0.001	99%
2.C.6	Zinc Production	CO2	501.9	0.001	99%
2.D.1	Non-energy Products from Fuels and Solvent Use - Lubricant use	CO2	461.9	0.001	99%
1.A.3.c	Railways	CO2	410.1	0.001	99%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CO2	384.6	0.001	99%
2.B.1	Ammonia Production	CO2	378.7	0.001	99%
1.A.3.b	Road Transportation	CH4	366.1	0.001	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CH4	341.3	0.001	99%
2.B.2	Nitric Acid Production	N2O	340.4	0.001	99%
3.B.5	Indirect N2O Emissions From Manure Management	N2O	333.0	0.001	99%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CH4	250.7	0.001	99%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CO2	227.5	0.000	99%
3.B.1.a.i	Dairy Cattle	N2O	213.7	0.000	99%
1.A.4	Other Sectors - Solid Fuels	N2O	207.1	0.000	99%
3.B.3	Swine	CH4	205.5	0.000	99%
3.B.4	Poultry	CH4	191.7	0.000	100%
2.A.3	Glass Production	CO2	177.3	0.000	100%
3.A.4	Horses	CH4	170.3	0.000	100%

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5.C	Incineration and Open Burning of Waste	CH4	167.2	0.000	100%
1.A.4	Other Sectors - Solid Fuels	CH4	161.8	0.000	100%
3.B.2	Sheep	N2O	158.2	0.000	100%
2.A.4	Other Process Uses of Carbonates	CO2	133.6	0.000	100%
2.B.1	Ammonia Production	CH4	113.7	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	N2O	109.3	0.000	100%
2.B.8	Petrochemical and Carbon Black Production	CO2	95.1	0.000	100%
3.B.2	Sheep	CH4	88.6	0.000	100%
2.G	Other Product Manufacture and Use	CO2	84.7	0.000	100%
2.B.8	Hydrogen Production	CO2	75.1	0.000	100%
1.B.2	Oil and Natural Gas	CO2	63.0	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CH4	57.2	0.000	100%
3.B.4	Goats	N2O	49.3	0.000	100%
3.A.4	Mules & Asses	CH4	45.2	0.000	100%
3.F	Field burning of agricultural residues	CH4	43.7	0.000	100%
3.A.3	Swine	CH4	42.5	0.000	100%
1.A.3.e	Railways	N2O	37.8	0.000	100%
5.C	Incineration and Open Burning of Waste	CO2	37.0	0.000	100%
5.C	Incineration and Open Burning of Waste	N2O	36.5	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CH4	32.9	0.000	100%
2.B.5	Carbide Production	CO2	31.6	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	N2O	27.3	0.000	100%
3.B.4	Goats	CH4	27.1	0.000	100%
3.B.3	Swine	N2O	23.8	0.000	100%
1.B.2	Oil and Natural Gas	CH4	22.5	0.000	100%
2.B.10	Other	CO2	20.4	0.000	100%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CO2	17.2	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	CH4	14.8	0.000	100%
2.B.10	Other	CH4	12.7	0.000	100%
3.F	Field burning of agricultural residues	N2O	10.7	0.000	100%
2.C.5	Lead Production	CO2	7.7	0.000	100%
2.B.7	Soda Ash Production	CO2	6.4	0.000	100%
1.A.3.a	Domestic Aviation	N2O	5.6	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	N2O	4.7	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	N2O	4.1	0.000	100%
2.B.5	Carbide Production	CH4	3.9	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	N2O	1.7	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	CH4	1.5	0.000	100%

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2.B.8	Petrochemical and Carbon Black Production	CH4	1.2	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CH4	1.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	0.9	0.000	100%
1.A.3.e	Railways	CH4	0.7	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.5	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	N2O	0.5	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	CH4	0.3	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	N2O	0.3	0.000	100%
1.A.3.a	Domestic Aviation	CH4	0.1	0.000	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CH4	0.1	0.000	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	N2O	0.1	0.000	100%
1.B.2	Oil and Natural Gas	N2O	0.1	0.000	100%
2.C.2	Ferroalloys Production	CH4	0.1	0.000	100%
2.C.3	Aluminium Production	Aggregate F-gases	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	0.0	0.000	100%
2.C.1	Iron and Steel Production	CH4	0.0	0.000	100%
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases	0.0	0.000	100%
2.B.2	Nitric Acid Production	CO2	0.0	0.000	100%
2.B.2	Nitric Acid Production	CH4	0.0	0.000	100%
2.C.2	Ferroalloys Production	N2O	0.0	0.000	100%
2.F.1.a	Refrigeration and Air conditioning - refrigeration and stationary ACs	CO2e	0.0	0.000	100%
2.F.1.b	Refrigeration and Air conditioning - mobile ACs	CO2e	0.0	0.000	100%

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Table A.I.3: Level assessment on emissions including LULUCF for South Africa (2024) with the key categories highlighted in green.

Code	Category Title	GHG	2024 Estimates	Level Assessment	Cumulative Total
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO2	194 648.2	0.301	30%
4.A.2.b	Grassland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-57 097.6	0.088	39%
1.A.3.b	Road Transportation	CO2	56 846.0	0.088	48%
4.C.2.a	Forest land converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	36 486.2	0.056	53%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO2	31 538.0	0.049	58%
3.A.1.a.ii	Non-dairy Cattle	CH4	24 291.0	0.038	62%
1.B.3	Fugitive emissions from - Other emissions from energy production	CO2	23 477.0	0.036	66%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO2	16 682.9	0.026	68%
4.C.2.e	Other land converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-15 836.5	0.024	71%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	14 635.7	0.023	73%
4.C.1.a	Grassland remaining Grassland – biomass (above and below)	CO2	-14 549.9	0.022	75%
1.A.4	Other Sectors - Liquid Fuels	CO2	14 134.1	0.022	77%
4.A.1.a	Forest land remaining forest land – biomass (above and below)	CO2	9 345.2	0.014	79%
3.D.1	Direct N2O Emissions From Managed Soils	N2O	8 166.5	0.013	80%
4.F.2.c	Grassland converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	7 549.5	0.012	81%
5.A	Solid Waste Disposal	CH4	7 376.7	0.011	82%
2.C.2	Ferroalloys Production	CO2	6 942.5	0.011	83%
2.C.1	Iron and Steel Production	CO2	6 894.0	0.011	84%
3.A.2	Sheep	CH4	6 313.1	0.010	85%
4.B.2.a	Forest land converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	5 450.4	0.008	86%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	5 063.6	0.008	87%
5.D	Wastewater Treatment and Discharge - Industrial	CH4	4 720.4	0.007	88%

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2.A.1	Cement Production	CO2	3 846.0	0.006	88%
1.A.4	Other Sectors - Solid Fuels	CO2	3 842.0	0.006	89%
3.A.1.a.i	Dairy Cattle	CH4	3 609.0	0.006	90%
5.D	Wastewater Treatment and Discharge - Domestic	CH4	3 552.8	0.005	90%
4.A.2.a	Cropland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-3 417.3	0.005	91%
4.E.1.a	Settlements remaining Settlements – biomass (above and below)	CO2	-3 103.4	0.005	91%
1.B.3	Fugitive emissions from - Other emissions from energy production	CH4	2 736.7	0.004	92%
4.B.2.b	Grassland converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	2 275.5	0.004	92%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	2 228.1	0.003	92%
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH4	2 039.0	0.003	93%
3.G	Liming	CO2	1 890.9	0.003	93%
5.B	Biological Treatment of Solid Waste	CH4	1 793.2	0.003	93%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CH4	1 754.0	0.003	93%
4.F.2.a	Forest land converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	1 744.6	0.003	94%
4.G	Harvested Wood Products	CO2	-1 718.3	0.003	94%
4.C.2.b	Cropland converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-1 672.7	0.003	94%
3.A.4	Goats	CH4	1 577.1	0.002	94%
3.D.2	Indirect N2O Emissions From Managed Soils	N2O	1 513.7	0.002	95%
4.A.2.e	Other land converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-1 487.8	0.002	95%
2.C.3	Aluminium Production	CO2	1 259.2	0.002	95%
4.E.2.a	Forest land converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	1 224.3	0.002	95%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO2	1 115.9	0.002	95%
4.A.2.d	Settlements converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-1 008.9	0.002	96%
4.A.1.b	Forest land remaining forest land – dead organic matter (dead wood and litter)	CO2	-1 006.1	0.002	96%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CO2	986.5	0.002	96%

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3.B.4	Poultry	N2O	953.0	0.001	96%
3.B.1.a.i i	Non-dairy Cattle	N2O	922.6	0.001	96%
4(V)	Biomass Burning	CH4	902.0	0.001	96%
4.A.2.c	Wetland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-850.6	0.001	96%
5.B	Biological Treatment of Solid Waste	N2O	826.9	0.001	97%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	N2O	808.2	0.001	97%
2.A.2	Lime Production	CO2	799.1	0.001	97%
1.A.3.a	Domestic Aviation	CO2	775.7	0.001	97%
4.F.2.e	Other land converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	749.9	0.001	97%
5.D	Wastewater Treatment and Discharge - Domestic	N2O	733.8	0.001	97%
1.A.3.b	Road Transportation	N2O	733.3	0.001	97%
2.D.2	Non-energy Products from Fuels and Solvent Use - Paraffin wax use	CO2	715.8	0.001	97%
4.C.1.c	Grassland remaining Grassland – soil (mineral)	CO2	-707.2	0.001	98%
4(V)	Biomass Burning	N2O	691.9	0.001	98%
2.B.6	Titanium Dioxide Production	CO2	683.3	0.001	98%
3.B.1.a.i i	Non-dairy Cattle	CH4	676.6	0.001	98%
3.H	Urea Application	CO2	670.8	0.001	98%
4.E.2.b	Cropland converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	606.9	0.001	98%
1.A.3.d	Domestic Navigation - Liquid Fuels	CO2	562.0	0.001	98%
3.B.1.a.i	Dairy Cattle	CH4	556.7	0.001	98%
1.A.4	Other Sectors - Gaseous Fuels	CO2	526.0	0.001	98%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	N2O	503.6	0.001	98%
2.C.6	Zinc Production	CO2	501.9	0.001	98%
2.D.1	Non-energy Products from Fuels and Solvent Use - Lubricant use	CO2	461.9	0.001	99%
4.C.2.d	Settlements converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-442.9	0.001	99%
4(III)	Direct N2O emissions from N mineralization/immobilization	N2O	438.0	0.001	99%
1.A.3.c	Railways	CO2	410.1	0.001	99%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CO2	384.6	0.001	99%

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4.D.2.c.iii	Grassland converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-381.2	0.001	99%
2.B.1	Ammonia Production	CO2	378.7	0.001	99%
1.A.3.b	Road Transportation	CH4	366.1	0.001	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CH4	341.3	0.001	99%
2.B.2	Nitric Acid Production	N2O	340.4	0.001	99%
3.B.5	Indirect N2O Emissions From Manure Management	N2O	333.0	0.001	99%
4.D.2.b.i	Forest land converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	320.1	0.000	99%
4.B.1.a	Cropland remaining Cropland – biomass (above and below)	CO2	312.3	0.000	99%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CH4	250.7	0.000	99%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CO2	227.5	0.000	99%
4.A.1.c	Forest land remaining forest land – soil (mineral)	CO2	-220.7	0.000	99%
3.B.1.a.i	Dairy Cattle	N2O	213.7	0.000	99%
1.A.4	Other Sectors - Solid Fuels	N2O	207.1	0.000	99%
3.B.3	Swine	CH4	205.5	0.000	99%
3.B.4	Poultry	CH4	191.7	0.000	99%
2.A.3	Glass Production	CO2	177.3	0.000	99%
4.D.2.b.iii	Grassland converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	171.0	0.000	99%
3.A.4	Horses	CH4	170.3	0.000	100%
5.C	Incineration and Open Burning of Waste	CH4	167.2	0.000	100%
4.E.2.c	Grassland converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-166.9	0.000	100%
1.A.4	Other Sectors - Solid Fuels	CH4	161.8	0.000	100%
3.B.2	Sheep	N2O	158.2	0.000	100%
4.C.2.c	Wetland converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-144.4	0.000	100%
2.A.4	Other Process Uses of Carbonates	CO2	133.6	0.000	100%
2.B.1	Ammonia Production	CH4	113.7	0.000	100%
4.D.1.c	Other Wetlands Remaining Other Wetlands	CO2	-109.4	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	N2O	109.3	0.000	100%
2.B.8	Petrochemical and Carbon Black Production	CO2	95.1	0.000	100%
4.D.1.b	Flooded Land Remaining Flooded Land	CO2	89.4	0.000	100%
3.B.2	Sheep	CH4	88.6	0.000	100%

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2.G	Other Product Manufacture and Use	CO2	84.7	0.000	100%
4.D.2.c.i	Forest land converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	78.6	0.000	100%
2.B.8	Hydrogen Production	CO2	75.1	0.000	100%
4.D.2.c.ii	Cropland converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-73.7	0.000	100%
1.B.2	Oil and Natural Gas	CO2	63.0	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CH4	57.2	0.000	100%
4(I)	Direct N2O emissions from N inputs to managed soils	N2O	54.2	0.000	100%
4.C.1.b	Grassland remaining Grassland – dead organic matter (dead wood and litter)	CO2	-49.8	0.000	100%
3.B.4	Goats	N2O	49.3	0.000	100%
4(IV)	Indirect N2O Emissions from Managed Soils	N2O	46.7	0.000	100%
4.D.2.b.ii	Cropland converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	46.3	0.000	100%
3.A.4	Mules & Asses	CH4	45.2	0.000	100%
3.F	Field burning of agricultural residues	CH4	43.7	0.000	100%
3.A.3	Swine	CH4	42.5	0.000	100%
4.B.2.e	Other land converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	38.2	0.000	100%
1.A.3.e	Railways	N2O	37.8	0.000	100%
5.C	Incineration and Open Burning of Waste	CO2	37.0	0.000	100%
5.C	Incineration and Open Burning of Waste	N2O	36.5	0.000	100%
4.E.2.e	Other land converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-35.8	0.000	100%
4.C.1.e	Grassland remaining Grassland – drained organic soil	CO2	-35.2	0.000	100%
4.B.2.c	Wetland converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	33.5	0.000	100%
4.F.2.d	Settlements converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	33.3	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CH4	32.9	0.000	100%
2.B.5	Carbide Production	CO2	31.6	0.000	100%
4.D.2.c.v	Other land converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-28.4	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	N2O	27.3	0.000	100%

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3.B.4	Goats	CH4	27.1	0.000	100%
3.B.3	Swine	N2O	23.8	0.000	100%
1.B.2	Oil and Natural Gas	CH4	22.5	0.000	100%
4.B.1.b	Cropland remaining Cropland – dead organic matter (dead wood and litter)	CO2	-22.1	0.000	100%
4.B.2.d	Settlements converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	20.7	0.000	100%
2.B.10	Other	CO2	20.4	0.000	100%
4.E.2.d	Settlements converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	20.4	0.000	100%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CO2	17.2	0.000	100%
4.F.2.b	Cropland converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	15.7	0.000	100%
4.B.1.c	Cropland remaining Cropland – soil (mineral)	CO2	-15.2	0.000	100%
1.A.4	Other Sectors - Liquid Fuels	CH4	14.8	0.000	100%
2.B.10	Other	CH4	12.7	0.000	100%
4.D.2.c.iv	Settlements converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-11.3	0.000	100%
3.F	Field burning of agricultural residues	N2O	10.7	0.000	100%
4.B.1.e	Cropland remaining Cropland – drained organic soil	CO2	-9.4	0.000	100%
2.C.5	Lead Production	CO2	7.7	0.000	100%
2.B.7	Soda Ash Production	CO2	6.4	0.000	100%
1.A.3.a	Domestic Aviation	N2O	5.6	0.000	100%
4.D.2.b.iv	Settlements converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	5.5	0.000	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	N2O	4.7	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	N2O	4.1	0.000	100%
2.B.5	Carbide Production	CH4	3.9	0.000	100%
4.E.1.b	Settlements remaining Settlements – dead organic matter (dead wood and litter)	CO2	1.7	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	N2O	1.7	0.000	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	CH4	1.5	0.000	100%
2.B.8	Petrochemical and Carbon Black Production	CH4	1.2	0.000	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CH4	1.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	0.9	0.000	100%
1.A.3.e	Railways	CH4	0.7	0.000	100%

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1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.5	0.000	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	N2O	0.5	0.000	100%
1.A.4	Other Sectors - Gaseous Fuels	N2O	0.3	0.000	100%
1.A.3.a	Domestic Aviation	CH4	0.1	0.000	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CH4	0.1	0.000	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	N2O	0.1	0.000	100%
1.B.2	Oil and Natural Gas	N2O	0.1	0.000	100%
2.C.2	Ferroalloys Production	CH4	0.1	0.000	100%
2.C.3	Aluminium Production	Aggregate F-gases	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	0.0	0.000	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	0.0	0.000	100%
2.C.1	Iron and Steel Production	CH4	0.0	0.000	100%
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases	0.0	0.000	100%
2.B.2	Nitric Acid Production	CO2	0.0	0.000	100%
2.B.2	Nitric Acid Production	CH4	0.0	0.000	100%
2.C.2	Ferroalloys Production	N2O	0.0	0.000	100%
2.F.1.a	Refrigeration and Air conditioning - refrigeration and stationary ACs	CO2e	0.0	0.000	100%
2.F.1.b	Refrigeration and Air conditioning - mobile ACs	CO2e	0.0	0.000	100%
4.D.2.b.v	Other land converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	0.0	0.000	100%
4.E.1.c	Settlements remaining Settlements – soil (mineral)	CO2	0.0	0.000	100%
4.F.1.a	Other land remaining Other land – biomass (above and below)	CO2	0.0	0.000	100%
4.F.1.b	Other land remaining Other land – dead organic matter (dead wood and litter)	CO2	0.0	0.000	100%
4.F.1.c	Other land remaining Other land – soil (mineral)	CO2	0.0	0.000	100%
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO2	0.0	0.000	100%

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Table A.I.4: Trend assessment on emissions excluding LULUCF for South Africa (1990 - 2024) with the key categories highlighted in green.

Code	Category Title	GHG	1990 Estimates	2024 Estimates	Contribution to Trend	Cumulative Total
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO2	137 910.7	194 648.2	32%	32%
1.A.4	Other Sectors - Solid Fuels	CO2	33 356.7	3 842.0	17%	49%
1.A.3.b	Road Transportation	CO2	41 755.4	56 846.0	9%	58%
1.A.4	Other Sectors - Liquid Fuels	CO2	5 480.3	14 134.1	5%	63%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO2	9 748.0	16 682.9	4%	67%
2.C.2	Ferroalloys Production	CO2	1 186.9	6 942.5	3%	70%
2.C.1	Iron and Steel Production	CO2	12 597.0	6 894.0	3%	73%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO2	26 631.5	31 538.0	3%	76%
5.A	Solid Waste Disposal	CH4	2 821.7	7 376.7	3%	79%
3.A.1.a.ii	Non-dairy Cattle	CH4	28 133.1	24 291.0	2%	81%
3.A.2	Sheep	CH4	10 019.9	6 313.1	2%	83%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	1 655.0	5 063.6	2%	85%
1.A.3.a	Domestic Aviation	CO2	3 408.9	775.7	2%	86%
1.B.3	Fugitive emissions from - Other emissions from energy production	CO2	25 903.1	23 477.0	1%	88%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	12 921.6	14 635.7	1%	89%
5.D	Wastewater Treatment and Discharge - Domestic	CH4	2 297.1	3 552.8	1%	89%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO2	2 282.2	1 115.9	1%	90%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	1 079.8	2 228.1	1%	91%
2.C.3	Aluminium Production	CO2	254.0	1 259.2	1%	91%
5.B	Biological Treatment of Solid Waste	CH4	858.5	1 793.2	1%	92%
2.B.2	Nitric Acid Production	N2O	1 227.4	340.4	1%	92%
2.D.2	Non-energy Products from Fuels and Solvent Use - Paraffin wax use	CO2	0.0	715.8	0%	93%
1.B.2	Oil and Natural Gas	CO2	773.3	63.0	0%	93%
3.A.4	Goats	CH4	2 285.5	1 577.1	0%	94%
3.A.1.a.i	Dairy Cattle	CH4	3 021.0	3 609.0	0%	94%
3.B.4	Poultry	N2O	367.6	953.0	0%	94%
3.G	Liming	CO2	2 470.8	1 890.9	0%	95%

3.H	Urea Application	CO2	91.0	670.8	0%	95%
1.A.4	Other Sectors - Gaseous Fuels	CO2	11.2	526.0	0%	95%
3.D.2	Indirect N2O Emissions From Managed Soils	N2O	1 008.9	1 513.7	0%	95%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CO2	1 466.1	986.5	0%	96%
5.D	Wastewater Treatment and Discharge - Industrial	CH4	4 250.7	4 720.4	0%	96%
2.D.1	Non-energy Products from Fuels and Solvent Use - Lubricant use	CO2	0.0	461.9	0%	96%
2.A.1	Cement Production	CO2	4 252.5	3 846.0	0%	97%
2.C.6	Zinc Production	CO2	128.7	501.9	0%	97%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CO2	20.4	384.6	0%	97%
5.B	Biological Treatment of Solid Waste	N2O	487.5	826.9	0%	97%
2.A.2	Lime Production	CO2	488.0	799.1	0%	97%
2.B.6	Titanium Dioxide Production	CO2	382.1	683.3	0%	97%
5.D	Wastewater Treatment and Discharge - Domestic	N2O	474.4	733.8	0%	98%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CH4	1 495.4	1 754.0	0%	98%
1.A.3.c	Railways	CO2	664.3	410.1	0%	98%
3.D.1	Direct N2O Emissions From Managed Soils	N2O	7 914.1	8 166.5	0%	98%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	N2O	566.5	808.2	0%	98%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CH4	18.3	250.7	0%	98%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	N2O	285.8	503.6	0%	98%
1.A.3.b	Road Transportation	N2O	519.5	733.3	0%	99%
1.A.4	Other Sectors - Solid Fuels	N2O	392.5	207.1	0%	99%
1.A.3.d	Domestic Navigation - Liquid Fuels	CO2	389.7	562.0	0%	99%
1.B.3	Fugitive emissions from - Other emissions from energy production	CH4	2 905.1	2 736.7	0%	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CH4	192.7	341.3	0%	99%
2.A.4	Other Process Uses of Carbonates	CO2	0.0	133.6	0%	99%
3.B.1.a.ii	Non-dairy Cattle	N2O	806.4	922.6	0%	99%
3.B.4	Poultry	CH4	79.2	191.7	0%	99%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	N2O	2.2	109.3	0%	99%
2.A.3	Glass Production	CO2	85.0	177.3	0%	99%
3.B.1.a.i	Dairy Cattle	CH4	466.0	556.7	0%	99%
2.G	Other Product Manufacture and Use	CO2	0.0	84.7	0%	99%
2.B.8	Hydrogen Production	CO2	0.0	75.1	0%	99%

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1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CO2	153.4	227.5	0%	99%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	73.2	0.0	0%	99%
3.B.5	Indirect N2O Emissions From Manure Management	N2O	268.3	333.0	0%	100%
5.C	Incineration and Open Burning of Waste	CH4	108.1	167.2	0%	100%
3.A.4	Horses	CH4	115.9	170.3	0%	100%
3.B.2	Sheep	CH4	134.6	88.6	0%	100%
2.B.1	Ammonia Production	CO2	423.7	378.7	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	44.6	0.0	0%	100%
1.A.4	Other Sectors - Solid Fuels	CH4	205.9	161.8	0%	100%
3.B.2	Sheep	N2O	199.0	158.2	0%	100%
2.B.1	Ammonia Production	CH4	76.3	113.7	0%	100%
3.B.1.a.i	Dairy Cattle	N2O	178.9	213.7	0%	100%
3.B.3	Swine	CH4	237.1	205.5	0%	100%
2.B.5	Carbide Production	CO2	1.7	31.6	0%	100%
1.A.3.e	Railways	N2O	67.5	37.8	0%	100%
3.B.1.a.ii	Non-dairy Cattle	CH4	703.2	676.6	0%	100%
2.B.8	Petrochemical and Carbon Black Production	CO2	121.0	95.1	0%	100%
2.B.10	Other	CO2	0.0	20.4	0%	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CH4	13.0	32.9	0%	100%
1.A.3.a	Domestic Aviation	N2O	24.8	5.6	0%	100%
3.A.4	Mules & Asses	CH4	62.7	45.2	0%	100%
3.B.4	Goats	N2O	66.8	49.3	0%	100%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CH4	39.9	57.2	0%	100%
1.A.4	Other Sectors - Liquid Fuels	N2O	11.3	27.3	0%	100%
5.C	Incineration and Open Burning of Waste	CO2	24.0	37.0	0%	100%
5.C	Incineration and Open Burning of Waste	N2O	23.6	36.5	0%	100%
2.B.10	Other	CH4	0.0	12.7	0%	100%
1.B.2	Oil and Natural Gas	CH4	10.0	22.5	0%	100%
3.B.4	Goats	CH4	38.5	27.1	0%	100%
1.A.4	Other Sectors - Liquid Fuels	CH4	6.1	14.8	0%	100%
2.C.5	Lead Production	CO2	16.0	7.7	0%	100%
3.A.3	Swine	CH4	49.0	42.5	0%	100%

2.B.7	Soda Ash Production	CO2	0.0	6.4	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.3	0.0	0%	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	N2O	0.3	4.7	0%	100%
2.B.5	Carbide Production	CH4	0.0	3.9	0%	100%
3.B.3	Swine	N2O	27.4	23.8	0%	100%
3.F	Field burning of agricultural residues	CH4	47.2	43.7	0%	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	N2O	4.7	1.7	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	2.6	0.0	0%	100%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CO2	14.7	17.2	0%	100%
1.A.3.b	Road Transportation	CH4	368.5	366.1	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	2.1	0.0	0%	100%
2.C.2	Ferroalloys Production	CH4	1.6	0.1	0%	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CH4	2.5	1.0	0%	100%
2.B.8	Petrochemical and Carbon Black Production	CH4	0.1	1.2	0%	100%
3.F	Field burning of agricultural residues	N2O	11.6	10.7	0%	100%
1.B.2	Oil and Natural Gas	N2O	0.8	0.1	0%	100%
1.A.3.a	Domestic Aviation	CH4	0.7	0.1	0%	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	N2O	3.6	4.1	0%	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	CH4	1.0	1.5	0%	100%
1.A.3.e	Railways	CH4	1.0	0.7	0%	100%
1.A.4	Other Sectors - Gaseous Fuels	CH4	0.0	0.3	0%	100%
1.A.4	Other Sectors - Gaseous Fuels	N2O	0.0	0.3	0%	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.7	0.5	0%	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	N2O	0.7	0.5	0%	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CH4	0.1	0.1	0%	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	N2O	0.1	0.1	0%	100%
2.C.3	Aluminium Production	Aggregate F-gases	0.0	0.0	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	0.9	0.9	0%	100%
2.C.1	Iron and Steel Production	CH4	0.0	0.0	0%	100%
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases	0.0	0.0	0%	100%
2.B.2	Nitric Acid Production	CO2	0.0	0.0	0%	100%

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2.B.2	Nitric Acid Production	CH4	0.0	0.0	0%	100%
2.C.2	Ferroalloys Production	N2O	0.0	0.0	0%	100%
2.F.1.a	Refrigeration and Air conditioning - refrigeration and stationary ACs	CO2e	0.0	0.0	0%	100%
2.F.1.b	Refrigeration and Air conditioning - mobile ACs	CO2e	0.0	0.0	0%	100%

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Table A.I.5: Trend assessment on emissions including LULUCF for South Africa (1990 - 2024) with the key categories highlighted in green.

Code	Category Title	GHG	1990 Estimates	2024 Estimates	Contribution to Trend	Cumulative Total
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CO2	137 910.7	194 648.2	21%	21%
1.A.4	Other Sectors - Solid Fuels	CO2	33 356.7	3 842.0	11%	32%
4.A.2.b	Grassland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-29 846.3	-57 097.6	10%	42%
4.C.2.a	Forest land converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	14 927.0	36 486.2	8%	50%
1.A.3.b	Road Transportation	CO2	41 755.4	56 846.0	6%	55%
4.A.1.a	Forest land remaining forest land – biomass (above and below)	CO2	20 674.8	9 345.2	4%	59%
4.C.2.e	Other land converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-5 730.6	-15 836.5	4%	63%
1.A.4	Other Sectors - Liquid Fuels	CO2	5 480.3	14 134.1	3%	66%
4.C.1.a	Grassland remaining Grassland – biomass (above and below)	CO2	-5 937.9	-14 549.9	3%	69%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CO2	9 748.0	16 682.9	3%	72%
2.C.2	Ferroalloys Production	CO2	1 186.9	6 942.5	2%	74%
2.C.1	Iron and Steel Production	CO2	12 597.0	6 894.0	2%	76%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CO2	26 631.5	31 538.0	2%	78%
5.A	Solid Waste Disposal	CH4	2 821.7	7 376.7	2%	80%
3.A.1.a.ii	Non-dairy Cattle	CH4	28 133.1	24 291.0	1%	81%
3.A.2	Sheep	CH4	10 019.9	6 313.1	1%	82%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	1 655.0	5 063.6	1%	84%
4.F.2.c	Grassland converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	4 685.3	7 549.5	1%	85%
4.B.2.a	Forest land converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	2 736.2	5 450.4	1%	86%
1.A.3.a	Domestic Aviation	CO2	3 408.9	775.7	1%	87%
1.B.3	Fugitive emissions from - Other emissions from energy production	CO2	25 903.1	23 477.0	1%	88%
4.E.1.a	Settlements remaining Settlements – biomass (above and below)	CO2	-1 336.8	-3 103.4	1%	88%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	12 921.6	14 635.7	1%	89%

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4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH4	656.2	2 039.0	1%	89%
5.D	Wastewater Treatment and Discharge - Domestic	CH4	2 297.1	3 552.8	0%	90%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CO2	2 282.2	1 115.9	0%	90%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	1 079.8	2 228.1	0%	91%
4.F.2.a	Forest land converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	623.0	1 744.6	0%	91%
2.C.3	Aluminium Production	CO2	254.0	1 259.2	0%	91%
5.B	Biological Treatment of Solid Waste	CH4	858.5	1 793.2	0%	92%
2.B.2	Nitric Acid Production	N2O	1 227.4	340.4	0%	92%
4.C.2.c	Wetland converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	720.2	-144.4	0%	92%
4.C.2.b	Cropland converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-2 520.7	-1 672.7	0%	93%
4.E.2.b	Cropland converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-126.2	606.9	0%	93%
2.D.2	Non-energy Products from Fuels and Solvent Use - Paraffin wax use	CO2	0.0	715.8	0%	93%
1.B.2	Oil and Natural Gas	CO2	773.3	63.0	0%	94%
3.A.4	Goats	CH4	2 285.5	1 577.1	0%	94%
4.G	Harvested Wood Products	CO2	-1 035.6	-1 718.3	0%	94%
3.A.1.a.i	Dairy Cattle	CH4	3 021.0	3 609.0	0%	94%
3.B.4	Poultry	N2O	367.6	953.0	0%	94%
3.G	Liming	CO2	2 470.8	1 890.9	0%	95%
3.H	Urea Application	CO2	91.0	670.8	0%	95%
1.A.4	Other Sectors - Gaseous Fuels	CO2	11.2	526.0	0%	95%
4.E.2.a	Forest land converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	716.6	1 224.3	0%	95%
3.D.2	Indirect N2O Emissions From Managed Soils	N2O	1 008.9	1 513.7	0%	95%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CO2	1 466.1	986.5	0%	96%
5.D	Wastewater Treatment and Discharge - Industrial	CH4	4 250.7	4 720.4	0%	96%
2.D.1	Non-energy Products from Fuels and Solvent Use - Lubricant use	CO2	0.0	461.9	0%	96%
4.A.2.a	Cropland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-2 955.4	-3 417.3	0%	96%

4.B.2.b	Grassland converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	2 737.2	2 275.5	0%	96%
2.A.1	Cement Production	CO2	4 252.5	3 846.0	0%	96%
4.B.1.a	Cropland remaining Cropland – biomass (above and below)	CO2	714.8	312.3	0%	97%
2.C.6	Zinc Production	CO2	128.7	501.9	0%	97%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CO2	20.4	384.6	0%	97%
4.A.2.e	Other land converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-1 127.6	-1 487.8	0%	97%
4.A.2.d	Settlements converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-662.7	-1 008.9	0%	97%
5.B	Biological Treatment of Solid Waste	N2O	487.5	826.9	0%	97%
4.C.2.d	Settlements converted to Grassland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-127.4	-442.9	0%	97%
2.A.2	Lime Production	CO2	488.0	799.1	0%	98%
2.B.6	Titanium Dioxide Production	CO2	382.1	683.3	0%	98%
4.A.1.c	Forest land remaining forest land – soil (mineral)	CO2	71.6	-220.7	0%	98%
5.D	Wastewater Treatment and Discharge - Domestic	N2O	474.4	733.8	0%	98%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CH4	1 495.4	1 754.0	0%	98%
1.A.3.c	Railways	CO2	664.3	410.1	0%	98%
3.D.1	Direct N2O Emissions From Managed Soils	N2O	7 914.1	8 166.5	0%	98%
4.A.2.c	Wetland converted to forest land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-1 093.7	-850.6	0%	98%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	N2O	566.5	808.2	0%	98%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	CH4	18.3	250.7	0%	98%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	N2O	285.8	503.6	0%	98%
1.A.3.b	Road Transportation	N2O	519.5	733.3	0%	99%
1.A.4	Other Sectors - Solid Fuels	N2O	392.5	207.1	0%	99%
1.A.3.d	Domestic Navigation - Liquid Fuels	CO2	389.7	562.0	0%	99%
1.B.3	Fugitive emissions from - Other emissions from energy production	CH4	2 905.1	2 736.7	0%	99%
4.D.2.b.i	Forest land converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	155.1	320.1	0%	99%
4.B.2.c	Wetland converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	183.8	33.5	0%	99%
1.A.5	Other (Not specified elsewhere) - Solid Fuels	CH4	192.7	341.3	0%	99%

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2.A.4	Other Process Uses of Carbonates	CO2	0.0	133.6	0%	99%
4.A.1.b	Forest land remaining forest land – dead organic matter (dead wood and litter)	CO2	-1 135.5	-1 006.1	0%	99%
4.D.2.b.iii	Grassland converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	43.2	171.0	0%	99%
3.B.1.a.ii	Non-dairy Cattle	N2O	806.4	922.6	0%	99%
3.B.4	Poultry	CH4	79.2	191.7	0%	99%
4.F.2.e	Other land converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	640.8	749.9	0%	99%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	N2O	2.2	109.3	0%	99%
2.A.3	Glass Production	CO2	85.0	177.3	0%	99%
4.E.2.c	Grassland converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-75.7	-166.9	0%	99%
3.B.1.a.i	Dairy Cattle	CH4	466.0	556.7	0%	99%
4(III)	Direct N2O emissions from N mineralization/immobilization	N2O	348.6	438.0	0%	99%
2.G	Other Product Manufacture and Use	CO2	0.0	84.7	0%	99%
4.D.2.c.i	Forest land converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	159.7	78.6	0%	99%
4.D.2.c.iii	Grassland converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-303.0	-381.2	0%	99%
2.B.8	Hydrogen Production	CO2	0.0	75.1	0%	99%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CO2	153.4	227.5	0%	99%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	73.2	0.0	0%	99%
4(V)	Biomass Burning	CH4	974.5	902.0	0%	100%
3.B.5	Indirect N2O Emissions From Manure Management	N2O	268.3	333.0	0%	100%
4.D.1.b	Flooded Land Remaining Flooded Land	CO2	28.6	89.4	0%	100%
5.C	Incineration and Open Burning of Waste	CH4	108.1	167.2	0%	100%
3.A.4	Horses	CH4	115.9	170.3	0%	100%
3.B.2	Sheep	CH4	134.6	88.6	0%	100%
2.B.1	Ammonia Production	CO2	423.7	378.7	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	44.6	0.0	0%	100%
1.A.4	Other Sectors - Solid Fuels	CH4	205.9	161.8	0%	100%
4.D.2.c.ii	Cropland converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-116.8	-73.7	0%	100%
3.B.2	Sheep	N2O	199.0	158.2	0%	100%

4(I)	Direct N2O emissions from N inputs to managed soils	N2O	13.6	54.2	0%	100%
4.D.2.b.ii	Cropland converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	8.2	46.3	0%	100%
2.B.1	Ammonia Production	CH4	76.3	113.7	0%	100%
4.B.2.e	Other land converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	1.5	38.2	0%	100%
3.B.1.a.i	Dairy Cattle	N2O	178.9	213.7	0%	100%
3.B.3	Swine	CH4	237.1	205.5	0%	100%
4.E.2.e	Other land converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-4.9	-35.8	0%	100%
2.B.5	Carbide Production	CO2	1.7	31.6	0%	100%
1.A.3.e	Railways	N2O	67.5	37.8	0%	100%
4(IV)	Indirect N2O Emissions from Managed Soils	N2O	18.1	46.7	0%	100%
3.B.1.a.ii	Non-dairy Cattle	CH4	703.2	676.6	0%	100%
2.B.8	Petrochemical and Carbon Black Production	CO2	121.0	95.1	0%	100%
4.B.1.b	Cropland remaining Cropland – dead organic matter (dead wood and litter)	CO2	3.8	-22.1	0%	100%
2.B.10	Other	CO2	0.0	20.4	0%	100%
1.A.1	Fuel combustion - Energy Industries - Liquid Fuels	CH4	13.0	32.9	0%	100%
4.C.1.b	Grassland remaining Grassland – dead organic matter (dead wood and litter)	CO2	-30.5	-49.8	0%	100%
1.A.3.a	Domestic Aviation	N2O	24.8	5.6	0%	100%
3.A.4	Mules & Asses	CH4	62.7	45.2	0%	100%
3.B.4	Goats	N2O	66.8	49.3	0%	100%
1.A.1	Fuel combustion - Energy Industries - Solid Fuels	CH4	39.9	57.2	0%	100%
4.B.2.d	Settlements converted to Cropland – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	3.4	20.7	0%	100%
4.F.2.d	Settlements converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	16.0	33.3	0%	100%
4.D.2.c.v	Other land converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-12.0	-28.4	0%	100%
1.A.4	Other Sectors - Liquid Fuels	N2O	11.3	27.3	0%	100%
5.C	Incineration and Open Burning of Waste	CO2	24.0	37.0	0%	100%
5.C	Incineration and Open Burning of Waste	N2O	23.6	36.5	0%	100%
2.B.10	Other	CH4	0.0	12.7	0%	100%
1.B.2	Oil and Natural Gas	CH4	10.0	22.5	0%	100%

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4.C.1.c	Grassland remaining Grassland – soil (mineral)	CO2	-695.6	-707.2	0%	100%
3.B.4	Goats	CH4	38.5	27.1	0%	100%
4.D.1.c	Other Wetlands Remaining Other Wetlands	CO2	-100.3	-109.4	0%	100%
1.A.4	Other Sectors - Liquid Fuels	CH4	6.1	14.8	0%	100%
2.C.5	Lead Production	CO2	16.0	7.7	0%	100%
4.E.2.d	Settlements converted to settlements – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	13.0	20.4	0%	100%
3.A.3	Swine	CH4	49.0	42.5	0%	100%
2.B.7	Soda Ash Production	CO2	0.0	6.4	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.3	0.0	0%	100%
4.B.1.c	Cropland remaining Cropland – soil (mineral)	CO2	-20.8	-15.2	0%	100%
4.C.1.e	Grassland remaining Grassland – drained organic soil	CO2	-29.6	-35.2	0%	100%
4.D.2.b.iv	Settlements converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	0.6	5.5	0%	100%
1.B.1.c	Fugitive emissions from Solid Fuels - Solid fuel transformation	N2O	0.3	4.7	0%	100%
2.B.5	Carbide Production	CH4	0.0	3.9	0%	100%
3.B.3	Swine	N2O	27.4	23.8	0%	100%
3.F	Field burning of agricultural residues	CH4	47.2	43.7	0%	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	N2O	4.7	1.7	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	2.6	0.0	0%	100%
1.B.1.a	Fugitive emissions from Solid Fuels - Coal mining and handling	CO2	14.7	17.2	0%	100%
4.E.1.b	Settlements remaining Settlements – dead organic matter (dead wood and litter)	CO2	4.2	1.7	0%	100%
1.A.3.b	Road Transportation	CH4	368.5	366.1	0%	100%
4(V)	Biomass Burning	N2O	689.6	691.9	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	2.1	0.0	0%	100%
4.B.1.e	Cropland remaining Cropland – drained organic soil	CO2	-7.6	-9.4	0%	100%
2.C.2	Ferroalloys Production	CH4	1.6	0.1	0%	100%
1.A.5	Other (Not specified elsewhere) - Liquid Fuels	CH4	2.5	1.0	0%	100%
4.D.2.c.iv	Settlements converted to other wetlands – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	-10.0	-11.3	0%	100%
2.B.8	Petrochemical and Carbon Black Production	CH4	0.1	1.2	0%	100%
3.F	Field burning of agricultural residues	N2O	11.6	10.7	0%	100%
1.B.2	Oil and Natural Gas	N2O	0.8	0.1	0%	100%

1.A.3.a	Domestic Aviation	CH4	0.7	0.1	0%	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	N2O	3.6	4.1	0%	100%
1.A.3.d	Domestic Navigation - Liquid Fuels	CH4	1.0	1.5	0%	100%
1.A.3.e	Railways	CH4	1.0	0.7	0%	100%
4.F.2.b	Cropland converted to other land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	16.0	15.7	0%	100%
1.A.4	Other Sectors - Gaseous Fuels	CH4	0.0	0.3	0%	100%
1.A.4	Other Sectors - Gaseous Fuels	N2O	0.0	0.3	0%	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.7	0.5	0%	100%
1.A.1	Fuel combustion - Energy Industries - Gaseous Fuels	N2O	0.7	0.5	0%	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	CH4	0.1	0.1	0%	100%
1.A.5	Other (Not specified elsewhere) - Gaseous Fuels	N2O	0.1	0.1	0%	100%
2.C.3	Aluminium Production	Aggregate F-gases	0.0	0.0	0%	100%
1.A.2	Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	0.9	0.9	0%	100%
2.C.1	Iron and Steel Production	CH4	0.0	0.0	0%	100%
2.F.1	Refrigeration and Air conditioning	Aggregate F-gases	0.0	0.0	0%	100%
2.B.2	Nitric Acid Production	CO2	0.0	0.0	0%	100%
2.B.2	Nitric Acid Production	CH4	0.0	0.0	0%	100%
2.C.2	Ferroalloys Production	N2O	0.0	0.0	0%	100%
2.F.1.a	Refrigeration and Air conditioning - refrigeration and stationary ACs	CO2e	0.0	0.0	0%	100%
2.F.1.b	Refrigeration and Air conditioning - mobile ACs	CO2e	0.0	0.0	0%	100%
4.D.2.b.v	Other land converted to flooded land – all pools (i.e., biomass, dead organic matter, soil (mineral), soil (organic), drained organic soil)	CO2	0.0	0.0	0%	100%
4.E.1.c	Settlements remaining Settlements – soil (mineral)	CO2	0.0	0.0	0%	100%
4.F.1.a	Other land remaining Other land – biomass (above and below)	CO2	0.0	0.0	0%	100%
4.F.1.b	Other land remaining Other land – dead organic matter (dead wood and litter)	CO2	0.0	0.0	0%	100%
4.F.1.c	Other land remaining Other land – soil (mineral)	CO2	0.0	0.0	0%	100%
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO2	0.0	0.0	0%	100%

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Annex II: Uncertainty analysis

Table A II. 1: Overall uncertainty analysis including LULUCF for 1990 to 2024.

IPCC Category		Gas	Base year emissions/ removals (1990)	Year t emissions / removals (2024)	Activity data uncertainty		Emission factor/estimation parameter uncertainty		Combined uncertainty		Contribution to variance in Year t		Uncertainty in trend in national emissions introduced by EF/ estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
			Gg CO2e	Gg CO2e	(-)%	(+)%	(-)%	(+)%	(-)%	(+)%	Lower (%)	Upper (%)	%	%	%
1A1a	Electricity and Heat Production	CO2	138 026,9	198 237,2	3,0%	5,0%	7,0%	7,0%	7,62%	8,60%	0,1177%	0,1502%	0,80%	3,52%	0,13%
1A1b	Petroleum Refining	CO2	2 545,2	1 491,0	3,0%	5,0%	7,0%	7,0%	7,62%	8,60%	0,0000%	0,0000%	0,02%	0,03%	0,00%
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CO2	25 436,2	27 444,5	3,0%	5,0%	7,0%	7,0%	7,62%	8,60%	0,0023%	0,0029%	0,01%	0,49%	0,00%
1A1a	Electricity and Heat Production	CH4	40,0	61,3	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A1b	Petroleum Refining	CH4	1,8	0,9	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CH4	11,8	28,4	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A1a	Electricity and Heat Production	N2O	566,7	815,9	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0002%	0,0002%	0,04%	0,01%	0,00%
1A1b	Petroleum Refining	N2O	2,7	1,3	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A1c	Manufacture of Solid Fuels and Other Energy Industries	N2O	0,0	100,7	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,02%	0,00%	0,00%

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1A2	Manufacturing Industries and Construction	CO2	15 656,4	21 927,4	5,0%	10,0%	7,0%	7,0%	8,60%	12,21%	0,0018%	0,0037%	0,08%	0,78%	0,01%
1A2	Manufacturing Industries and Construction	CH4	53,6	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,01%	0,00%	0,00%
1A2	Manufacturing Industries and Construction	N2O	76,2	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,02%	0,00%	0,00%
1A3a	Civil Aviation	CO2	3 408,9	775,7	5,0%	5,0%	1,5%	1,5%	5,22%	5,22%	0,0000%	0,0000%	0,01%	0,01%	0,00%
1A3b	Road Transport	CO2	41 755,4	56 925,6	5,0%	5,0%	2,0%	2,0%	5,39%	5,39%	0,0049%	0,0049%	0,05%	1,01%	0,01%
1A3c	Railways	CO2	664,3	410,1	5,0%	5,0%	2,0%	2,0%	5,39%	5,39%	0,0000%	0,0000%	0,00%	0,01%	0,00%
1A3d	Water-Borne Navigation	CO2	389,7	562,0	5,0%	5,0%	3,0%	3,0%	5,83%	5,83%	0,0000%	0,0000%	0,00%	0,01%	0,00%
1A3a	Civil Aviation	CH4	0,7	0,1	5,0%	5,0%	70,0%	70,0%	70,18%	70,18%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A3b	Road Transport	CH4	368,5	366,1	5,0%	5,0%	9,0%	9,0%	10,30%	10,30%	0,0000%	0,0000%	0,00%	0,01%	0,00%
1A3c	Railways	CH4	1,0	0,7	5,0%	5,0%	9,0%	9,0%	10,30%	10,30%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A3d	Water-Borne Navigation	CH4	1,0	1,5	5,0%	5,0%	50,0%	50,0%	50,25%	50,25%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A3a	Civil Aviation	N2O	24,8	5,6	5,0%	5,0%	70,0%	50,0%	70,18%	50,25%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A3b	Road Transport	N2O	519,5	733,3	5,0%	5,0%	70,0%	72,0%	70,18%	72,17%	0,0001%	0,0001%	0,03%	0,01%	0,00%
1A3c	Railways	N2O	67,5	37,8	5,0%	5,0%	70,0%	72,0%	70,18%	72,17%	0,0000%	0,0000%	0,01%	0,00%	0,00%
1A3d	Water-Borne Navigation	N2O	2,8	4,1	5,0%	5,0%	40,0%	140,0%	40,31%	140,09%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A4a	Commercial/Institutional	CO2	15 992,7	11 819,8	5,0%	10,0%	7,0%	7,0%	8,60%	12,21%	0,0005%	0,0011%	0,10%	0,42%	0,00%
1A4b	Residential	CO2	20 774,9	3 608,2	5,0%	10,0%	7,0%	7,0%	8,60%	12,21%	0,0000%	0,0001%	0,34%	0,13%	0,00%
1A4c	Agriculture/Forestry/Fishing/Fish Farms	CO2	2 080,6	3 074,2	5,0%	10,0%	7,0%	7,0%	8,60%	12,21%	0,0000%	0,0001%	0,01%	0,11%	0,00%
1A4a	Commercial/Institutional	CH4	6,8	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%

1A4b	Residential	CH4	202,8	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,04%	0,00%	0,00%
1A4c	Agriculture/Forestry/Fishing/Fish Farms	CH4	2,3	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A4a	Commercial/Institutional	N2O	69,7	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,01%	0,00%	0,00%
1A4b	Residential	N2O	329,0	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,07%	0,00%	0,00%
1A4c	Agriculture/Forestry/Fishing/Fish Farms	N2O	5,0	0,0	5,0%	10,0%	75,0%	75,0%	75,17%	75,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1A5a	Stationary	CO2	12 183,6	18 026,3	3,0%	5,0%	7,0%	7,0%	7,62%	8,60%	0,0010%	0,0012%	0,08%	0,32%	0,00%
1A5a	Stationary	CH4	195,3	0,0	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,04%	0,00%	0,00%
1A5a	Stationary	N2O	290,5	0,0	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,06%	0,00%	0,00%
1B1a	Coal mining and handling	CO2	14,7	17,2	10,0%	10,0%	63,0%	63,0%	63,79%	63,79%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1B1a	Coal mining and handling	CH4	1 495,4	1 754,0	10,0%	10,0%	63,0%	63,0%	63,79%	63,79%	0,0006%	0,0006%	0,02%	0,06%	0,00%
1B1c	Solid fuel transformation	CO2	20,4	384,6	10,0%	10,0%	63,0%	63,0%	63,79%	63,79%	0,0000%	0,0000%	0,06%	0,01%	0,00%
1B1c	Solid fuel transformation	CH4	18,3	250,7	10,0%	10,0%	63,0%	63,0%	63,79%	63,79%	0,0000%	0,0000%	0,04%	0,01%	0,00%
1B1c	Solid fuel transformation	N2O	0,3	4,7	10,0%	10,0%	63,0%	63,0%	63,79%	63,79%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1B2a	Oil	CO2	773,3	63,0	25,0%	25,0%	75,0%	75,0%	79,06%	79,06%	0,0000%	0,0000%	0,15%	0,01%	0,00%
1B2a	Oil	CH4	10,0	22,5	25,0%	25,0%	75,0%	75,0%	79,06%	79,06%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1B2a	Oil	N2O	0,8	0,1	25,0%	25,0%	75,0%	75,0%	79,06%	79,06%	0,0000%	0,0000%	0,00%	0,00%	0,00%
1B3	Other Emissions from Energy Production	CO2	25 903,1	23 477,0	25,0%	25,0%	75,0%	75,0%	79,06%	79,06%	0,1779%	0,1779%	0,97%	2,08%	0,05%
1B3	Other Emissions from Energy Production	CH4	2 905,1	2 736,7	25,0%	25,0%	75,0%	75,0%	79,06%	79,06%	0,0024%	0,0024%	0,09%	0,24%	0,00%

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2A1	Cement Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2A2	Lime Production	CO2	488,0	799,1	30,0%	30,0%	6,0%	6,0%	30,59%	30,59%	0,0000%	0,0000%	0,00%	0,09%	0,00%
2A3	Glass Production	CO2	85,0	177,3	1,0%	3,0%	1,0%	3,0%	1,41%	4,24%	0,0000%	0,0000%	0,00%	0,00%	0,00%
2A4a	Ceramics	CO2	0,0	54,5	1,0%	85,0%	1,0%	5,0%	1,41%	85,15%	0,0000%	0,0000%	0,00%	0,02%	0,00%
2A4b	Other Uses of Soda Ash	CO2	0,0	51,9	1,0%	85,0%	1,0%	5,0%	1,41%	85,15%	0,0000%	0,0000%	0,00%	0,02%	0,00%
2A4d	Other	CO2	0,0	27,2	15,0%	85,0%	1,0%	5,0%	15,03%	85,15%	0,0000%	0,0000%	0,00%	0,01%	0,00%
2B1	Ammonia Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B1	Ammonia Production	CH4	C	C	C	C	C	C	C	C	C	C	C	C	C
2B2	Nitric Acid Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B3	Nitric Acid Production	CH4	C	C	C	C	C	C	C	C	C	C	C	C	C
2B2	Nitric Acid Production	N2O	C	C	C	C	C	C	C	C	C	C	C	C	C
2B5	Carbide Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B5	Carbide Production	CH4	C	C	C	C	C	C	C	C	C	C	C	C	C
2B6	Titanium Dioxide Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B7	Soda Ash Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B8f	Carbon Black production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B8f	Carbon Black production	CH4	C	C	C	C	C	C	C	C	C	C	C	C	C
2B8g	Hydrogen Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B10	Other	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2B10	Other	CH4	C	C	C	C	C	C	C	C	C	C	C	C	C

2C1	Iron and Steel Production	CO2	12 597,0	6 894,0	5,0%	10,0%	25,0%	25,0%	25,50%	26,93%	0,0016%	0,0018%	0,44%	0,24%	0,00%
2C1	Iron and Steel Production	CH4	0,0	0,0	5,0%	10,0%	25,0%	25,0%	25,50%	26,93%	0,0000%	0,0000%	0,00%	0,00%	0,00%
2C2	Ferroalloys Production	CO2	1 186,9	6 942,5	5,0%	5,0%	5,0%	25,0%	7,07%	25,50%	0,0001%	0,0016%	0,35%	0,12%	0,00%
2C2	Ferroalloys Production	CH4	0,1	0,0	5,0%	5,0%	25,0%	25,0%	25,50%	25,50%	0,0000%	0,0000%	0,00%	0,00%	0,00%
2C2	Ferroalloys Production	N2O	0,0	0,0	5,0%	5,0%	25,0%	25,0%	25,50%	25,50%	0,0000%	0,0000%	0,00%	0,00%	0,00%
2C3	Aluminium Production	CO2	C	C	C	C	C	C	C	C	C	C	C	C	C
2C3	Aluminium Production	PFCs	C	C	C	C	C	C	C	C	C	C	C	C	C
2C5	Lead Production	CO2	16,0	7,7	10,0%	10,0%	50,0%	50,0%	50,99%	50,99%	0,0000%	0,0000%	0,00%	0,00%	0,00%
2C6	Zinc Production	CO2	128,7	501,9	10,0%	10,0%	50,0%	50,0%	50,99%	50,99%	0,0000%	0,0000%	0,05%	0,02%	0,00%
2D1	Lubricant Use	CO2	0,0	461,9	10,0%	20,0%	50,0%	50,0%	50,99%	53,85%	0,0000%	0,0000%	0,06%	0,03%	0,00%
2D2	Paraffin Wax Use	CO2	0,0	715,8	10,0%	20,0%	50,0%	50,0%	50,99%	53,85%	0,0001%	0,0001%	0,09%	0,05%	0,00%
2F1	Refrigeration and Air Conditioning	HFCs	0,0	6 577,2	25,0%	25,0%	25,0%	25,0%	35,36%	35,36%	0,0028%	0,0028%	0,41%	0,58%	0,01%
2F2	Foam Blowing Agents	HFCs	0,0	2,1	50,0%	50,0%	25,0%	25,0%	55,90%	55,90%	0,0000%	0,0000%	0,00%	0,00%	0,00%
2F3	Fire Protection	HFCs	0,0	87,5	25,0%	25,0%	25,0%	25,0%	35,36%	35,36%	0,0000%	0,0000%	0,01%	0,01%	0,00%
2F4	Aerosols	HFCs	0,0	18,3	25,0%	25,0%	25,0%	25,0%	35,36%	35,36%	0,0000%	0,0000%	0,00%	0,00%	0,00%
2G1	Use of Electrical equipment	SF6	0,0	84,7	25,0%	25,0%	25,0%	25,0%	35,36%	35,36%	0,0000%	0,0000%	0,01%	0,01%	0,00%
3A1	Enteric fermentation - cattle	CH4	28 133,1	24 291,0	17,2%	17,2%	13,8%	13,8%	22,06%	22,06%	0,0148%	0,0148%	0,23%	1,48%	0,02%
3A2	Enteric fermentation - sheep	CH4	10 019,9	6 313,1	13,1%	13,1%	30,8%	30,8%	33,46%	33,46%	0,0023%	0,0023%	0,37%	0,29%	0,00%

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3A3	Enteric fermentation - swine	CH4	49,0	42,5	50,2%	50,2%	20,0%	20,0%	54,08%	54,08%	0,0000%	0,0000%	0,00%	0,01%	0,00%
3A4d	Enteric fermentation - goats	CH4	2 285,5	2 285,5	20,6%	20,6%	35,5%	35,5%	41,05%	41,05%	0,0005%	0,0005%	0,02%	0,17%	0,00%
3A4e	Enteric fermentation - horses	CH4	115,9	170,3	7,1%	7,1%	40,0%	40,0%	40,62%	40,62%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3A4f	Enteric fermentation - mules and asses	CH4	62,7	45,2	11,2%	11,2%	40,0%	40,0%	41,53%	41,53%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3A4h	Enteric fermentation - other game	CH4	0,0	0,0					0,00%	0,00%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3B1	Manure management - cattle	CH4	1 169,2	1 233,2	17,2%	17,2%	12,0%	12,0%	20,97%	20,97%	0,0000%	0,0000%	0,00%	0,08%	0,00%
3B2	Manure management - sheep	CH4	134,6	88,6	13,1%	13,1%	16,0%	16,0%	20,66%	20,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3B3	Manure management - swine	CH4	237,1	205,5	50,2%	50,2%	20,0%	20,0%	54,08%	54,08%	0,0000%	0,0000%	0,00%	0,04%	0,00%
3B4d	Manure management - goats	CH4	38,5	27,1	20,6%	20,6%	47,8%	47,8%	52,01%	52,01%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3B4e	Manure management - horses	CH4	0,0	0,0	7,1%	7,1%	30,0%	30,0%	30,82%	30,82%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3B4f	Manure management - mules and asses	CH4	0,0	0,0	11,2%	11,2%	30,0%	30,0%	32,02%	32,02%	0,0000%	0,0000%	0,00%	0,00%	0,00%

3B4g	Manure management - poultry	CH4	79,2	191,7	20,6%	20,6%	20,0%	20,0%	28,72%	28,72%	0,0000%	0,0000%	0,01%	0,01%	0,00%
3B4h	Manure management - other game	CH4	0,0	0,0					0,00%	0,00%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3A2a	Manure management - cattle	N2O	985,3	1 136,3	43,2%	43,2%	50,0%	100,0%	66,08%	108,93%	0,0003%	0,0008%	0,01%	0,17%	0,00%
3A2c	Manure management - sheep	N2O	199,0	158,2	33,0%	33,0%	50,0%	100,0%	59,88%	105,29%	0,0000%	0,0000%	0,02%	0,02%	0,00%
3B3	Manure management - swine	N2O	27,4	23,8	59,4%	59,4%	50,0%	100,0%	77,62%	116,30%	0,0000%	0,0000%	0,00%	0,01%	0,00%
3A2d	Manure management - goats	N2O	66,8	49,3	36,5%	36,5%	50,0%	100,0%	61,88%	106,44%	0,0000%	0,0000%	0,01%	0,01%	0,00%
3B4e	Manure management - horses	N2O	0,0	0,0	31,2%	31,2%	50,0%	100,0%	58,95%	104,76%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3B4f	Manure management - mules and asses	N2O	0,0	0,0	32,1%	32,1%	50,0%	100,0%	59,41%	105,02%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3B4g	Manure management - poultry	N2O	367,6	953,0	44,2%	44,2%	50,0%	100,0%	66,71%	109,32%	0,0002%	0,0006%	0,14%	0,15%	0,00%
3B4h	Manure management - other game	N2O							0,00%	0,00%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3B5	Indirect N2O from manure management	N2O	268,3	333,0	89,5%	89,5%	100,0 %	101,0%	134,18 %	134,93%	0,0001%	0,0001%	0,01%	0,11%	0,00%

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3D1a	Inorganic fertilisers	N2O	715,6	864,0	15,0%	15,0%	100,0 %	120,0%	101,12 %	120,93%	0,0004%	0,0006%	0,02%	0,05%	0,00%
3D1b	Organic fertilisers	N2O	544,2	783,2	41,2%	41,2%	100,0 %	120,0%	108,15 %	126,87%	0,0004%	0,0005%	0,05%	0,11%	0,00%
3D1c	Urine and dund deposited by grazing animals	N2O	6 302,6	5 256,5	53,6%	53,6%	100,0 %	230,0%	113,44 %	236,16%	0,0184%	0,0796%	0,98%	1,00%	0,02%
3D1d	Crop residues	N2O	350,7	1 261,7	91,2%	91,2%	100,0 %	120,0%	135,37 %	150,75%	0,0015%	0,0019%	0,26%	0,41%	0,00%
3D1e	FSOM	N2O	0,9	1,1	5,0%	5,0%	100,0 %	230,0%	100,12 %	230,05%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3D2a	Atmospheric deposition	N2O	969,8	920,4	203,9 %	203,9 %	100,0 %	120,0%	227,13 %	236,62%	0,0023%	0,0024%	0,05%	0,67%	0,00%
3D2b	Nitrogen leaching and runoff	N2O	39,2	593,3	58,4%	58,4%	100,0 %	82,0%	115,83 %	100,70%	0,0002%	0,0002%	0,11%	0,12%	0,00%
3F	Field burning of agricultural residues	CH4	47,2	43,7	21,2%	21,2%	40,0%	40,0%	45,28%	45,28%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3F	Field burning of agricultural residues	N2O	11,6	10,7	21,2%	21,2%	27,0%	27,0%	34,34%	34,34%	0,0000%	0,0000%	0,00%	0,00%	0,00%
3G	Liming	CO2	2 470,8	1 890,9	75,0%	75,0%	50,0%	50,0%	90,14%	90,14%	0,0015%	0,0015%	0,11%	0,50%	0,00%
3H	Urea application	CO2	91,0	670,8	10,0%	10,0%	50,0%	50,0%	50,99%	50,99%	0,0001%	0,0001%	0,07%	0,02%	0,00%
4A1	Forest land remaining forest land	CO2	19 610,9	8 118,3	42,3%	42,3%	56,9%	56,8%	70,86%	70,80%	0,0171%	0,0171%	1,93%	1,22%	0,05%
4A2	Land converted to forest land	CO2	-35 685,8	-63 862,3	58,7%	58,7%	56,9%	56,9%	81,72%	81,72%	1,4066%	1,4066%	3,49%	13,31%	1,89%
4A1	Forest land remaining forest land	CH4	690,1	265,6	21,7%	21,7%	40,3%	40,3%	45,77%	45,77%	0,0000%	0,0000%	0,05%	0,02%	0,00%
4A2	Land converted to forest land	CH4	5 662,1	7 818,3	40,9%	40,9%	53,2%	53,2%	67,09%	67,09%	0,0142%	0,0142%	0,21%	1,14%	0,01%

4A1	Forest land remaining forest land	N2O	-6 693,6	-15 342,1	41,2%	41,2%	40,3%	40,3%	57,65%	57,65%	0,0404%	0,0404%	0,80%	2,24%	0,06%
4A2	Land converted to forest land	N2O	7 268,5	18 389,6	61,8%	61,8%	53,2%	53,2%	81,48%	81,48%	0,1160%	0,1160%	1,38%	4,03%	0,18%
4B1	Cropland remaining cropland	CO2	-71,6	-20,0	17,7%	17,7%	40,3%	40,3%	44,03%	44,03%	0,0000%	0,0000%	0,01%	0,00%	0,00%
4B2	Land converted to cropland	CO2	-74,9	126,8	44,4%	44,4%	53,2%	53,2%	69,24%	69,24%	0,0000%	0,0000%	0,03%	0,02%	0,00%
4C1	Grassland remaining grassland	CO2	-1 332,6	-3 101,7	18,3%	18,3%	40,3%	40,3%	44,29%	44,29%	0,0010%	0,0010%	0,16%	0,20%	0,00%
4C2	Land converetd to grassland	CO2	522,9	1 648,9	49,2%	49,2%	53,2%	53,2%	72,41%	72,41%	0,0007%	0,0007%	0,14%	0,29%	0,00%
4C1	Grassland remaining grassland	CH4	0,0	0,0	30,2%	30,2%	35,0%	35,0%	46,26%	46,26%	0,0000%	0,0000%	0,00%	0,00%	0,00%
4C2	Land converetd to grassland	CH4	5 981,1	10 093,1	61,8%	61,8%	40,3%	40,3%	73,75%	73,75%	0,0286%	0,0286%	0,35%	2,21%	0,05%
4C1	Grassland remaining grassland	N2O	13,6	54,2	20,0%	20,0%	90,0%	80,0%	92,20%	82,46%	0,0000%	0,0000%	0,01%	0,00%	0,00%
4C2	Land converetd to grassland	N2O	9,3	37,1	20,0%	20,0%	100,0 %	82,0%	101,98 %	84,40%	0,0000%	0,0000%	0,01%	0,00%	0,00%
4D1	Wetland remaining wetland	CO2	656,2	2 039,0	10,0%	10,0%	71,2%	71,2%	71,90%	71,90%	0,0011%	0,0011%	0,23%	0,07%	0,00%
4D2	Land converted to wetland	CO2	0,0	0,0	10,0%	10,0%	58,1%	58,1%							
4D1	Wetland remaining wetland	CH4	348,6	438,0	20,0%	20,0%	90,0%	80,0%	92,20%	82,46%	0,0001%	0,0001%	0,01%	0,03%	0,00%
4D2	Land converted to wetland	CH4	8,8	9,6	20,0%	20,0%	100,0 %	82,0%	101,98 %	84,40%	0,0000%	0,0000%	0,00%	0,00%	0,00%

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4D1	Wetland remaining wetland	N2O	974,5	902,0	31,6%	31,6%	40,4%	40,4%	51,26%	51,26%	0,0001%	0,0001%	0,02%	0,10%	0,00%
4D2	Land converted to wetland	N2O	689,6	691,9	31,6%	31,6%	47,6%	47,6%	57,11%	57,11%	0,0001%	0,0001%	0,01%	0,08%	0,00%
4E1	Settlement remaining settlement	CO2	-1 035,6	-1 718,3	10,0%	10,0%	10,0%	10,0%	14,14%	14,14%	0,0000%	0,0000%	0,01%	0,06%	0,00%
4E2	Land converted to settlements	CO2	2 821,7	7 376,7	50,0%	50,0%	40,0%	40,0%	64,03%	64,03%	0,0115%	0,0115%	0,43%	1,31%	0,02%
4E1	Settlement remaining settlement	CH4	858,5	1 793,2	50,0%	50,0%	50,0%	50,0%	70,71%	70,71%	0,0008%	0,0008%	0,11%	0,32%	0,00%
4E2	Land converted to settlements	CH4	487,5	826,9	50,0%	50,0%	50,0%	50,0%	70,71%	70,71%	0,0002%	0,0002%	0,04%	0,15%	0,00%
4E1	Settlement remaining settlement	N2O	24,0	37,0	50,0%	50,0%	40,0%	40,0%	64,03%	64,03%	0,0000%	0,0000%	0,00%	0,01%	0,00%
4E2	Land converted to settlements	N2O	108,1	167,2	50,0%	50,0%	100,0 %	100,0%	111,80 %	111,80%	0,0000%	0,0000%	0,01%	0,03%	0,00%
4F1	Other land remaining other land	CO2	23,6	36,5	50,0%	50,0%	100,0 %	100,0%	111,80 %	111,80%	0,0000%	0,0000%	0,00%	0,01%	0,00%
4F2	Land converted to other land	CO2	2 297,1	3 552,8	50,0%	50,0%	40,0%	40,0%	64,03%	64,03%	0,0027%	0,0027%	0,10%	0,63%	0,00%
4G	Harvested wood products	CO2	474,4	733,8	50,0%	50,0%	90,0%	90,0%	102,96 %	102,96%	0,0003%	0,0003%	0,05%	0,13%	0,00%
5A	Solid Waste Disposal	CH4	4 250,7	4 720,4	50,0%	50,0%	40,0%	40,0%	64,03%	64,03%	0,0047%	0,0047%	0,00%	0,84%	0,01%
5B	Biological Treatment of Solid Waste	CH4	138 026,9	198 237,2	3,0%	5,0%	7,0%	7,0%	7,62%	8,60%	0,1177%	0,1502%	0,80%	3,52%	0,13%

5B	Biological Treatment of Solid Waste	N2O	2 545,2	1 491,0	3,0%	5,0%	7,0%	7,0%	7,62%	8,60%	0,0000%	0,0000%	0,02%	0,03%	0,00%
5C2	Open Burning of Waste	CO2	25 436,2	27 444,5	3,0%	5,0%	7,0%	7,0%	7,62%	8,60%	0,0023%	0,0029%	0,01%	0,49%	0,00%
5C2	Open Burning of Waste	CH4	40,0	61,3	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
5C2	Open Burning of Waste	N2O	1,8	0,9	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
5D1	Domestic wastewater treatment and discharge	CH4	11,8	28,4	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
5D1	Domestic wastewater treatment and discharge	N2O	566,7	815,9	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0002%	0,0002%	0,04%	0,01%	0,00%
5D2	Industrial wastewater treatment and discharge	CH4	2,7	1,3	3,0%	5,0%	75,0%	75,0%	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%
			398 428,0	**440 046,1**							**2,01%**	**2,11%**			**2,55%**
										Uncertainty in total inventory	**14,16%**	**14,51%**		**Trend uncertainty**	**15,98%**

C = Confidential

Table A II.2: Overall uncertainty analysis excluding LULUCF for 1990 to 2024.

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		Gas	Base year emissions/ removals (1990)	Year t emissions / removals (2024)	Activity data uncertainty		Emission factor/estimation parameter uncertainty		Combined uncertainty		Contribution to variance in Year t	Contribution to variance in Year t		Uncertainty in trend in national emissions introduced by EF/ estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
			Gg CO2e	Gg CO2e	(-)%	(+)%	(-)%	(+)%	(-)%		(+)%	Lower (%)	Upper (%)	%	%	%
1A1a	Electricity and Heat Production	CO2	138 026,88	198 237,24	3,00%	5,00%	7,00%	7,00%	7,62%	8,60%	0,1017%	0,1297%	0,61%	3,50%	0,13%	138 026,88
1A1b	Petroleum Refining	CO2	2 545,20	1 491,00	3,00%	5,00%	7,00%	7,00%	7,62%	8,60%	0,0000%	0,0000%	0,03%	0,03%	0,00%	2 545,20
1A1c	Manufacture of Solid Fuels and	CO2	25 436,24	27 444,51	3,00%	5,00%	7,00%	7,00%	7,62%	8,60%	0,0019%	0,0025%	0,05%	0,48%	0,00%	25 436,24

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	Other Energy Industries															
1A1a	Electricity and Heat Production	CH4	40,04	61,32	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%	40,04
1A1b	Petroleum Refining	CH4	1,76	0,94	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%	1,76
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CH4	11,84	28,40	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%	11,84
1A1a	Electricity and Heat Production	N2O	566,73	815,89	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0002%	0,0002%	0,03%	0,01%	0,00%	566,73
1A1b	Petroleum Refining	N2O	2,65	1,32	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0000%	0,0000%	0,00%	0,00%	0,00%	2,65
1A1c	Manufacture of Solid Fuels and Other Energy Industries	N2O	0,00	100,73	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0000%	0,0000%	0,02%	0,00%	0,00%	0,00

1A2	Manufacturing Industries and Construction	CO2	15 656,41	21 927,35	5,00%	10,00 %	7,00%	7,00%	8,60%	12,21%	0,0016%	0,0032%	0,06%	0,77%	0,01%	15 656,41
1A2	Manufacturing Industries and Construction	CH4	53,55	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,01%	0,00%	0,00%	53,55
1A2	Manufacturing Industries and Construction	N2O	76,18	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,02%	0,00%	0,00%	76,18
1A3a	Civil Aviation	CO2	3 408,93	775,70	5,00%	5,00%	1,50%	1,50%	5,22%	5,22%	0,0000%	0,0000%	0,01%	0,01%	0,00%	3 408,93
1A3b	Road Transport	CO2	41 755,37	56 925,56	5,00%	5,00%	2,00%	2,00%	5,39%	5,39%	0,0042%	0,0042%	0,04%	1,00%	0,01%	41 755,37
1A3c	Railways	CO2	664,26	410,07	5,00%	5,00%	2,00%	2,00%	5,39%	5,39%	0,0000%	0,0000%	0,00%	0,01%	0,00%	664,26
1A3d	Water-Borne Navigation	CO2	389,69	561,98	5,00%	5,00%	3,00%	3,00%	5,83%	5,83%	0,0000%	0,0000%	0,00%	0,01%	0,00%	389,69

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1A3a	Civil Aviation	CH4	0,65	0,15	5,00%	5,00%	70,00 %	70,00 %	70,18%	70,18%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,65
1A3b	Road Transport	CH4	368,50	366,13	5,00%	5,00%	9,00%	9,00%	10,30%	10,30%	0,0000%	0,0000%	0,00%	0,01%	0,00%	368,50
1A3c	Railways	CH4	1,03	0,68	5,00%	5,00%	9,00%	9,00%	10,30%	10,30%	0,0000%	0,0000%	0,00%	0,00%	0,00%	1,03
1A3d	Water-Borne Navigation	CH4	1,04	1,50	5,00%	5,00%	50,00 %	50,00 %	50,25%	50,25%	0,0000%	0,0000%	0,00%	0,00%	0,00%	1,04
1A3a	Civil Aviation	N2O	24,77	5,62	5,00%	5,00%	70,00 %	50,00 %	70,18%	50,25%	0,0000%	0,0000%	0,00%	0,00%	0,00%	24,77
1A3b	Road Transport	N2O	519,52	733,32	5,00%	5,00%	70,00 %	72,00 %	70,18%	72,17%	0,0001%	0,0001%	0,02%	0,01%	0,00%	519,52
1A3c	Railways	N2O	67,45	37,81	5,00%	5,00%	70,00 %	72,00 %	70,18%	72,17%	0,0000%	0,0000%	0,01%	0,00%	0,00%	67,45
1A3d	Water-Borne Navigation	N2O	2,80	4,05	5,00%	5,00%	40,00 %	140,0 0%	40,31%	140,09%	0,0000%	0,0000%	0,00%	0,00%	0,00%	2,80
1A4a	Commercial /Institutional	CO2	15 992,75	11 819,78	5,00%	10,00 %	7,00%	7,00%	8,60%	12,21%	0,0005%	0,0009%	0,12%	0,42%	0,00%	15 992,75
1A4b	Residential	CO2	20 774,88	3 608,15	5,00%	10,00 %	7,00%	7,00%	8,60%	12,21%	0,0000%	0,0001%	0,37%	0,13%	0,00%	20 774,88

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1A4c	Agriculture/ Forestry/Fishing/Fish Farms	CO2	2 080,55	3 074,24	5,00%	10,00 %	7,00%	7,00%	8,60%	12,21%	0,0000%	0,0001%	0,01%	0,11%	0,00%	2 080,55
1A4a	Commercial /Institutional	CH4	6,84	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%	6,84
1A4b	Residential	CH4	202,83	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,04%	0,00%	0,00%	202,83
1A4c	Agriculture/ Forestry/Fishing/Fish Farms	CH4	2,30	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%	2,30
1A4a	Commercial /Institutional	N2O	69,74	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,02%	0,00%	0,00%	69,74
1A4b	Residential	N2O	329,05	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,07%	0,00%	0,00%	329,05
1A4c	Agriculture/ Forestry/Fishing/Fish Farms	N2O	4,96	0,00	5,00%	10,00 %	75,00 %	75,00 %	75,17%	75,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%	4,96
1A5a	Stationary	CO2	12 183,63	18 026,27	3,00%	5,00%	7,00%	7,00%	7,62%	8,60%	0,0008%	0,0011%	0,06%	0,32%	0,00%	12 183,63
1A5a	Stationary	CH4	195,28	0,00	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0000%	0,0000%	0,04%	0,00%	0,00%	195,28

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1A5a	Stationary	N2O	290,49	0,00	3,00%	5,00%	75,00 %	75,00 %	75,06%	75,17%	0,0000%	0,0000%	0,06%	0,00%	0,00%	290,49
1B1a	Coal mining and handling	CO2	14,69	17,23	10,00 %	10,00 %	63,00 %	63,00 %	63,79%	63,79%	0,0000%	0,0000%	0,00%	0,00%	0,00%	14,69
1B1a	Coal mining and handling	CH4	1 495,36	1 754,03	10,00 %	10,00 %	63,00 %	63,00 %	63,79%	63,79%	0,0006%	0,0006%	0,00%	0,06%	0,00%	1 495,36
1B1c	Solid fuel transformation	CO2	20,41	384,60	10,00 %	10,00 %	63,00 %	63,00 %	63,79%	63,79%	0,0000%	0,0000%	0,06%	0,01%	0,00%	20,41
1B1c	Solid fuel transformation	CH4	18,34	250,69	10,00 %	10,00 %	63,00 %	63,00 %	63,79%	63,79%	0,0000%	0,0000%	0,04%	0,01%	0,00%	18,34
1B1c	Solid fuel transformation	N2O	0,28	4,67	10,00 %	10,00 %	63,00 %	63,00 %	63,79%	63,79%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,28
1B2a	Oil	CO2	773,34	63,05	25,00 %	25,00 %	75,00 %	75,00 %	79,06%	79,06%	0,0000%	0,0000%	0,16%	0,01%	0,00%	773,34
1B2a	Oil	CH4	10,05	22,54	25,00 %	25,00 %	75,00 %	75,00 %	79,06%	79,06%	0,0000%	0,0000%	0,00%	0,00%	0,00%	10,05
1B2a	Oil	N2O	0,81	0,06	25,00 %	25,00 %	75,00 %	75,00 %	79,06%	79,06%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,81

1B3	Other Emissions from Energy Production	CO2	25 903,05	23 477,02	25,00 %	25,00 %	75,00 %	75,00 %	79,06%	79,06%	0,1537%	0,1537%	1,33%	2,07%	0,06%	25 903,05
1B3	Other Emissions from Energy Production	CH4	2 905,14	2 736,72	25,00 %	25,00 %	75,00 %	75,00 %	79,06%	79,06%	0,0021%	0,0021%	0,13%	0,24%	0,00%	2 905,14
2A1	Cement Production	CO2	4 252,49	3 846,02	30,00 %	30,00 %	35,00 %	35,00 %	46,10%	46,10%	0,0014%	0,0014%	0,10%	0,41%	0,00%	4 252,49
2A2	Lime Production	CO2	488,03	799,12	30,00 %	30,00 %	6,00%	6,00%	30,59%	30,59%	0,0000%	0,0000%	0,00%	0,08%	0,00%	488,03
2A3	Glass Production	CO2	85,01	177,32	1,00%	3,00%	1,00%	3,00%	1,41%	4,24%	0,0000%	0,0000%	0,00%	0,00%	0,00%	85,01
2A4a	Ceramics	CO2	0,00	54,48	1,00%	85,00 %	1,00%	5,00%	1,41%	85,15%	0,0000%	0,0000%	0,00%	0,02%	0,00%	0,00
2A4b	Other Uses of Soda Ash	CO2	0,00	51,92	1,00%	85,00 %	1,00%	5,00%	1,41%	85,15%	0,0000%	0,0000%	0,00%	0,02%	0,00%	0,00
2A4d	Other	CO2	0,00	27,24	15,00 %	85,00 %	1,00%	5,00%	15,03%	85,15%	0,0000%	0,0000%	0,00%	0,01%	0,00%	0,00
2B1	Ammonia Production	CO2	423,68	378,66	2,00%	2,00%	2,00%	2,00%	2,83%	2,83%	0,0000%	0,0000%	0,00%	0,00%	0,00%	423,68
2B1	Ammonia Production	CH4	76,32	113,68	2,00%	2,00%	2,00%	2,00%	2,83%	2,83%	0,0000%	0,0000%	0,00%	0,00%	0,00%	76,32

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2B2	Nitric Acid Production	CO2	1 227,36	1,72	2,00%	2,00%	2,00%	2,00%	2,83%	2,83%	0,0000%	0,0000%	0,01%	0,00%	0,00%	1 227,36
2B3	Nitric Acid Production	CH4	0,00	0,00	2,00%	2,00%	2,00%	2,00%	2,83%	2,83%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2B2	Nitric Acid Production	N2O	4,63	1,28	2,00%	2,00%	2,00%	2,00%	2,83%	2,83%	0,0000%	0,0000%	0,00%	0,00%	0,00%	4,63
2B5	Carbide Production	CO2	0,00	0,14	5,00%	5,00%	10,00 %	10,00 %	11,18%	11,18%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2B5	Carbide Production	CH4	0,00	3,89	5,00%	5,00%	10,00 %	10,00 %	11,18%	11,18%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2B6	Titanium Dioxide Production	CO2	0,00	0,00	2,00%	2,00%	2,00%	2,00%	2,83%	2,83%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2B7	Soda Ash Production	CO2	0,00	0,00	5,00%	5,00%	0,00%	0,00%	5,00%	5,00%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2B8f	Carbon Black production	CO2	120,98	95,10	15,00 %	15,00 %	15,00 %	15,00 %	21,21%	21,21%	0,0000%	0,0000%	0,00%	0,01%	0,00%	120,98
2B8f	Carbon Black production	CH4	0,00	0,04	85,00 %	85,00 %	85,00 %	85,00 %	120,21%	120,21%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2B8g	Hydrogen Production	CO2	0,00	75,07	2,00%	2,00%	2,00%	2,00%	2,83%	2,83%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00

2B10	Other	CO2	0,00	20,43	5,00%	5,00%	10,00 %	10,00 %	11,18%	11,18%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2B10	Other	CH4	0,00	0,45	5,00%	5,00%	10,00 %	10,00 %	11,18%	11,18%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2C1	Iron and Steel Production	CO2	12 597,03	6 893,96	5,00%	10,00 %	25,00 %	25,00 %	25,50%	26,93%	0,0014%	0,0015%	0,50%	0,24%	0,00%	12 597,03
2C1	Iron and Steel Production	CH4	0,00	0,00	5,00%	10,00 %	25,00 %	25,00 %	25,50%	26,93%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2C2	Ferroalloys Production	CO2	1 186,94	6 942,48	5,00%	5,00%	5,00%	25,00 %	7,07%	25,50%	0,0001%	0,0014%	0,35%	0,12%	0,00%	1 186,94
2C2	Ferroalloys Production	CH4	0,06	0,00	5,00%	5,00%	25,00 %	25,00 %	25,50%	25,50%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,06
2C2	Ferroalloys Production	N2O	0,00	0,00	5,00%	5,00%	25,00 %	25,00 %	25,50%	25,50%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2C3	Aluminium Production	CO2	254,05	1 259,24	1,00%	1,00%	5,00%	5,00%	5,10%	5,10%	0,0000%	0,0000%	0,01%	0,00%	0,00%	254,05
2C3	Aluminium Production	PFCs	0,00	0,01	1,00%	1,00%	15,00 %	15,00 %	15,03%	15,03%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2C5	Lead Production	CO2	16,04	7,70	10,00 %	10,00 %	50,00 %	50,00 %	50,99%	50,99%	0,0000%	0,0000%	0,00%	0,00%	0,00%	16,04

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2C6	Zinc Production	CO2	128,66	501,87	10,00 %	10,00 %	50,00 %	50,00 %	50,99%	50,99%	0,0000%	0,0000%	0,04%	0,02%	0,00%	128,66
2D1	Lubricant Use	CO2	0,00	461,88	10,00 %	20,00 %	50,00 %	50,00 %	50,99%	53,85%	0,0000%	0,0000%	0,06%	0,03%	0,00%	0,00
2D2	Paraffin Wax Use	CO2	0,00	715,79	10,00 %	20,00 %	50,00 %	50,00 %	50,99%	53,85%	0,0001%	0,0001%	0,09%	0,05%	0,00%	0,00
2F1	Refrigeration and Air Conditioning	HFCs	0,00	6 577,21	25,00 %	25,00 %	25,00 %	25,00 %	35,36%	35,36%	0,0024%	0,0024%	0,41%	0,58%	0,01%	0,00
2F2	Foam Blowing Agents	HFCs	0,00	2,13	50,00 %	50,00 %	25,00 %	25,00 %	55,90%	55,90%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2F3	Fire Protection	HFCs	0,00	87,50	25,00 %	25,00 %	25,00 %	25,00 %	35,36%	35,36%	0,0000%	0,0000%	0,01%	0,01%	0,00%	0,00
2F4	Aerosols	HFCs	0,00	18,25	25,00 %	25,00 %	25,00 %	25,00 %	35,36%	35,36%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
2G1	Use of Electrical equipment	SF6	0,00	84,72	25,00 %	25,00 %	25,00 %	25,00 %	35,36%	35,36%	0,0000%	0,0000%	0,01%	0,01%	0,00%	0,00
3A1	Enteric fermentation - cattle	CH4	28 133,05	24 291,03	17,19 %	17,19 %	13,82 %	13,82 %	22,06%	22,06%	0,0128%	0,0128%	0,31%	1,47%	0,02%	28 133,05

3A2	Enteric fermentation - sheep	CH4	10 019,94	6 313,14	13,07 %	13,07 %	30,80 %	30,80 %	33,46%	33,46%	0,0020%	0,0020%	0,42%	0,29%	0,00%	10 019,94
3A3	Enteric fermentation - swine	CH4	49,04	42,51	50,25 %	50,25 %	20,00 %	20,00 %	54,08%	54,08%	0,0000%	0,0000%	0,00%	0,01%	0,00%	49,04
3A4d	Enteric fermentation - goats	CH4	2 285,46	2 285,46	20,62 %	20,62 %	35,50 %	35,50 %	41,05%	41,05%	0,0004%	0,0004%	0,04%	0,17%	0,00%	2 285,46
3A4e	Enteric fermentation - horses	CH4	115,92	170,32	7,07%	7,07%	40,00 %	40,00 %	40,62%	40,62%	0,0000%	0,0000%	0,00%	0,00%	0,00%	115,92
3A4f	Enteric fermentation - mules and asses	CH4	62,72	45,16	11,18 %	11,18 %	40,00 %	40,00 %	41,53%	41,53%	0,0000%	0,0000%	0,00%	0,00%	0,00%	62,72
3A4h	Enteric fermentation - other game	CH4	0,00	0,00					0,00%	0,00%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
3B1	Manure management - cattle	CH4	1 169,19	1 233,23	17,19 %	17,19 %	12,00 %	12,00 %	20,97%	20,97%	0,0000%	0,0000%	0,00%	0,07%	0,00%	1 169,19
3B2	Manure management - sheep	CH4	134,58	88,58	13,07 %	13,07 %	16,00 %	16,00 %	20,66%	20,66%	0,0000%	0,0000%	0,00%	0,00%	0,00%	134,58

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3B3	Manure management - swine	CH4	237,09	205,51	50,25 %	50,25 %	20,00 %	20,00 %	54,08%	54,08%	0,0000%	0,0000%	0,00%	0,04%	0,00%	237,09
3B4d	Manure management - goats	CH4	38,54	27,05	20,62 %	20,62 %	47,75 %	47,75 %	52,01%	52,01%	0,0000%	0,0000%	0,00%	0,00%	0,00%	38,54
3B4e	Manure management - horses	CH4	0,00	0,00	7,07%	7,07%	30,00 %	30,00 %	30,82%	30,82%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
3B4f	Manure management - mules and asses	CH4	0,00	0,00	11,18 %	11,18 %	30,00 %	30,00 %	32,02%	32,02%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
3B4g	Manure management - poultry	CH4	79,23	191,73	20,62 %	20,62 %	20,00 %	20,00 %	28,72%	28,72%	0,0000%	0,0000%	0,00%	0,01%	0,00%	79,23
3B4h	Manure management - other game	CH4	0,00	0,00					0,00%	0,00%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
3A2a	Manure management - cattle	N2O	985,27	1 136,31	43,20 %	43,20 %	50,00 %	100,00%	66,08%	108,93%	0,0003%	0,0007%	0,01%	0,17%	0,00%	985,27
3A2c	Manure management - sheep	N2O	198,98	158,22	32,95 %	32,95 %	50,00 %	100,00%	59,88%	105,29%	0,0000%	0,0000%	0,02%	0,02%	0,00%	198,98

3B3	Manure management - swine	N2O	27,43	23,77	59,37 %	59,37 %	50,00 %	100,00%	77,62%	116,30%	0,0000%	0,0000%	0,00%	0,00%	0,00%	27,43
3A2d	Manure management - goats	N2O	66,83	49,35	36,46 %	36,46 %	50,00 %	100,00%	61,88%	106,44%	0,0000%	0,0000%	0,01%	0,01%	0,00%	66,83
3B4e	Manure management - horses	N2O	0,00	0,00	31,22 %	31,22 %	50,00 %	100,00%	58,95%	104,76%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
3B4f	Manure management - mules and asses	N2O	0,00	0,00	32,08 %	32,08 %	50,00 %	100,00%	59,41%	105,02%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
3B4g	Manure management - poultry	N2O	367,62	952,97	44,16 %	44,16 %	50,00 %	100,00%	66,71%	109,32%	0,0002%	0,0005%	0,13%	0,15%	0,00%	367,62
3B4h	Manure management - other game	N2O	0,00	0,00					0,00%	0,00%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,00
3B5	Indirect N2O from manure management	N2O	268,28	333,03	89,47 %	89,47 %	100,00 %	101,00%	134,18%	134,93%	0,0001%	0,0001%	0,00%	0,11%	0,00%	268,28

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3D1a	Inorganic fertilisers	N2O	715,61	863,97	15,00 %	15,00 %	100,00 %	120,0 0%	101,12%	120,93%	0,0003%	0,0005%	0,01%	0,05%	0,00%	715,61
3D1b	Organic fertilisers	N2O	544,24	783,20	41,18 %	41,18 %	100,00 %	120,0 0%	108,15%	126,87%	0,0003%	0,0004%	0,04%	0,11%	0,00%	544,24
3D1c	Urine and dund deposited by grazing animals	N2O	6 302,61	5 256,51	53,57 %	53,57 %	100,00 %	230,0 0%	113,44%	236,16%	0,0159%	0,0687%	1,25%	0,99%	0,03%	6 302,61
3D1d	Crop residues	N2O	350,74	1 261,69	91,24 %	91,24 %	100,00 %	120,0 0%	135,37%	150,75%	0,0013%	0,0016%	0,25%	0,41%	0,00%	350,74
3D1e	FSOM	N2O	0,94	1,12	5,00%	5,00%	100,00 %	230,0 0%	100,12%	230,05%	0,0000%	0,0000%	0,00%	0,00%	0,00%	0,94
3D2a	Atmospheri c deposition	N2O	969,77	920,39	203,9 4%	203,9 4%	100,00 %	120,0 0%	227,13%	236,62%	0,0019%	0,0021%	0,07%	0,66%	0,00%	969,77
3D2b	Nitrogen leaching and runoff	N2O	39,18	593,29	58,45 %	58,45 %	100,00 %	82,00 %	115,83%	100,70%	0,0002%	0,0002%	0,11%	0,12%	0,00%	39,18
3F	Field burning of agricultural residues	CH4	47,25	43,74	21,21 %	21,21 %	40,00 %	40,00 %	45,28%	45,28%	0,0000%	0,0000%	0,00%	0,00%	0,00%	47,25
3F	Field burning of	N2O	11,59	10,73	21,21 %	21,21 %	27,00 %	27,00 %	34,34%	34,34%	0,0000%	0,0000%	0,00%	0,00%	0,00%	11,59

	agricultural residues															
3G	Liming	CO2	2 470,81	1 890,95	75,00 %	75,00 %	50,00 %	50,00 %	90,14%	90,14%	0,0013%	0,0013%	0,13%	0,50%	0,00%	2 470,81
3H	Urea application	CO2	90,99	670,76	10,00 %	10,00 %	50,00 %	50,00 %	50,99%	50,99%	0,0001%	0,0001%	0,07%	0,02%	0,00%	90,99
5A	Solid Waste Disposal	CH4	2 821,75	7 376,74	50,00 %	50,00 %	40,00 %	40,00 %	64,03%	64,03%	0,0100%	0,0100%	0,40%	1,30%	0,02%	2 821,75
5B	Biological Treatment of Solid Waste	CH4	858,48	1 793,24	50,00 %	50,00 %	50,00 %	50,00 %	70,71%	70,71%	0,0007%	0,0007%	0,10%	0,32%	0,00%	858,48
5B	Biological Treatment of Solid Waste	N2O	487,50	826,92	50,00 %	50,00 %	50,00 %	50,00 %	70,71%	70,71%	0,0002%	0,0002%	0,03%	0,15%	0,00%	487,50
5C2	Open Burning of Waste	CO2	23,95	37,05	50,00 %	50,00 %	40,00 %	40,00 %	64,03%	64,03%	0,0000%	0,0000%	0,00%	0,01%	0,00%	23,95
5C2	Open Burning of Waste	CH4	108,12	167,23	50,00 %	50,00 %	100,00 %	100,00%	111,80%	111,80%	0,0000%	0,0000%	0,01%	0,03%	0,00%	108,12
5C2	Open Burning of Waste	N2O	23,61	36,52	50,00 %	50,00 %	100,00 %	100,00%	111,80%	111,80%	0,0000%	0,0000%	0,00%	0,01%	0,00%	23,61

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5D1	Domestic wastewater treatment and discharge	CH4	2 297,12	3 552,82	50,00 %	50,00 %	40,00 %	40,00 %	64,03%	64,03%	0,0023%	0,0023%	0,08%	0,63%	0,00%	2 297,12
5D1	Domestic wastewater treatment and discharge	N2O	474,42	733,76	50,00 %	50,00 %	90,00 %	90,00 %	102,96%	102,96%	0,0003%	0,0003%	0,04%	0,13%	0,00%	474,42
5D2	Industrial wastewater treatment and discharge	CH4	4 250,75	4 720,43	50,00 %	50,00 %	40,00 %	40,00 %	64,03%	64,03%	0,0041%	0,0041%	0,03%	0,83%	0,01%	4 250,75
			460 959.8	434 702.1								0.33%	0.41%			0.20%
											Uncertainty in total inventory	5.73%	6.44%		Trend uncertainty	4.45%

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Annex III: Detailed description of reference approach

The figures below show the comparison between the Reference and Sectoral Approach for 1992-2022 this in line with the latest available data from the energy balance.

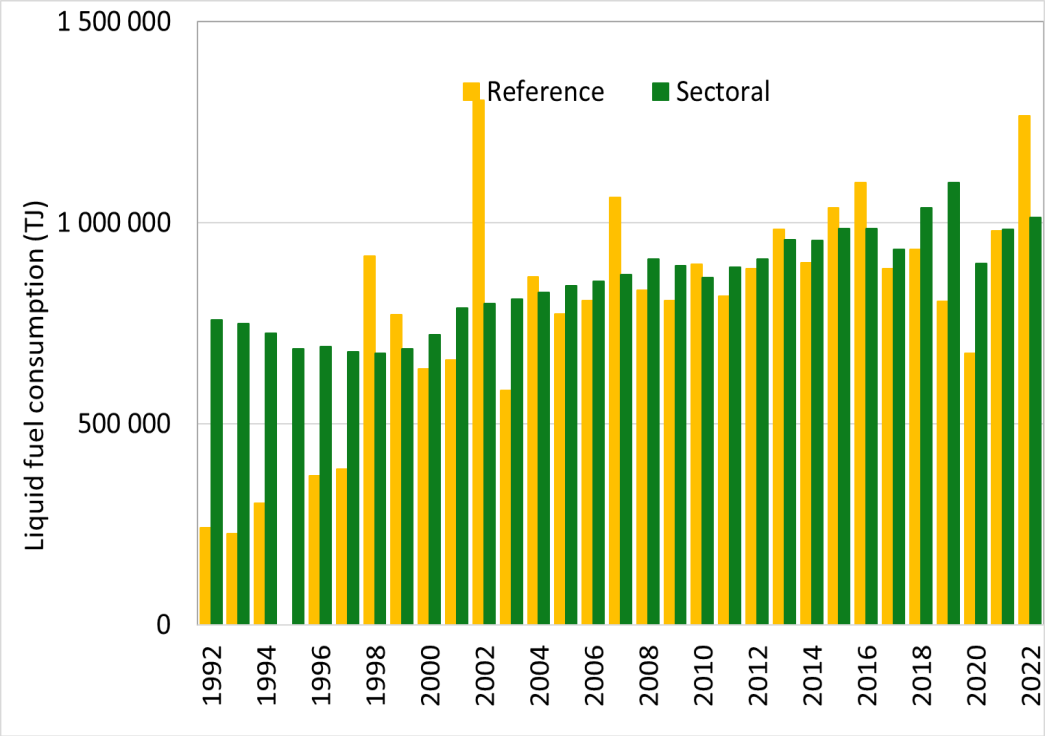


Figure D.1: Comparisons between the solid fuel consumption determined by the reference and sectoral approaches, 1992 – 2022.

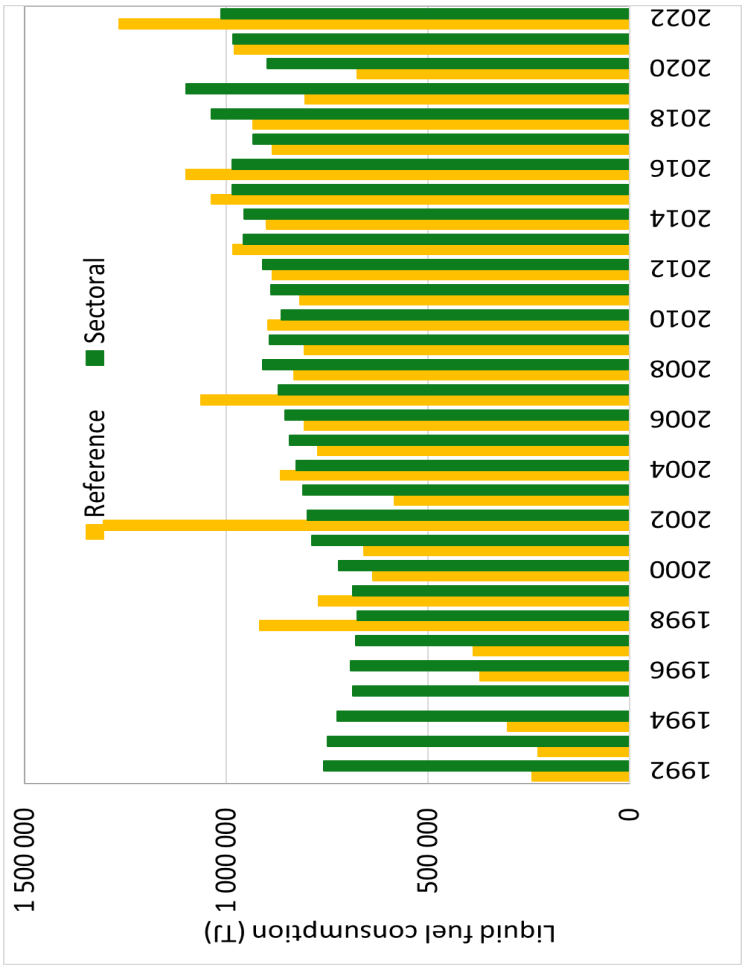


Figure D.2: Comparisons between the liquid fuel consumption determined by the reference and sectoral approaches, 1992 – 2022.

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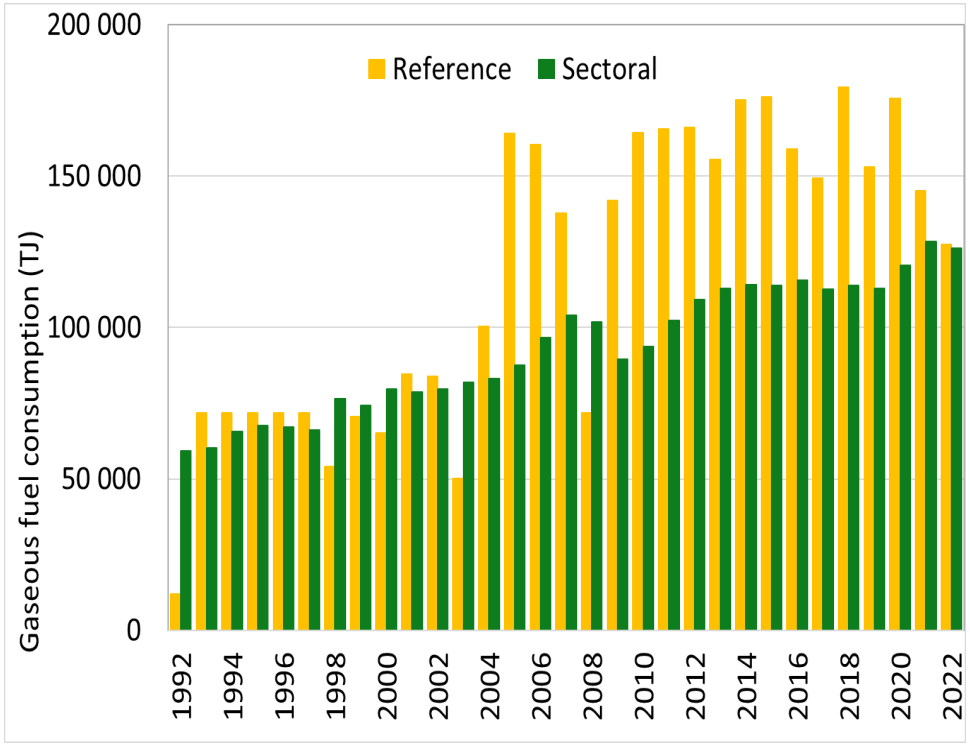


Figure D.3: Comparisons between the gaseous fuel consumption determined by the reference and sectoral approaches, 1992– 2022.

Annex IV: QA/QC Plan

The Department of Forestry, Fisheries, and the Environment (DFFE), as the Single National Entity, oversees the centralized management, coordination, compilation, publication, and submission of the inventory. Currently, DFFE is responsible for data collection, compilation, and quality control (QC) of the Energy, IPPU, Agriculture, and Waste sector inventories as well as the quality assurance and verification. The Land Use, Land-Use Change, and Forestry (LULUCF) sector inventory, however, is compiled by external consultants Gondwana Environmental Solutions (GES).

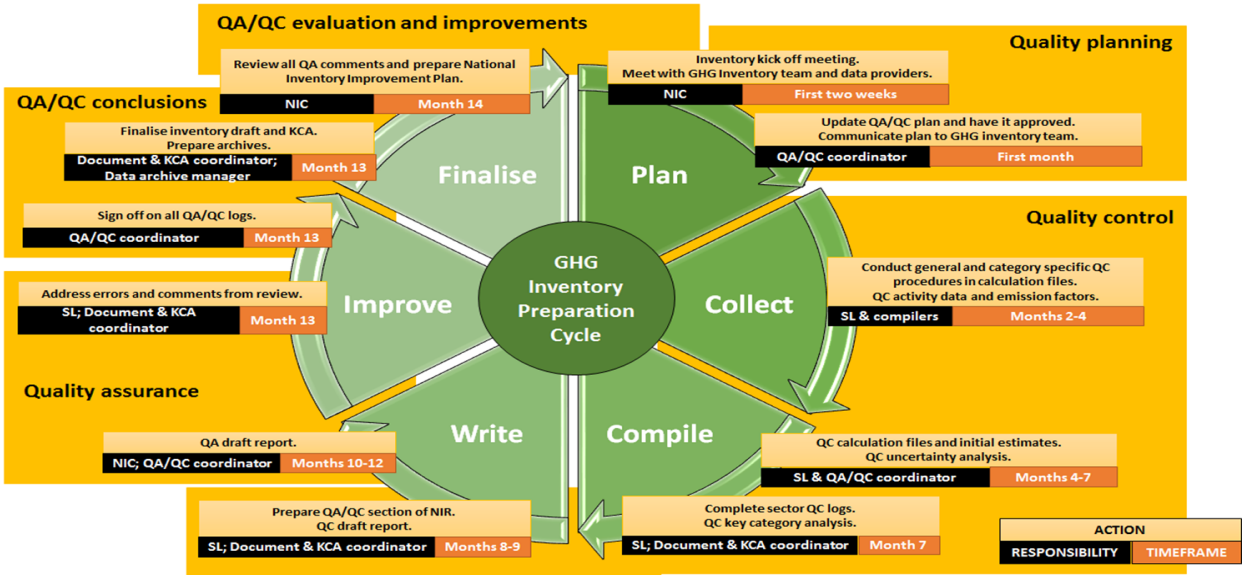
Framework for quality

The inventory principles defined by the UNFCCC & IPCC guidelines namely, transparency, consistency, comparability, completeness and accuracy, are dimensions of quality for the inventory and form the set of criteria for assessing the output produced by South Africa's national inventory system. In addition, the principle of continuous improvement is included.

Overall QA/QC process and timeframes

The phases of the QA/QC process and their timeframes relative to the GHG Inventory

Preparation Cycle is shown in Figure 1:



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Quality planning

In the planning stages of the inventory a planning meeting is held to plan the work for the next inventory submission. During this meeting the review comments from the previous year's submission are considered and improvement plans are made for the upcoming submission. It is during this planning phase that the QA/QC plan is reviewed and improved. The planning stage includes the setting of quality objectives and elaboration of the QA/QC plan for the coming inventory preparation, compilation and reporting work and reviewing the quality control checks.

Quality planning process:

The steps to be followed in this stage are:

(a) National Inventory Coordinator (NIC) designates a QA/QC coordinator;

(b) QA/QC coordinator updates QA/QC plan and QA/QC checklists;

(c) NIC approves it;

(d) QA/QC coordinator makes relevant changes to QA/QC plan on the NGHGIS

(e) QA/QC coordinator updates QA/QC checklists on the NGHGIS

(f) QA/QC coordinator communicates QA/QC responsibilities to Sector Leads (SL) and Overall Document Manager and sets deadlines for completion.

Overall QA/QC objectives

The overall aim of the quality system is to maintain and improve the quality in all stages of the inventory work, in accordance with decision 19/CMP.1. The quality objectives of the QA/QC system and its application are an essential requirement in the GHG inventory and submission processes in order to ensure and improve the inventory principles: transparency, consistency, comparability, completeness, accuracy, timeliness and confidence in the national emissions and removals estimates. If necessary, they may be reviewed when revising the programme.

Following the definitions, guidelines and processes presented in Chapter 6 "Quality Assurance/Quality Control and Verification" of the IPCC 2006 Guidelines (IPCC, 2006) and Chapter 8 "Quality Assurance and Quality Control" of the Good Practice Guidance,

South Africa's QA/QC system objectives for the 2024 inventory are as follows:

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(a) transparency

- providing transparent estimates with clear and up-to-date descriptions of the methodologies, data sources and assumptions information in the NID;
- using the notation keys as indicated in the UNFCCC guidelines;
- justifying recalculations as improvements in accuracy;
- addressing the recommendations related to transparency from independent reviewers
- providing full documentation on quality checks used in the QA/QC procedures; and
- documenting uncertainty estimates;

(b) completeness

- reporting estimates for all sources and sinks and for all gases included in the IPCC 2006 Guidelines as well as for other relevant source/sink categories;
- ensuring all data is representative of the national territory;
- addressing the recommendations related to completeness provided from previous independent review reports, during the preparation of the following inventory submission;
- ensuring the submission includes all calculations, methods and trend descriptions;
- ensuring the submission includes all mandatory sections;
- providing all CRT tables;
- providing information in the NID on completeness of NGHGI; and
- providing a summary in the NID regarding the changes related to completeness of NGHGI and the improvements of completeness from the previous submission.

(c) consistency:

- maintaining a consistent time-series of emissions and removals;
- maintaining consistency in method application;
- ensuring estimates are consistent with other related datasets or including explanations of the differences between datasets;
- ensuring consistency between common data parameters;
- addressing the recommendations related to consistency provided in the previous independent review reports, during the preparation of the following inventory submission;
- providing information in the NID on consistency and recalculations of NGHGI;
- explaining the major trends and sharp increases/decreases of time series emissions in the NGHGI; and
- ensuring there are no inconsistences between the NID and the CRT tables.

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(d) comparability:

- using the methodologies, procedures and formats agreed upon under the UNFCCC and the Kyoto Protocol for estimating and reporting the national GHG emissions and removals by sinks;
- allocating the emissions and removals to source and sink categories in accordance with the aggregation level presented in the IPCC 2006 Guidelines and IPCC-GPG;
- ensuring the most up-to-date templates are used; and
- ensuring minimal use of 'IE' and full justification of 'NE'.

(e) accuracy :

- ensuring methods, data sources and assumptions result in accurate estimates;
- ensuring all data is aggregated correctly between reporting levels;
- providing uncertainty estimates;
- providing a summary of improvements concerning uncertainties performed from the previous submission;
- ensuring there are verification activities; and
- ensuring there is continuous improvement and implementation of all review recommendations.

Quality control

This is the phase in which the quality checks, which are performed by the experts during inventory calculation and compilation, are implemented. After data collection, selection of emission factors and calculation of emissions the quality is checked (units, sources, methodology, emission factors, transcription, documentation, aggregation, etc) by performing the general and specific quality checks discussed in each sector chapter. Further uncertainty analyses and recalculations are performed.

Quality control procedures

The quality control (QC) procedures are performed by the sector experts during inventory calculation and compilation. QC measures are aimed at the attainment of the quality objectives. The QC procedures comply with the IPCC good practice guidance and the IPCC 2006 Guidelines. General inventory QC checks include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions.

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In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

General QC procedures

The general quality checks are used routinely throughout the inventory compilation process. The general QC checks carried out on South Africa's 2024 inventory are provided in each sector chapter.

Category specific QC procedures

Category-specific QC complements general inventory QC procedures and are directed at specific types of data used in the methods for individual source or sink categories. These procedures require knowledge of the specific category, the types of data available and the parameters associated with emissions or removals and are performed in addition to the general QC checks. Category-specific QC activities include both emissions (or removals) data QC and activity data QC.

The category specific QC checks carried out on South Africa's 2024 inventory are provided in each sector chapter. These are reviewed and updated each year during the evaluation and planning phase.

QC process

Data collection and emission calculation quality control process

A number of common sense procedures govern the collection, maintenance, and use of electronic and transcribed data for all activity data, emission factors, and other primary data elements. Appropriate procedures can minimize the extent to which errors in data collection occur; various checks on the data and files can further reduce the errors that occur.

Quality checks are incorporated into the spreadsheets and checks are recorded by means of comments in the excel spreadsheets. The comments should always start with # initials of quality controller, followed by # date. After this there should be a # and a comment code.

These codes are provided in Table 1.

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Tag category	QA Analyst tag	Tag name	Tag description
Problem identified	#PPE	Possible error	A possible error has been identified, which needs to be reviewed
Problem identified	#PIE	Identified error	An error has been identified in the calculations, which needs to be reviewed
Problem identified	#PT	Transparency	Documentation is needed for source referencing, assumptions, etc
Problem identified	#PCm	Completeness	Data gaps in the inventory have been identified
Problem identified	#PCs	Problem identified	A change in method or data source within a time-series has led to issues of consistency
Documentation added	#DA	Assumptions used	Information regarding the assumptions that have been applied to the calculations
Documentation added	#DM	Description of method	Information regarding the methods that have been applied to the calculations
Documentation added	#DSR	Source data reference	Information regarding the source of data used in the calculations
Documentation added	#DRfC	Reason for change	Information regarding the reasons for change in the calculations
Documentation added	#DChR	Evidence of a check	Information regarding the QC activities that have been applied to the calculations
Documentation added	#DTF	Trend feature	Information regarding the reasons for the trends that can be seen in the data
Documentation added	#Dimp	Improvement flag	Information regarding future improvement suggestions for the calculations
Comment review	#response	Response to tagged comment	Use this tab to add a response to any comment; always include #[initials] #[date] before #response
Comment review	#OK	Tagged comment sign-off	Tagged comment has been finalised and is ready for final review
Comment review	#FixChck	Tagged comment sign-off	Tagged comment has been reviewed by QA/QC expert and finalisation has been accepted

The following steps are carried out during the quality control of the calculation files:

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(a) Compilers complete the QC checks in the calculation files as they are compiling the inventory;

(b) Sector Leads (SL) sends calculation files to QC reviewer;

(c) QC reviewer checks the calculations files and makes any further comments;

(d) QC reviewer sends checked calculation file to SL who reverts comments back to compilers;

(e) Compilers respond to outstanding comments, sign off on QC checks and send final files to SL;

(f) SL uploads final calculation files onto the "GHG estimation files" tab of the NGHGIS

(g) SL produces the QC log for the sector and uploads the log onto the "QA/QC log" tab of the NGHGIS;

(h) QA/QC controller gets notified of the log, checks the log file and signs off that the QC process for the sector is complete.

Cross cutting activities and National Inventory Report quality control process

The following steps are carried out during the quality control phase for cross-cutting issues and the National Inventory Report:

(a) QA/QC coordinator compiles the QA/QC section of the NID and sends it to the Overall Document coordinator;

(b) Overall Document coordinator compiles the draft NID;

(c) Overall Document coordinator conducts the document quality checks and completes the Document Manager QAQC Checklist found on the "QAQC tools" tab on the NGHGIS

(d) Completed Document Manager QAQC Checklist is uploaded by the Overall Document coordinator onto the "QAQC Log" tab of the NGHGIS

(e) QA/QC controller gets notified of the log, checks the log file and signs off that the QC process for the NID is complete.

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Quality assurance

Quality Assurance, as defined in the IPCC Good Practice Guidance, comprises a "planned system of review procedures conducted by personnel not directly involved in the inventory compilation and development process." The quality assurance process includes both expert review and a general public review. The expert and public reviews each present opportunity to uncover technical issues related to the application of methodologies, selection of activity data, or the development and choice of emission factors. The expert and public reviews of the draft document offer a broader range of researchers and practitioners in government, industry and academia, as well as the general public, the opportunity to contribute to the final document. The comments received during these processes are reviewed and, as appropriate, incorporated into the Inventory Report or reflected in the inventory estimates. The results of the QA activities and procedures are documented and described in the QA/QC sub-chapter from the NID.

Quality assurance procedures:

There are three QA procedures in the South African GHG Inventory:

Peer reviews of specific sectors or categories which are provided by external experts or expert groups. The external experts are independent of the inventory preparation. The reviewers may also be experts in other calculation sectors of the GHG inventory system. These reviews are only conducted on selected sectors or categories, and are often dependant on in-kind contributions from experts and the availability of funding;

Public review and commenting process. A broad spectrum of groups and individuals may participate in the public review, including interested researchers, non-governmental organizations, trade associations, and other interested in the inventory process. The public review process allows parties that might not be readily identified by the expert review, an opportunity to review and comment on the inventory. For these purposes it is necessary to publish Inventory results to ensure the availability of the draft document. The public review process is dependent on Ministerial approval.

External review of the calculation files and the NID which is provided by a group of external experts. The external experts are independent of the inventory preparation. The objective of the peer review is to ensure that the inventory's results, assumptions and methods are reasonable, as judged by those knowledgeable in the specific field. This activity is dependent on funding

Quality assessment process

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Peer review comments are documented separately on the "QAQC log" tab of the NGHGIS

The process for the public commenting is as follows:

(a) NIC obtains permission from the Minister to put the draft GHG NID out for public comment;

(b) NIC informs the QA/QC coordinator when approval has been given;

(c) QA/QC co-ordinator initiates and manages the public commenting process;

(d) QA/QC coordinator compiles a public comment database;

(e) QA/QC coordinator sends comments to the SL's;

(f) SL's send responses back to QA/QC coordinator;

(g) QA/QC coordinator compiles a response database and logs this under the "QAQC log" tab on the NGHGIS;

(h) QA/QC coordinator ensures all comments are incorporated into the inventory.

External reviews are organized and managed by the NIC The external review can run simultaneously with the public commenting process. The QA/QC coordinator is responsible for logging the review on the NGHGIS and for ensuring all comments, improvements and recommendations get included in the inventory.

Verification

Emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system. These include measurement and research projects and programmes initiated to support the inventory system, or for other purposes, but producing information relevant to the inventory preparation

Conclusions and improvements

The ultimate aim of the QA/QC process is to ensure the quality of the inventory and to contribute to the improvement of the inventory. In the improvement stage of the QA/QC process, conclusions are made on the basis of the realised QA/QC measures and their results. The final project evaluation takes place at the next year's inventory planning meeting.

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Annex V: Additional information: LULUCF sector

V.1: Additional details on the land cover maps

This annex provides detail on mapping methodologies for the LULUCF sector. The text are summaries of the SANLC maps that have been generated. The SANLC datasets, land cover reports and change assessment data can be found on the DFFE website (https://www.dffe.gov/egis).

1990 South African National Land Cover

The 1990 South African National Land Cover (SANLC 1990) is a 72 x class national land-cover dataset for South Africa, circa 1990, generated primarily from multi-seasonal Landsat 5 imagery, acquired mainly between 1989-1991. This is a complimentary dataset to the previous 72 x class 2013-14 South African national land-cover dataset, generated from comparable Landsat 8 imagery acquired between 2013-14. These two comparable datasets can be used to determine land-cover and land-use change over a period of ± 24 years across the South African landscape. The 1990 national land-cover dataset, is, as per the 2013-14 national land-cover dataset, based on 30x30m raster cells, and is ideally suited for ± 1:75,000 - 1:250,000 scale GIS-based mapping and modelling applications. The 1990 land-cover dataset has been generated using the same operationally proven, semi-automated modelling procedures used to generate the comparable Landsat 8 derived 2013-14 South African national land-cover dataset. It is recommended that the 1990 South African National Land Cover report is read in conjunction with the 2013-14 South African National Land-Cover report associated with the 72 x class 2013-14 South African National Land-Cover Dataset.

2014 South African National Land Cover

The 2014 South African National Land Cover (SANLC 2014) is a 72 x class national land-cover dataset for South Africa, circa 2013-14, generated primarily from multi-seasonal Landsat 8 imagery, using operationally proven, semi-automated modelling procedures developed specifically for the generation of this dataset, based on repeatable and standardised modelling routines. The 2014 national land-cover dataset is, as per 1990 national land-cover dataset, based on 30x30m raster cells, and is ideally suited for ± 1:75,000 - 1:250,000 scale GIS-based mapping and modelling applications. The 1990 and 2014 land-cover are two comparable datasets that can be used to determine land-cover and land-use change over a period of ± 24 years across the South African landscape.

2018 South African National Land Cover

The 2018 South African National Land Cover (SANLC 2018) is a raster format dataset generated from automated mapping models (as opposed to conventional image classification procedures), using multi-seasonal 20m resolution Sentinel 2 satellite imagery. The imagery used represents the full temporal range of available imagery

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acquired by Sentinel 2 during the period 01 January 2018 to 31 December 2018. The SANLC 2018 dataset represents a new chapter in the generation of South African National Land-Cover datasets as it was generated using the CALC (Computer Automated Land-Cover) system. CALC is a DFFE fully automated land-cover production system designed to use Sentinel 2 imagery to produce standardised data-content and consistent SANLC updates in the future.

2020 South African National Land Cover

The 2020 South African National Land Cover (SANLC 2020) is a raster format dataset generated from automated mapping models (as opposed to conventional image classification procedures), using multi-seasonal 20m resolution Sentinel 2 satellite imagery. The imagery used represents the full temporal range of available imagery acquired by Sentinel 2 during the period 01 January 2020 to 31 December 2020. The automated 2020 South African National Land Cover (SANLC 2020) was generated through the CALC system using the same methodology as the SANLC 2018 dataset.

2022 South African National Land Cover

The 2022 South African National Land Cover (SANLC 2022) is a raster format dataset generated from automated mapping models (as opposed to conventional image classification procedures), using multi-seasonal 20m resolution Sentinel 2 satellite imagery. The imagery used represents the full temporal range of available imagery acquired by Sentinel 2 during the period 01 January 2022 to 31 December 2022. The automated 2022 South African National Land Cover (SANLC 2022) was generated through the CALC system using the same methodology as the SANLC 2018 and SANLC 2020 datasets.

Computer Automated Land Cover (CALC) System Methodology

The Computer Automated Land Cover (CALC) is a DFFE automated system that generates land cover and land use change datasets. CALC is designed and operationally implemented as an automated, cloud-based solution for the future production of South African National Land-Cover datasets. The system produces national land-cover data for South Africa, based on the new Gazetted land-cover classes (SANS 19144-2), associated map accuracy and change detection analyses datasets and reports.

Each CALC generated SANLC dataset represents a 20m resolution, raster format, land-cover and land-use (LCLU) automated classification of the entire South African landscape, including a 100 metre buffer into neighbouring countries, and 10 km buffer into coastal waters. Each SANLC dataset represents a particular assessment year, not a specific date nor season. The CALC classification process used all available Sentinel-2 image acquisitions acquired between and including January and December in the assessment year. The automated land-cover mapping models and associated rules utilise both cloud-based image archives and cloud-based geo-data computing capabilities.

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The land-cover / land-use (LCLU) legend and associated information content used with all CALC generated SANLC datasets is based primarily on the new gazetted land-cover classification standard (SANS 19144-2), but with modifications to ensure, as far as possible, comparability and compatibility with the legend and information content associated with the previous 1990 and 2013-14 South African National Land-Cover (SANLC) datasets. These modifications have been made in order to facilitate more representative change detection and reporting between the SANLC 1990 and SANLC 2013-14 datasets, the SANLC 2018, 2020 and the new SANLC 2022 dataset.

CALC generated SANLC datasets are generated using only European Space Agencies (ESA) free-to-access Sentinel-2 satellite imagery. No other satellite image sources have been used. Sentinel-2 imagery has been chosen over Landsat as the preferred source of imagery due to its improved spatial, spectral and temporal (i.e. re-visit) capabilities, compared to Landsat. Sentinel-2A and 2B satellites are collectively able to provide 20 metre resolution imagery, containing 12 spectral bands, every 5 days, anywhere across the globe.

This system enables the DFFE to generate single-year-representative, full legend content, national land-cover datasets over South Africa that are compatible with both the new Gazetted land-cover classes (SANS 19144-2), and the information content in the existing 1990 and 2013/14 South African National Land-Cover datasets. The CALC system also supports the calculation and reporting of land-cover mapping accuracies against independently obtained validation points; and land-cover change assessments with statistical reporting based on a simplified legend (20 classes) and reduced spatial resolution (30 m). CALC also generates RGB false-colour image tiles from Sentinel-2 imagery that is used as a visual reference to update 12 dynamic geographical masks before classification takes place. These visual backdrops are only used for on-screen updating within a GIS environment and should not be used for spectral classification of the imagery.

The CALC system is a fully functional, operational system capable of generating SANLC datasets for DFFE, enabling the Department to maintain and expand its inventory of SANLC content into the future.

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V.2: Annual conversion areas before corrections

This section provides the annual change areas for 1990-2014, 2014-2018, 2018-2020 and 2020-2022 before corrections discussed in section 6.3.3.2. were applied.

Table A V. 1: Annual land change areas (ha) for 1990-2014 before corrections.

Land categories		1990																			
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
2014	Indigenous Forest		1 617	672	1 308	344	1 462	29	270	22	0	8	0	0	55	35	73	3	3	1	0
	Thicket / Dense Bush	1 725		62 647	5 319	26 423	72 094	1 209	6 047	3 560	233	563	175	97	3 423	3 591	2 725	162	120	133	305
	Natural woodland	446	53 900		1 968	68 524	128 942	674	3 203	8 787	1 030	350	22	245	9 159	7 572	1 126	242	37	68	777
	Planted Forest	61	477	1 498		562	11 969	45	377	17	2	60	7	5	1 165	89	412	187	5	8	34
	Shrubland	88	16 780	62 477	1 052		176 234	1 221	5 444	148 400	7 478	234	190	139	16 664	1 232	737	49	49	69	584
	Grassland	436	36 562	78 471	5 765	184 838		1 602	16 522	8 422	3 517	393	49	216	31 291	3 471	3 904	290	79	142	2 091
	Waterbodies	5	519	540	66	592	1 102		528	1 185	10	8	10	2	139	45	24	7	2	3	110
	Wetlands	73	1 419	833	673	1 396	5 961	2 312		276	77	35	25	17	1 395	64	134	36	7	11	63
	Barren Land	38	989	6 436	43	105 562	7 688	3 761	378		1 456	6	8	5	293	27	62	4	9	22	171
	Eroded Land	0	101	613	1	1 451	1 981	11	27	31		1	0	2	116	226	46	0	1	1	13
	Permanent Orchards	33	955	474	258	535	433	15	89	10	0		143	144	1 295	114	28	4	0	2	0
	Permanent Vines	0	144	67	29	557	67	7	86	109	0	401		38	343	11	6	3	1	2	0
	Annuals Pivot Irrigated	1	370	1 439	25	2 875	2 852	8	251	75	9	148	24		16 209	75	4	3	0	0	5
	Annuals Non-Pivot	67	3 994	3 870	1 002	8 904	24 381	163	1 709	112	25	703	110	949		1 865	501	324	4	14	49
	Cultivated Subsistence	67	2 261	3 002	106	2 646	10 053	37	617	16	146	167	0	15	719		1 465	21	1	0	19

Land categories		1990																		
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
2018	Residential	112	1 915	3 170	796	2 445	7 874	34	137	171	45	33	11	15	785	423		408	165	192	29
	Smallholdings	0	48	238	346	97	366	6	8	1	6	7	10	1	349	38	21		1	2	2
	Commercial	1	65	30	20	51	121	2	8	5	0	1	0	0	11	1	433	27		26	3
	Industrial	1	77	33	19	97	189	7	8	17	0	5	2	0	34	0	49	33	8		23
	Mines	12	357	649	149	545	2 198	234	75	112	13	2	0	27	1 527	59	35	3	3	21	

Table A V. 2: Annual land change areas (ha) for 2014-2018 before corrections.

Land categories		2014																		
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
2018	Indigenous Forest		2 128	2 755	7 523	664	2 377	35	1 634	660	0	46	0	2	324	195	1 312	51	11	6	34
	Thicket / Dense Bush	23 463		32 840	8 364	8 700	35 887	710	3 107	1 398	5	1 655	174	345	8 284	5 069	2 604	130	117	119	10
	Natural woodland	10 315	1 020 737		9 907	337 121	899 760	4 186	12 863	7 071	5 133	7 578	1 244	4 968	45 821	33 892	11 328	767	954	635	2 078
	Planted Forest	3 213	29 393	15 072		3 824	47 650	200	4 296	246	16	987	149	77	6 708	364	565	252	11	15	304
	Shrubland	230	133 711	270 988	1 953		408 251	4 596	10 807	722 051	3 073	2 457	3 972	1 884	43 205	229	445	59	23	40	7 448
	Grassland	4 971	391 110	846 856	24 978	2 957 420		5 052	37 269	29 501	16 977	1 538	641	4 523	150 151	58 250	8 286	389	1 576	1 677	18 944
	Waterbodies	105	9 008	5 321	270	4 725	10 930		9 506	10 118	131	65	55	68	862	223	301	69	5	10	1 508
	Wetlands	246	17 765	8 857	1 768	5 762	61 660	1 493		572	129	121	95	146	4 107	945	823	108	19	35	376
	Barren Land	148	33 676	73 619	864	603 836	109 865	7 469	6 958		1 684	268	297	197	5 500	3 018	455	17	19	36	467
	Eroded Land	13	1 989	5 605	45	38 891	29 686	39	315	6 679		1	1	12	240	1 163	77	1	0	0	41

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Land categories		2014																		
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
2020	Permanent Orchards	28	3 094	783	627	1 415	866	49	274	35	1		4 144	605	5 810	138	68	243	0	4	2
	Permanent Vines	0	1 176	192	33	1 221	274	55	157	158	0	317		63	1 343	0	25	147	1	3	1
	Annuals Pivot Irrigated	5	1 402	3 128	63	3 984	5 326	27	460	61	20	673	99		25 525	93	10	126	0	1	19
	Annuals Non-Pivot	299	16 505	12 853	3 164	47 661	108 471	417	6 827	863	381	14 686	5 426	8 176		2 042	398	3 141	3	18	578
	Cultivated Subsistence	506	16 706	41 138	673	2 502	20 661	39	991	45	1 774	615	0	156	8 801		3 149	846	1	1	29
	Residential	259	24 750	16 702	4 223	16 028	54 721	174	1 097	1 841	727	315	327	92	6 172	10 536		1 115	1 085	117	236
	Smallholdings	4	542	1 724	1 248	286	1 504	13	90	15	3	13	7	6	1 862	74	1 203		48	113	5
	Commercial	7	784	337	70	650	734	11	32	107	6	9	9	1	78	11	8 914	41		251	25
	Industrial	4	1 045	938	94	2 147	1 973	181	67	954	11	953	46	150	916	18	4 169	148	113		353
	Mines	50	1 631	3 550	291	5 959	7 168	648	282	3 532	191	6	10	91	2 234	247	1 113	49	68	498	

Table A V. 3: Annual land change areas (ha) for 2018-2020 before corrections.

Land categories		2018																		
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
2020	Indigenous Forest		2	887	489	71	2 073	27	79	33	0	0	0	0	2	0	96	1	1	0	24
	Thicket / Dense Bush	1		129 657	10	5 671	11 724	248	128	162	1	118	0	58	158	219	339	0	33	10	18
	Natural woodland	755	338 706		94	130 694	1 868 624	6 224	474	29 944	4 445	2 121	6	989	15 656	70 530	11 313	43	1 059	847	2 042
	Planted Forest	416	2 034	3 705		3 114	31 727	236	1 569	730	29	128	0	3	385	54	1 445	80	14	37	179
	Shrubland	60	4 927	47 688	1 595		1 103 458	3 910	224	887 743	10 316	19	19	94	1 194	7	10	0	1	6	3 375

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Land categories		2018																		
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
	Grassland	2 410	77 871	1 311 421	31 151	1 289 396		14 734	5 248	119 831	24 893	121	7	496	7 038	7 750	170	9	2 874	3 185	16 293
	Waterbodies	16	156	4 461	207	6 742	8 511		3 299	9 445	189	18	6	25	615	54	196	41	8	49	1 723
	Wetlands	154	206	613	1 367	1 549	7 725	4 058		1 398	0	3	0	10	89	27	67	26	8	16	169
	Barren Land	84	1 280	17 473	557	848 638	109 418	13 265	377		15	5	0	8	78	54	17	0	2	23	490
	Eroded Land	0	2	1 732	43	10 488	28 023	230	1	389		0	0	1	1	33	0	0	0	0	23
	Permanent Orchards	7	759	6 339	1 282	742	1 376	9	83	237	0		23	2 327	8 555	249	48	69	0	0	3
	Permanent Vines	0	43	596	14	1 171	161	3	9	92	0	11		16	57	0	30	14	0	0	3
	Annuals Pivot Irrigated	0	715	5 525	105	1 241	6 946	20	194	169	24	151	47		20 528	116	27	36	0	0	64
	Annuals Non-Pivot	48	2 140	56 466	2 528	13 428	119 605	344	2 760	5 550	137	4 107	63	9 922		6 105	557	797	0	0	1 342
	Cultivated Subsistence	48	462	16 598	84	138	23 656	162	186	2 606	1 545	181	0	154	1 205		915	320	0	0	150
	Residential	308	1 986	17 786	990	609	8 020	245	75	823	63	6	0	22	479	2 015		48	62	7	683
	Smallholdings	2	0	16	19	0	5	73	25	0	0	10	0	3	36	157	125		46	82	29
	Commercial	0	11	445	7	10	1 762	7	6	29	0	2	0	0	0	1	34	26		1	38
	Industrial	0	19	467	20	437	1 902	37	15	183	1	30	1	9	166	8	74	75	1		305
	Mines	37	9	955	413	5 031	9 787	1 347	185	738	57	4	2	106	2 220	221	369	13	25	203	

Table A V. 4: Annual land change areas (ha) for 2020-2022 before corrections.

Land categories		2020																		
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
2022	Indigenous Forest		6	780	440	78	2 730	9	149	70	0	0	0	0	0	0	262	2	0	0	19

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Land categories		2020																		
		Indigenous Forest	Thicket / Dense Bush	Natural woodland	Planted Forest	Shrubland	Grassland	Waterbodies	Wetlands	Barren Land	Eroded Land	Permanent Orchards	Permanent Vines	Annuals Pivot Irrigated	Annuals Non-Pivot	Cultivated Subsistence	Residential	Smallholdings	Commercial	Industrial	Mine
	Thicket / Dense Bush	63		442 516	1	3 795	115 156	128	184	341	1	0	0	0	1	5	3 513	0	11	7	7
	Natural woodland	841	110 037		56	347 782	3 022 644	2 979	742	59 519	5 255	22	7	93	223	6 720	27 519	0	802	548	2 390
	Planted Forest	277	2 687	4 135		3 263	52 573	123	2 589	846	63	3	1	1	24	1	2 118	145	11	27	258
	Shrubland	40	4 749	44 263	1 888		136 426	2 434	291	2 938 345	11 633	16	18	2	133	0	52	0	9	6	4 704
	Grassland	1 057	7 582	914 627	16 831	4 010 564		4 310	5 079	249 884	71 966	30	6	125	1 951	225	465	1	2 502	3 113	20 906
	Waterbodies	79	886	20 145	611	15 875	42 795		13 607	37 257	505	24	16	183	3 213	446	434	149	9	46	2 703
	Wetlands	113	235	797	765	397	10 956	1 774		590	1	1	0	1	7	7	133	42	7	15	126
	Barren Land	30	231	14 163	281	221 295	49 462	3 150	882		5	0	0	6	35	17	18	0	2	1	940
	Eroded Land	0	0	1 030	15	13 399	5 975	61	0	112		0	0	0	0	1	1	0	0	0	151
	Permanent Orchards	0	3	214	21	151	301	7	6	23	0		0	0	115	0	1	0	0	0	5
	Permanent Vines	0	0	10	0	87	32	3	1	13	0	0		0	33	0	0	0	0	0	3
	Annuals Pivot Irrigated	0	81	2 282	57	460	2 745	19	104	21	6	42	0		4 017	207	2	5	0	0	59
	Annuals Non-Pivot	0	297	3 253	959	1 382	7 418	291	216	196	2	2	1	361		2	27	19	1	0	1 139
	Cultivated Subsistence	0	38	37 764	1	2	644	47	13	8	3	0	0	0	22		53	275	0	0	168
	Residential	117	379	14 881	571	1 305	16 193	152	69	2 081	290	10	6	13	461	2 311		33	802	46	870
	Smallholdings	2	0	36	19	0	39	23	31	7	0	0	0	0	0	1	205		29	72	27
	Commercial	1	19	573	9	35	1 673	5	6	115	1	1	0	0	12	8	722	28		20	40
	Industrial	0	13	542	29	388	1 958	48	18	543	3	3 748	1 567	174	1 498	19	640	105	86		386
	Mines	25	3	1 074	275	4 082	7 411	1 206	158	1 198	59	2	1	52	1 574	84	375	13	22	294	

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V.3: Burnt area processing workflow

Data collection:

The MCD64A1 Burned Area Product (hereafter the MCD64A1) is a monthly, Level-3 gridded 500-m product containing per-pixel burning and quality information, and tile-level metadata.

The MCD64A1 files (window 13 files) were downloaded directly from the USGS servers for the 2018 to 2024 annual periods. (Window 13 of the MCD64A1 contains southern Africa.):

The soil type data set was obtained from the previous NID project files – original source was the ARC.

The National Land Cover datasets for 2018, 2020 and 2022 were downloaded from the DFFE's egis portal.

The data was processed using a combination of QGIS and an Anaconda Python environment with NumPy and Rasterio packages installed to process the geospatial data.

Data Processing:

Burned Area:

- The raw resolution of the MCD64A1 is ~500m (463.31271653m) after reprojecting it to EPSG 4326 (WGS84) [All layers were reprojected to WGS84 if they were not in that projection already].
- Each monthly active fire file was reclassified with 0 representing no burns and 1 representing the burned area (12 raster files reclassified to Boolean values (0 and 1)).
    - For the multi burn file: Perform basic resampling where cells are summed to represent the total active burns per pixel for calendar year. Add the "1's" that overlap in an annual period together.
    - Annual raster is the summed total of all 12 raster files and where there was a burn the value of 1 was assigned and where there were none, the value 0.
- Clip the Window 13 Modis Burnt Area (Southern Africa) to a South African boundary shapefile (sourced from Humanitarian Data Exchange SA administration boundaries <https://data.humdata.org/dataset/cod-ab-zaf> accessed 11 November 2024) that was later converted to raster format.
- Burnt Area product was then resampled to the highest possible resolution necessary for the analysis, in this case it was resampled to 18.535m for the South African National Land Cover (SANLC) Raster Geographic data set), i.e., the dataset with the smallest resolution.

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Printed by and obtainable from the Government Printer, Bosman Street, Private Bag X85, Pretoria, 0001
Contact Centre Tel: 012-748 6200. eMail: info.egazette@gpw.gov.za
Publications: Tel: (012) 748 6053, 748 6061, 748 6065

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Government Gazette
Staatskoerant

REPUBLIC OF SOUTH AFRICA
REPUBLIEK VAN SUID AFRIKA

Vol. 731 29 May Mei 2026 No. 54758

PART 6 OF 7

N.B. The Government Printing Works will not be held responsible for the quality of "Hard Copies" or "Electronic Files" submitted for publication purposes

ISSN 1682-5845

9 771682 584003 54758

AIDS HELPLINE: 0800-0123-22 Prevention is the cure

Soil type dataset

- Geo-reference the ALU soils file (.ovr pyramid structure) to corresponding raster outline of South Africa (EPSG 4326 (WGS84)).
- The resolution of the ALU soils raster (50 m) was then resampled to the highest resolution necessary for the analysis. i.e., the dataset with the smallest resolution (18.535m, SANLC Raster).

SANLC Raster dataset

- Reclassify the 73-class dataset to the predetermined 20 classes that were used in previous NIDs.
- No resampling the pixel/cell sizes since the SANLC was the reference resolution for the other datasets.

"Overlay" and counts:

- The next step was to convert the raster datasets into arrays for processing. The datasets were set to an equal extent to ensure the layers identically fit on top of one another.
- The spatial extent was indexed to assign each pixel in the spatial dataset a value (location) in the array.
- The Burned area was set to be a mask, i.e., only the cells that were classified to 1 (burned) will be identified in the processing.
- Next the code was instructed to Loop through each Array and count the number of unique pixels that correspond to the unique cells of the other rasters (np.unique = Counts the unique values in the array).
- To reduce the size of the output, the code was instructed to loop through the ALU soils and find the corresponding Landcover class and then count the number of unique pixels that occurred in the BA mask.
    - i.e., what is the number of pixels that occurred within each LC/soil classification?
    - Determine counts of pixels where a burn was recorded for each LC class corresponding to the unique 7 soil classes of the ALU dataset.
    - The results were exported as text files.
- The pixel counts of Burned area per land cover and soil type was then copied into an excel workbook for further processing.
- The pixel count was multiplied by the pixel area (resolution 18.535m x18.535m = 343.548m^2) to give the area burned per soil type and landcover class. The area burned was also converted into hectares by dividing the square meters by 10 000.

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V.4: Biomass and DOM parameters

Parameter	Vegetation subdivision	Value	Range	Source
Indigenous forests				
Above ground biomass (t dm/ha)	Afrotemperate (primary)	519.8 537.7 372.2 498.7	435.5 – 622.6 411.5 – 722.6 310.6 – 434.0	(Adie, et al., 2013) (Adie, et al., 2013) (Fisher, 2024) (Midgley & Seydack, 2006)
	Afrotemperate (secondary)	243.2 171.7 198.9 226.4	214.5 – 270.6 105.1 – 245.1 174.5 – 217.0	(Adie, et al., 2013) (Adie, et al., 2013) (Fisher, 2024) (Cardoso, et al., 2017)
	Afrotemperate (degraded)	179.8	91.7 – 281.1	(Adie, et al., 2013)
	Mistbelt forest	358.1 (±31.9) 316.7 (±21.4)	98.2 – 952.2	(Mensah, et al., 2016) (Honold, et al., 2025)
	Coastal lowland	199.6 151.6 (±16.6)	154.4 – 253.8	(Smithwick, 2019) (Glenday, 2007)
	Coastal scarp	134.0 (±18) 227.4 (±29.8)		(Glenday, 2007) (Mangwale, et al., 2017)
	Coastal scarp (degraded)	27.2 (±14.2)		(Mangwale, et al., 2017)
	Coastal scarp (regrowth)	24.8 (±10.0)		(Mangwale, et al., 2017)
	Swamp forest	205.0 (±64)		(Glenday, 2007)
	Dune forest	83.6 (±13)		(Glenday, 2007)
	Transitional forest	34.8 (±15.4)		(Glenday, 2007)
	Ironwood forest	108.7 (±8.7)		(Honold, et al., 2025)
Above ground biomass growth (t dm/ha/yr)	Afromontane	4.7 (gross) 0.92 (net)		(Midgley & Seydack, 2006)
	Coastal scarp	0 (>20yrs) 3.58 (<20yrs)[36]		(Glenday, 2007)
	Coastal lowland	0.12 (>20yrs) 3.78 (<20yrs)		(Glenday, 2007)
	Dune	0.06 (>20yrs) 2.74 (<20yrs)		(Glenday, 2007)
	Transitional	0.16 (>20yrs)		(Glenday, 2007)

[36] *These were post disturbance values so assumed this to be for forests <20yrs.*

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		2.16 (<20yrs)		
Net annual increment (m3/ha/yr)	Afrotemperate	1.12		(Gush, 2011)
Ratio of BGB to AGB (t dm BGB/t dm AGB)	Coastal scarp	0.27 0.13		(Glenday, 2007) (Mangwale, et al., 2017)
	Coastal scarp (degraded)	0.14		(Mangwale, et al., 2017)
	Coastal scarp (regrowth)	0.15		(Mangwale, et al., 2017)
	Swamp	0.25		(Glenday, 2007)
	Coastal lowland	0.27		(Glenday, 2007)
	Dune	0.33		(Glenday, 2007)
	Transitional	0.33		(Glenday, 2007)
Mortality rate (% of AGB)	Afrotemperate	0.8 0.6		(Midgley & Seydack, 2006) (Cardoso, et al., 2017)
Deadwood stock (t C/ha)	Coastal scarp	10.6 (±4.7) 19.4 (±3)[37]		(Glenday, 2007) (Mangwale, et al., 2017)
	Coastal scarp (degraded)	1.2 (±0.4)		(Mangwale, et al., 2017)
	Coastal scarp (regrowth)	0.12 (±0.8)		(Mangwale, et al., 2017)
	Swamp	3.1 (±1.8)		(Glenday, 2007)
	Coastal lowland	5.8 (±2.2)		(Glenday, 2007)
	Dune	2.6 (±0.9)		(Glenday, 2007)
	Transitional	2.2 (±1.7)		(Glenday, 2007)
	Mistbelt	5.3 (±1.3)		(Honold, et al., 2025)
	Ironwood	9.5 (±3.5)		(Honold, et al., 2025)
Litter stock (t C/ha)	Coastal scarp	3.7(±0.3) 12.8 (±1.2)		(Glenday, 2007) (Mangwale, et al., 2017)
	Coastal scarp (degraded)	1 (±0.4)		(Mangwale, et al., 2017)
	Coastal scarp (regrowth)	0.16 (±0.04)		(Mangwale, et al., 2017)
	Swamp	3.2 (±0.0)		(Glenday, 2007)
	Coastal lowland	3.8 (±0.3)		(Glenday, 2007)
	Dune	4.5 (±0.5)		(Glenday, 2007)
	Transitional	2.7 (±0.6)		(Glenday, 2007)

[37] These values were indicated to be large litter, and a separate litter value was provided, therefore the values were utilised as deadwood.

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Litter production (% of AGB)	Forests	1 - 5		(Lechmere-Oertel, et al., 2008)
Litter decomposition rate (per year)	Afrotemperate	0.24		
Mass of fuel available for combustion (t/ha)	Forests	60		(DEA, 1999)
	Secondary tropical forests	76.7		(IPCC, 2019)
Biomass burning combustion factor	Forests	0.4		(DEA, 1999)
	Secondary tropical forests	0.55		(IPCC, 2019)
Thickets				
Above ground biomass (t dm/ha)	Dry valley thicket	61.6 (±6.8)		(Glenday, 2007)
	Alien thicket	24.2 (±7.4)		(Glenday, 2007)
	Succulent	82	67.0 -97.0	(Lechmere-Oertel, et al., 2008)
	Succulent (transformed <20yrs)	3.96 (±0.4) 11.0 (±0.4) 29.6 (±6.3)		(Mills & Cowling, 2006)
	Succulent (transformed >20yrs)	64.4 (±8.3)		(Mills & Cowling, 2006)
	Succulent (transformed)	16.7	9.5 – 23.9	(Lechmere-Oertel, et al., 2008)
	Semiarid	84 (±6)		(Mills, et al., 2005)
	Semi-arid (transformed)	14.6 (±6.3)		(Mills, et al., 2005)
	Subtropical	57.1 (±8.4) 58.08 77.41 76.02 53.68 46.25 44.1 (±5.97)		(Powell, 2009) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (Harris, et al., 2021)
	Subtropical (restored >20yrs)	94.8 (±22.1) 224.2 (±22.5)		(van der Vyver, et al., 2013)
	Subtropical (degraded)	10.3 (±1.7) 33.1 (±20.4) 13 25.8 20.36		(Powell, 2009) (van der Vyver, et al., 2013) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019)

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		8.65 3.27 29 (moderate) 13.1 (severe)		(van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (Harris, et al., 2021) (Harris, et al., 2021)
Above ground biomass growth (t dm/ha/yr)	Dry valley thicket	1.0 (>20yrs) 2.3 (<20yrs)		(Glenday, 2007)
Ratio of BGB to AGB (t dm BGB/t dm AGB)	Succulent (transformed <20yrs)	0.4 0.37		(Mills & Cowling, 2006)
	Succulent (transformed >20yrs)	0.3		(Mills & Cowling, 2006)
	Semiarid	0.63		(Mills, et al., 2005)
	Semi-arid (transformed)	1.6		(Mills, et al., 2005)
	Subtropical	0.2		(Powell, 2009)
	Subtropical (degraded)	0.5		(Powell, 2009)
	Subtropical (restored >20yrs)	0.2		(van der Vyver, et al., 2013)
Deadwood stock (t C/ha)	Dry valley thicket	3 (±1)		(Glenday, 2007)
	Alien thicket	0		(Glenday, 2007)
Litter stock (t C/ha)	Dry valley thicket	5.2 (±0.6)		(Glenday, 2007)
	Alien thicket	4 (±1.2)		(Glenday, 2007)
	Succulent (transformed <20yrs)	0.1 (±0.02) 0.5 (±0.2) 0.7 (±0.1)		(Mills & Cowling, 2006)
	Succulent (>20yrs)	1.2 (±0.3)		(Mills & Cowling, 2006)
	Semi-arid	11.5 (±1.4)		(Mills, et al., 2005)
	Semi-arid (transformed)	1 (±0.4)		(Mills, et al., 2005)
	Subtropical	3.7 (±0.72) 8.04 5.81 5.81 11.49 4.12 9.18 (±3.57)		(Powell, 2009) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (Harris, et al., 2021)

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	Subtropical (degraded)	1.4 (±0.31) 0 0.56 0.6 1.86 0.31 0.95 4.0 (moderate) 1.9 (severe)		(Powell, 2009) (van der Vyver, et al., 2013) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (van der Vyver & Cowling, 2019) (Harris, et al., 2021) (Harris, et al., 2021)
	Subtropical (restored >20yrs)	12.8 (±2.4) 25.3 (±2.2)		(van der Vyver, et al., 2013)
Litter production (t dm/ha/yr)	Succulent (intact)	4.1		(Lechmere-Oertel, et al., 2008)
	Succulent (transformed)	2.9		(Lechmere-Oertel, et al., 2008)
Litter production (% of AGB)	Succulent (intact)	4 – 6		(Lechmere-Oertel, et al., 2008)
	Succulent (transformed)	12 - 32		(Lechmere-Oertel, et al., 2008)
Litter decomposition (t dm/ha/yr)	Succulent (intact)			(Lechmere-Oertel, et al., 2008)
	Succulent (transformed)			(Lechmere-Oertel, et al., 2008)
Mass of fuel available for combustion (t/ha)	Thickets	1.4		(DEAT, 2009)
Biomass burning combustion factor	Thickets	0.95		(DEAT, 2009)
Woodlands				
Above ground biomass (t dm/ha)	Moist woodland	81.5 (±6.1)		(Honold, et al., 2025)
	Dry woodland	38.4 (±8.4)		(Honold, et al., 2025)
	Lowveld woodland	33.5 (±2.8)		(Honold, et al., 2025)
	Mopane woodland	38.7 (±4.3)		(Honold, et al., 2025)
	Woodland (woody)	58 (±6)		(Glenday, 2007)
	Alien woodland (woody)	28 (±10)		(Glenday, 2007)

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	Wooded grassland (woody)	9.4 (±1.4)		(Glenday, 2007)
	Woodland – disturbed (woody)	18.2 (±6.8)		(Glenday, 2007)
	Woodland (herbaceous)	3.6 (±0.8)		(Glenday, 2007)
	Alien woodland (herbaceous)	4.2 (±1)		(Glenday, 2007)
	Wooded grassland (herbaceous)	5.2 (±1)		(Glenday, 2007)
	Woodland – disturbed (herbaceous)	5.2 (±1)		(Glenday, 2007)
	Savanna woodland	28.3 27 (woody) 26 19.2[38] 23.4	 4.7 – 41.9 9.4 – 27 22 – 25	(Colgan, 2012) (Colgan, 2012) (Lembani, 2018) (Mograbi, et al., 2015) (Nickless, et al., 2011)
	Savanna	14.4 (woody) 1.9 (herb)		(Rutherford, 1979)
	Savanna (arid)	23.1 (±2.28)		(Shackleton & Scholes, 2011)
	Savanna (semi-arid)	18.9 (±3.67)		(Shackleton & Scholes, 2011)
	Savanna (mesic)	41.3 (±4.53)		(Shackleton & Scholes, 2011)
Above ground biomass growth (t dm/ha/yr)	Woodland (>20yrs)	0.06		(Glenday, 2007)
	Woodland (<20yrs)	2.3		(Glenday, 2007)
	Alien woodland (>20yrs)	0		(Glenday, 2007)
	Alien woodland (<20yrs)	1.3		(Glenday, 2007)
	Wooded grassland (>20yrs)	0		(Glenday, 2007)
	Wooded grassland (<20yrs)	0.36		(Glenday, 2007)
	Savanna (wood)	1.3		(Rutherford, 1979)

[38] *This value is for land experiencing different levels of wood extraction.*

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		0.9		(Scholes & Walker, 1993)
Ratio of BGB to AGB (t dm BGB/t dm AGB)	Woodland (woody)	0.32		(Glenday, 2007)
	Savanna	1.99		(Qi, et al., 2019)
	Wooded savanna	0.5		(IPCC, 2006)
Deadwood (t C/ha)	Moist woodland	0.8 (±0.4)		(Honold, et al., 2025)
	Dry woodland	0.8 (±0.4)		(Honold, et al., 2025)
	Lowveld woodland	0.1 (±0.08)		(Honold, et al., 2025)
	Mopane woodland	0.1 (±0.08)		(Honold, et al., 2025)
	Woodland	1.5 (±0.5)		(Glenday, 2007)
	Alien woodland	1.3 (±0.8)		(Glenday, 2007)
	Wooded grassland	0.4 (±0.2)		(Glenday, 2007)
	Woodland – disturbed	1 (±1)		(Glenday, 2007)
	Savanna	0.87		(Rutherford, 1979)
Litter stock (t C/ha)	Woodland	2.6 (±0.3)		(Glenday, 2007)
	Alien woodland	4.5 (±0.8)		(Glenday, 2007)
	Wooded grassland	0.8 (±0.6)		(Glenday, 2007)
	Woodland – disturbed	3.3 (±1.2)		(Glenday, 2007)
Mass of fuel available for combustion (t/ha)	Savanna	4.3	3.5 – 5.5	(Shea, et al., 1996)
	Grassland savanna	5.3 (±2)		(van Leeuwen, et al., 2014)
	Wooded savanna	11 (±99.1)		(van Leeuwen, et al., 2014)
Combustion fraction	Savanna	0.8		(Shea, et al., 1996)
	Grassland savanna	0.81 (±0.12) 0.88		(van Leeuwen, et al., 2014) (Hely, et al., 2003)
	Wooded savanna	0.58 (±0.18)		(van Leeuwen, et al., 2014)
Low shrubland				
Above ground biomass (t dm/ha)	Succulent karoo	3.3 7.6 3.8 3.3 19.8 3.72	0.5 – 7	(Milton, 1990) (Rutherford, 1978) (Rutherford & Westfall, 1986) (Anderson, et al., 2010) (Anderson, et al., 2010) (Anderson, et al., 2010)

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		25.7		(Anderson, et al., 2010)
	Karoo	4.0	1 – 7	(Rutherford & Westfall, 1986)
	Nama karoo	3.4		(Skowno, 2003)
	Fynbos	18.6 (±2) 15.5 18.1 14.3 4.85 (2yrs) 18.5 (mature) 35.4 (21yrs)[39] 22.6 (37yrs)[40] 6.6 (4yrs) 5.9 (4yrs)	6 – 25 2.2 – 7.5 11 – 26	(Mills, et al., 2012) (Rutherford & Westfall, 1986) (Abanda, et al., 2011) (Rutherford, 1978) (Kruger, 1977) (Kruger, 1977) (van Wilgen, 1980) (van Wilgen, 1980) (van Wilgen, 1980) (van Wilgen, 1980)
Above ground biomass growth (t dm/ha/yr)	Fynbos	2.5	1 - 4	(Kruger, 1977)
Litter stock (t C/ha)	Succulent karoo	2.1 2.5 0.2		(Rutherford, 1978) (Rutherford, 1978) (Milton, 1990)
	Fynbos	0.76 3.4 (±0.7) 1.0 5.3 (21yrs) 19.6 (37yrs) 0.2 (4yrs) 0.12 (4yrs) 6.3	0.8 – 1.4	(Rutherford, 1978) (Mills, et al., 2012) (Kruger, 1977) (van Wilgen, 1980) (van Wilgen, 1980) (van Wilgen, 1980) (van Wilgen, 1980) (Abanda, et al., 2011)
Ratio of BGB to AGB (t dm BGB/t dm AGB)	Arid shrublands	1.1		(Mokany, et al., 2006)
	Fynbos (perennial)	0.26 (±0.05)		(Higgins, et al., 1987)
	Fynbos (herbaceous)	1.68 (±0.3)		(Higgins, et al., 1987)
Litter production (t dm/ha/yr)	Fynbos	0.7		(Witkowski, 1989)
Mass of fuel available for combustion (t/ha)	Nama karoo	1		(DEA, 1999)
	Succulent karoo	0.6		(DEA, 1999)
	Fynbos	12.9		(Richardson, et al., 1994)

[39] *This plot is 21yrs post fire.*
[40] *This plot was after 37yr of fire exclusion and so was excluded from totals as fires naturally occur in the fynbos*

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Combustion fraction	Nama karoo	0.95		(DEA, 1999)
	Succulent karoo	0.95		(DEA, 1999)
	Fynbos	0.61		(IPCC, 2006)
Mangroves				
Above ground biomass (t dm/ha)	Mangroves	94.5 (±7.8) 157		(Steinke, et al., 1995) (Johnson, et al., 2020)
Ratio of BGB to AGB (t dm BGB/t dm AGB)	Mangroves	0.1		(Steinke, et al., 1995)
Litter production (t dm/ha/yr)	Mangroves	7.5	4.5 – 10.6	(Naidoo, 2016)
Deadwood stock (t C/ha)	Mangrove	7.63 (±0.9)		(Steinke, et al., 1995)

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Annex VI: Common Reporting Tables

Table A VI. 1: Summary emission table for South Africa for 2024.

IPCC 2006 category	Emissions and removals									
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF6	NOx	CO	NMVOC	Total GHGs
	(Gg)			(Gg CO_2e)		(Gg)				(Gg CO_2e)
Emissions (incl. LULUCF)	**356 325.7**	**2 276.1**	**65.0**	**6 685.1**	**113.0**	**84.7**	**49.4**	**930.0**	**78.9**	**444 164.5**
Emissions (excl. LULUCF)	**393 909.3**	**2 171.1**	**60.3**	**6 685.1**	**113.0**	**84.7**	**1.4**	**53.2**	**0.0**	**477 576.4**
1 - Energy	**368 289.1**	**186.5**	**6.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**375 215.7**
1.A - Fuel Combustion Activities	344 347.2	16.4	6.4				NE	NE	NE	346 505.1
1.B - Fugitive emissions from fuels	23 941.9	170.1	0.0				NE	NE	NE	28 710.6
1.C - Carbon dioxide Transport and Storage	NE									NE
2 - Industrial Processes and Product Use	**23 029.6**	**4.2**	**1.3**	**6 685.1**	**113.0**	**84.7**	**0.0**	**0.0**	**0.0**	**30 371.6**
2.A - Mineral Industry	4 956.1	NE								4 956.1
2.B - Chemical Industry	1 290.6	4.2	1.3							1 749.8
2.C - Metal Industry	15 605.2	0.0	0.0	NE	113.0					15 718.3
2.D - Non-Energy Products from Fuels and Solvent Use	1 177.7	NE	NE							1 177.7
2.E - Electronics Industry	NE		NE	NE	NE					NE
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE			6 685.1	NE					6 685.1
2.G - Other Product Manufacture and Use			NE	NE	NE	84.7				84.7
2.H - Other	NA	NA	NA							NA
3 - Agriculture	**2 561.7**	**1 351.4**	**46.6**	**0.0**	**0.0**	**0.0**	**1.4**	**53.2**	**0.0**	**52 744.4**
3.A – Enteric fermentation		1 287.4								36 048.3

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3.B – Manure management		62.4	10.0							4 399.8
3.C – Rice cultivation		NO								NO
3.D – Agricultural soils		NA	36.5				NE	NE	NE	9 680.2
3.E – Prescribed burning of savannas		IE	IE				IE	IE	IE	IE
3.F – Field burning of agricultural residues		1.6	0.0				1.4	53.2	NE	54.5
3.G – Liming	1 890.9									1 890.9
3.H – Urea application	670.8									670.8
3.I – Other carbon-containing fertilisers	NE									NE
4 - LULUCF	**-37 583.7**	**105.0**	**4.6**	**0.0**	**0.0**	**0.0**	**48.0**	**876.7**	**78.9**	**-33 411.9**
4.A – Forest land	-55 744.0	14.2	1.2				17.6	368.2	51.6	-55 036.7
4.B - Cropland	8 083.9	2.5	0.6				0.1	3.2	0.3	8 311.1
4.C - Grassland	3 047.5	18.5	1.3				24.4	406.8	21.9	3 917.9
4.D - Wetland	106.8	69.0	0.3				4.7	77.8	4.1	2 105.3
4.E - Settlements	-1 452.7	0.7	0.4				1.2	20.7	1.1	-1 325.7
4.F – Other land	10 093.1	0.0	0.9				0.0	0.0	0.0	10 334.5
4.G – Harvested wood products	-1 718.3									-1 718.3
5 - Waste	**28.9**	**628.9**	**6.0**							**19 244.7**
5.A - Solid Waste Disposal		263.5	NE							7 376.7
5.B - Biological Treatment of Solid Waste		64.0	3.1							2 620.2
5.C - Incineration and Open Burning of Waste	28.9	6.0	0.1							240.8
5.D - Wastewater Treatment and Discharge		295.5	2.8							9 007.0
5.E – Other	NO	NO	NO							NO
Memo items										
International bunkers	**4 166.1**	**0.2**	**0.1**							**4 200.9**
International aviation	*2 621.2*	*0.0*	*0.1*							*2 640.6*
International water-borne transport	*1 544.9*	*0.1*	*0.0*							*1 560.3*
Multilateral operations	*NA*	*NA*	*NA*							*NA*

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Table A VI. 2: Summary Energy sector emission table for South Africa for 2024.

Categories	Emissions (Gg)							Emissions
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SO_2	(Gg CO_2e)
1 - Energy	**363 767**	**199,3**	**8,331**	**0**	**0**	**0**	**0**	**371 555**
1.A - Fuel Combustion Activities	339 825,0	29,2	8,3	0	0	0	0	342 844,6
1.A.1 - Energy Industries	*227 173*	*3,24*	*3*	*0*	*0*	*0*	*0*	*228 181*
1.A.1.a - Main Activity Electricity and Heat Production	198 237	2	3	NE	NE	NE	NE	199 114
1.A.1.a.i - Electricity Generation	*198 237*	*2*	*3*	*NE*	*NE*	*NE*	*NE*	*199 114*
1.A.1.a.ii - Combined Heat and Power Generation (CHP)				*NE*	*NE*	*NE*	*NE*	0
1.A.1.a.iii - Heat Plants				*NE*	*NE*	*NE*	*NE*	0
1.A.1.b - Petroleum Refining	1 491	0	0	NE	NE	NE	NE	1 493
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	27 445	1	0	NE	NE	NE	NE	27 574
1.A.1.c.i - Manufacture of Solid Fuels	*27 445*	*1*	*0*	*NE*	*NE*	*NE*	*NE*	*27 574*
1.A.1.c.ii - Other Energy Industries	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
1.A.2 - Manufacturing Industries and Construction	*24 141*	*0*	*0*	*0*	*0*	*0*	*0*	*24 141*
1.A.2.a - Iron and Steel	1 674	0	0	NE	NE	NE	NE	1 674
1.A.2.b - Non-Ferrous Metals	366	0	0	NE	NE	NE	NE	367
1.A.2.-ab - 1A2 Remainder	19 887	0	0	NE	NE	NE	NE	19 887
1.A.2.c - Chemicals	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.d - Pulp, Paper and Print	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.e - Food Processing, Beverages and Tobacco	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.f - Non-Metallic Minerals	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.g - Transport Equipment	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.h - Machinery	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.i - Mining (excluding fuels) and Quarrying	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.j - Wood and wood products	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.k - Construction	IE	IE	IE	NE	NE	NE	NE	IE

1.A.2.l - Textile and Leather	IE	IE	IE	NE	NE	NE	NE	IE
1.A.2.m - Non-specified Industry	IE	IE	IE	NE	NE	NE	NE	IE
1.A.3 - Transport	*51 983*	*13*	*3*	*0*	*0*	*0*	*0*	*53 133*
1.A.3.a - Civil Aviation	776	0	0	NE	NE	NE	NE	781
1.A.3.a.i - International Aviation (International Bunkers)	*2 311*	*0*	*0*	*NE*	*NE*	*NE*	*NE*	*2 330*
1.A.3.a.ii - Domestic Aviation	*776*	*0*	*0*	*NE*	*NE*	*NE*	*NE*	*781*
1.A.3.b - Road Transportation	50 190	13	3	NE	NE	NE	NE	51 289
1.A.3.b.i - Cars				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.i.1 - Passenger cars with 3-way catalysts				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.i.2 - Passenger cars without 3-way catalysts				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.ii - Light-duty trucks				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.iii - Heavy-duty trucks and buses				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.iv - Motorcycles				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.v - Evaporative emissions from vehicles				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.b.vi - Urea-based catalysts				*NE*	*NE*	*NE*	*NE*	*0*
1.A.3.c - Railways	410	0	0	NE	NE	NE	NE	444
1.A.3.d - Water-borne Navigation	562	0	0	NE	NE	NE	NE	567
1.A.3.d.i - International water-borne navigation (International bunkers)	*1 545*	*0*	*0*					*1 559*
1.A.3.d.ii - Domestic Water-borne Navigation	*562*	*0*	*0*	*NE*	*NE*	*NE*	*NE*	*567*
1.A.3.e - Other Transportation	46	0	0	*NE*	*NE*	*NE*	*NE*	*51*
1.A.3.e.i - Pipeline Transport	*46*	*0*	*0*	*NE*	*NE*	*NE*	*NE*	*51*
1.A.3.e.ii - Off-road	*IE*	*IE*	*IE*	*NE*	*NE*	*NE*	*NE*	*NE*
1.A.4 - Other Sectors	*18 502*	*1*	*0*	*0*	*0*	*0*	*0*	*18 517*
1.A.4.a - Commercial/Institutional	11 820	0	0	NE	NE	NE	NE	11 831
1.A.4.b - Residential	3 608	0	0	NE	NE	NE	NE	3 608

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1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	3 074	0	0	NE	NE	NE	NE	3 078
1.A.4.c.i - Stationary	*3 074*	*0*	*0*	*NE*	*NE*	*NE*	*NE*	*3 078*
1.A.4.c.ii - Off-road Vehicles and Other Machinery	*IE*	*IE*	*IE*	*NE*	*NE*	*NE*	*NE*	*NE*
1.A.4.c.iii - Fishing (mobile combustion)	*IE*	*IE*	*IE*	*NE*	*NE*	*NE*	*NE*	*NE*
1.A.5 - Non-Specified	*18 026*	*12*	*2*	*0*	*0*	*0*	*0*	*18 873*
1.A.5.a - Stationary	18 026	12	2	NE	NE	NE	NE	18 873
1.A.5.b - Mobile				NE	NE	NE	NE	0
1.A.5.b.i - Mobile (aviation component)	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
1.A.5.b.ii - Mobile (water-borne component)	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
1.A.5.b.iii - Mobile (Other)	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
1.A.5.c - Multilateral Operations								0
1.B - Fugitive emissions from fuels	23 942	170	0,0176	0	0	0	0	28 711
1.B.1 - Solid Fuels	*402*	*72*		*0*	*0*	*0*	*0*	*2 407*
1.B.1.a - Coal mining and handling	17	63		NE	NE	NE	NE	*1 771*
1.B.1.a.i - Underground mines	*17*	*63*		*NE*	*NE*	*NE*	*NE*	*1 771*
1.B.1.a.i.1 - Mining	*14*	*51*		*NE*	*NE*	*NE*	*NE*	*1 436*
1.B.1.a.i.2 - Post-mining seam gas emissions	*3*	*12*		*NE*	*NE*	*NE*	*NE*	*336*
1.B.1.a.i.3 - Abandoned underground mines	*NE*	*NE*		*NE*	*NE*	*NE*	*NE*	*NE*
1.B.1.a.i.4 - Flaring of drained methane or conversion of methane to CO2	*NE*	*NE*		*NE*	*NE*	*NE*	*NE*	*NE*
1.B.1.a.ii - Surface mines	*0*	*0*		*NE*	*NE*	*NE*	*NE*	0
1.B.1.a.ii.1 - Mining	*0*	*0*		*NE*	*NE*	*NE*	*NE*	0
1.B.1.a.ii.2 - Post-mining seam gas emissions	*0*	*0*		*NE*	*NE*	*NE*	*NE*	0
1.B.1.b - Uncontrolled combustion and burning coal dumps	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1.c - Solid fuel transformation	385	9	0	NE	NE	NE	NE	NE
1.B.2 - Oil and Natural Gas	*63*	*1*	*0*	*0*	*0*	*0*	*0*	*86*
1.B.2.a - Oil	63	1	0	NE	NE	NE	NE	86

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1.B.2.a.i - Venting				*NE*	*NE*	*NE*	*NE*	*NE*
1.B.2.a.ii - Flaring				*NE*	*NE*	*NE*	*NE*	*NE*
1.B.2.a.iii - All Other				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.a.iii.1 - Exploration				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.a.iii.2 - Production and Upgrading				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.a.iii.3 - Transport				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.a.iii.4 - Refining				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.a.iii.5 - Distribution of oil products				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.a.iii.6 - Other				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b - Natural Gas				NE	NE	NE	NE	0
1.B.2.b.i - Venting				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.ii - Flaring				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.iii - All Other				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.iii.1 - Exploration				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.iii.2 - Production				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.iii.3 - Processing				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.iii.4 - Transmission and Storage				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.iii.5 - Distribution				*NE*	*NE*	*NE*	*NE*	*0*
1.B.2.b.iii.6 - Other				*NE*	*NE*	*NE*	*NE*	*0*
1.B.3 - Other emissions from Energy Production	*23 477*	*98*	*0*	*0*	*0*	*0*	*0*	*26 214*
1.C - Carbon dioxide Transport and Storage	0			0	0	0	0	0
1.C.1 - Transport of CO2	*0*			*0*	*0*	*0*	*0*	*0*
1.C.1.a - Pipelines	NE			NE	NE	NE	NE	NE
1.C.1.b - Ships	NE			NE	NE	NE	NE	NE
1.C.1.c - Other (please specify)	NE			NE	NE	NE	NE	NE
1.C.2 - Injection and Storage	*0*			*0*	*0*	*0*	*0*	*0*

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1.C.2.a - Injection	NE			NE	NE	NE	NE	NE
1.C.2.b - Storage	NE			NE	NE	NE	NE	NE
1.C.3 - Other	*0*			*0*	*0*	*0*	*0*	*0*

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Table A VI. 3: Summary IPPU sector emission table for South Africa for 2024

Categories	Emissions (Gg)										Emissions
	CO_2	CH_4	N_2O	HFCs	PFCs	SF6	NOx	CO	NMVOC	SO_2	(Gg CO_2e)
2. Industrial processes and product use	**23 029.6**	**4.2**	**1.3**	**6 685.1**	**113.0**	**84.7**	**0.0**	**0.0**	**0.0**	**0.0**	**30 371.6**
2A Mineral Industry	**4 956.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**4 956.1**
2A1 Cement production	3 846.0						NE	NE	NE	NE	3 846.0
2A2 Lime production	799.1						NE	NE	NE	NE	799.1
2A3 Glass Production	177.3						NE	NE	NE	NE	177.3
2A4 Other Process Uses of Carbonates	133.6						NE	NE	NE	NE	133.6
2A4a Ceramics							*NE*	*NE*	*NE*	*NE*	*NE*
2A4b Other Uses of Soda Ash							*NE*	*NE*	*NE*	*NE*	*NE*
2A4c Non Metallurgical Magnesia Production							*NE*	*NE*	*NE*	*NE*	*NE*
2A4d Other (please specify) (3)							*NE*	*NE*	*NE*	*NE*	*NE*
2A5 Other (please specify (3)	NE						NE	NE	NE	NE	NE
2B Chemical Industry	**1 290.6**	**4.2**	**1.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1 749.8**
2B1 Ammonia Production	C	C					NE	NE	NE	NE	C
2B2 Nitric Acid Production			C				NE	NE	NE	NE	C
2B3 Adipic Acid Production			NE				NE	NE	NE	NE	NE
2B4 Caprolactam. Glyoxal and Glyoxylic Acid Production			NE				NE	NE	NE	NE	NE
2B5 Carbide Production	C	NE					NE	NE	NE	NE	C
2B6 Titanium Dioxide Production	C						NE	NE	NE	NE	C
2B7 Soda Ash Production	C						NE	NE	NE	NE	C
2B8 Petrochemical and Carbon Black Production	C	C	NE	NE	NE	NE	NE	NE	NE	NE	C
2B8a Methanol	*C*	*C*					*NE*	*NE*	*NE*	*NE*	*C*
2B8b Ethylene	*C*	*C*					*NE*	*NE*	*NE*	*NE*	*C*
2B8c Ethylene Dichloride and Vinyl Chloride Monomer	*NO*	*NO*					*NO*	*NO*	*NO*	*NO*	*NO*
2B8d Ethylene Oxide	*C*	*C*					*NE*	*NE*	*NE*	*NE*	*C*

2B8e Acrylonitrile	*NO*	*NO*					*NO*	*NO*	*NO*	*NO*	*NO*
2B8f Carbon Black	*C*	*C*					*NE*	*NE*	*NE*	*NE*	*C*
2B8g Hydrogen Production	*C*	*C*					*NE*	*NE*	*NE*	*NE*	*C*
2B9 Fluorochemical Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2B9a By-product emissions (4)				*NE*			*NE*	*NE*	*NE*	*NE*	*NE*
2B9b Fugitive Emissions (4)							*NE*	*NE*	*NE*	*NE*	*NE*
2B10 Other (Please specify) (3)							NE	NE	NE	NE	0.0
2C Metal Industry	**15 605.2**	**0.0**	**0.0**	**0.0**	**113.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**15 718.3**
2C1 Iron and Steel Production	6 894.0	0.0					NE	NE	NE	NE	6 894.0
2C2 Ferroalloys Production	6 942.5	0.0					NE	NE	NE	NE	6 942.5
2C3 Aluminium production	C				C		NE	NE	NE	NE	C
2C4 Magnesium production (5)	NO					NO	NO	NO	NO	NO	NO
2C5 Lead Production	7.7						NE	NE	NE	NE	7.7
2C6 Zinc Production	501.9						NE	NE	NE	NE	501.9
2C7 Other (please specify) (3)	0.0						NE	NE	NE	NE	0.0
2D Non-Energy Products from Fuels and Solvent Use (6)	**1 177.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1 177.7**
2D1 Lubricant Use	461.9						NE	NE	NE	NE	461.9
2D2 Paraffin Wax Use	715.8						NE	NE	NE	NE	715.8
2D3 Solvent Use (7)							NE	NE	NE	NE	0.0
2D4 Other (please specify) (3). (8)							NE	NE	NE	NE	0.0
2E Electronics Industry	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
2E1 Integrated Circuit or Semiconductor (9)				NE	NE	NE	NE	NE	NE	NE	NE
2E2 TFT Flat Panel Display (9)					NE	NE	NE	NE	NE	NE	NE
2E3 Photovoltaics (9)					NE		NE	NE	NE	NE	NE
2E4 Heat Transfer Fluid (10)					NE		NE	NE	NE	NE	NE
2E5 Other (please specify) (3)							NE	NE	NE	NE	NE
2F Product Uses as Substitutes for Ozone Depleting Substances	**0.0**	**0.0**	**0.0**	**6 685.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6 685.1**
2F1 Refrigeration and Air Conditioning	0.0	0.0	0.0	6 577.2	NE	NE	NE	NE	NE	NE	6 577.2
2F1a Refrigeration and Stationary Air Conditioning				*6 577.2*			*NE*	*NE*	*NE*	*NE*	*6 577.2*

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2F1b Mobile Air Conditioning				*0.0*			*NE*	*NE*	*NE*	*NE*	*0.0*
2F2 Foam Blowing Agents				2.1			NE	NE	NE	NE	2.1
2F3 Fire Protection				87.5	NE		NE	NE	NE	NE	87.5
2F4 Aerosols				18.3			NE	NE	NE	NE	18.3
2F5 Solvents				NE	NE		NE	NE	NE	NE	NE
2F6 Other Applications (please specify) (3)				NO	NO		NO	NO	NO	NO	NO
2G Other Product Manufacture and Use	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**84.7**	**0.0**	**0.0**	**0.0**	**0.0**	**84.7**
2G1 Electrical Equipment					NE	84.7	NE	NE	NE	NE	NE
2G1a Manufacture of Electrical Equipment					*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
2G1b Use of Electrical Equipment					*NE*	*84.7*	*NE*	*NE*	*NE*	*NE*	*84.7*
2G1c Disposal of Electrical Equipment					*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
2G2 SF6 and PFCs from Other Product Uses	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2G2a Military Applications					*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
2G2b Accelerators					*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
2G2c Other (please specify) (3)					*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
2G3 N2O from Product Uses	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2G3a Medical Applications			*NE*				*NE*	*NE*	*NE*	*NE*	*NE*
2G3b Propellant for pressure and aerosol products			*NE*				*NE*	*NE*	*NE*	*NE*	*NE*
2G3c Other (Please specify) (3)			*NE*				*NE*	*NE*	*NE*	*NE*	*NE*
2G4 Other (Please specify) (3)							NE	NE	NE	NE	NE
2H Other	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
2H1 Pulp and Paper Industry							NE	NE	NE	NE	0.0
2H2 Food and Beverages Industry							NE	NE	NE	NE	0.0
2H3 Other (please specify) (3)							NE	NE	NE	NE	0.0

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Table A VI. 4: Summary Agriculture sector emission table for South Africa for 2024

	Emissions						Total emissions
	(Gg)						(Gg CO_2e)
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	
3 - Agriculture	**2 561.7**	**1 380.1**	**11.54**	**1 095.3**	**100.9**	**53.4**	**52 744.4**
3.A - Enteric Fermentation	**0.0**	**1 287.4**	**0.0**	**0.0**	**0.0**	**0.0**	**36 048.3**
3.A.1 - Cattle		996.4					27 900.1
3.A.1.a - Dairy Cows		*128.9*					*3 609.0*
3.A.1.b - Other Cattle		*867.5*					*24 291.0*
3.A.2 - Sheep		225.5					6 313.1
3.A.3 - Swine		1.5					42.5
3.A.4 – Other							
3.A.4.a- Buffalo		*NO*					*NO*
3.A.4.b - Camels		*NO*					*NO*
3.A.4.d - Goats		*56.3*					*1 577.1*
3.A.4.e - Horses		*6.1*					*170.3*
3.A.4.f - Mules and Asses		*1.6*					*45.2*
3.B - Manure Management	**0.0**	**51.9**	**8.8**	**0.0**	**0.0**	**0.0**	**4 399.8**
3.B.1 - Cattle		44.0	4.3				2 369.5
3.B.1.a - Dairy Cows		*19.9*	*0.8*				*770.4*
3.B.1.b - Other Cattle		*24.2*	*3.5*				*1 599.2*
3.B.2 - Sheep		3.2	0.6				246.8
3.B.3 - Swine		7.3	0.1				229.3
3.B.4 – Other							
3.B.4-a Buffalo		*NO*	*NO*				*NO*
3.B.4-b Camels		*NO*	*NO*				*NO*
3.B.4.d - Goats		*1.0*	*0.2*				*76.4*
3.B.4.e - Horses		*NO*	*NO*				*NO*
3.B.4.f - Mules and Asses		*NO*	*NO*				*NO*
3.B.4.g - Poultry		*6.8*	*3.6*				*1 144.7*
3.B.5 – Indirect N_2O emissions			1.3				333.0

3.C - Rice cultivation	**NE**	**NE**	**NE**				**NE**
3.D - Agricultural soils	**0.0**	**39.2**	**2.7**	**1 093.9**	**47.7**	**53.4**	**9 680.2**
3.D.1-Direct N_2O Emissions from managed soils			30.8				8 166.5
3.D.2-Indirect N_2O Emissions from managed soils			5.7				1 513.7
3.E - Prescribed burning of savannas	**IE**	**IE**	**IE**				**IE**
3.F-Field burning of agricultural residues	**IE**	**1.6**	**0.04**	**1.4**	**53.2**	**NE**	**54.5**
3.G - Liming	**1 890.95**						**1 890.95**
3.H - Urea application	**670.8**						**670.8**
3.I - Other carbon containing fertilisers	**NE**	**NE**	**NE**				**NE**
3.J - Other	**NO**	**NO**	**NO**				**NO**

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Table A VI. 5: Summary LULUCF sector emission table for South Africa for 2024

	Emissions						Total emissions
	(Gg)						(Gg CO_2e)
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	
4 - LULUCF	**-37 583.65**	**105.03**	**4.64**	**47.97**	**876.75**	**78.89**	**-33 411.95**
4.A - Forest land	**-55 743.95**	**14.24**	**1.16**	**17.56**	**368.24**	**51.58**	**-55 036.66**
4.A.1 - Forest land Remaining Forest land	8 118.34	8.10	0.53	7.57	196.94	40.61	8 486.16
4.A.2 - Land Converted to Forest land	-63 862.29	6.14	0.63	10.00	171.30	10.97	-63 522.82
4.A.2.a - Cropland converted to Forest Land	*-3 417.30*	*0.20*	*0.02*	*0.32*	*5.54*	*0.37*	*-3 407.05*
4.A.2.b - Grassland converted to Forest Land	*-57 097.62*	*5.63*	*0.58*	*9.22*	*157.36*	*9.83*	*-56 785.79*
4.A.2.c - Wetlands converted to Forest Land	*-850.65*	*0.07*	*0.01*	*0.08*	*1.75*	*0.26*	*-846.97*
4.A.2.d - Settlements converted to Forest Land	*-1 008.90*	*0.10*	*0.01*	*0.14*	*2.67*	*0.25*	*-1 003.14*
4.A.2.e - Other Land converted to Forest Land	*-1 487.82*	*0.14*	*0.01*	*0.23*	*3.98*	*0.25*	*-1 479.87*
4.B - Cropland	**8 083.92**	**2.53**	**0.59**	**0.09**	**3.24**	**0.27**	**8 311.11**
4.B.1 - Cropland Remaining Cropland	265.59	2.51	0.00	0.07	2.74	0.23	336.46
4.B.2 - Land Converted to Cropland	7 818.33	0.01	0.59	0.01	0.50	0.04	7 974.65
4.B.2.a - Forest Land converted to Cropland	*5 450.45*	*0.01*	*0.23*	*0.01*	*0.30*	*0.03*	*5 512.55*
4.B.2.b - Grassland converted to Cropland	*2 275.52*	*0.00*	*0.34*	*0.00*	*0.17*	*0.01*	*2 365.12*
4.B.2.c - Wetlands converted to Cropland	*33.47*	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*	*34.59*
4.B.2.d - Settlements converted to Cropland	*20.66*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*21.72*
4.B.2.e - Other Land converted to Cropland	*38.24*	*0.00*	*0.01*	*0.00*	*0.01*	*0.00*	*40.68*
4.C - Grassland	**3 047.52**	**18.54**	**1.33**	**24.41**	**406.80**	**21.89**	**3 917.92**
4.C.1 - Grassland Remaining Grassland	-15 342.11	14.55	0.95	17.65	294.14	15.85	-14 682.78
4.C.2 - Land Converted to Grassland	18 389.63	3.99	0.38	6.76	112.65	6.04	18 600.70
4.C.2.a - Forest Land converted to Grassland	*36 486.15*	*2.96*	*0.28*	*5.01*	*83.56*	*4.39*	*36 642.49*
4.C.2.b - Cropland converted to Grassland	*-1 672.66*	*0.24*	*0.02*	*0.40*	*6.74*	*0.36*	*-1 660.21*
4.C.2.c - Wetlands converted to Grassland	*-144.45*	*0.16*	*0.02*	*0.27*	*4.49*	*0.24*	*-135.94*
4.C.2.d - Settlements converted to Grassland	*-442.87*	*0.12*	*0.01*	*0.21*	*3.45*	*0.18*	*-436.37*
4.C.2.e - Other Land converted to Grassland	*-15 836.54*	*0.51*	*0.05*	*0.86*	*14.41*	*0.87*	*-15 809.27*
4.D - Wetlands	**106.81**	**69.00**	**0.25**	**4.67**	**77.75**	**4.07**	**2 105.25**

4.D.1 - Wetlands Remaining Wetlands	-20.01	10.04	0.18	3.37	56.24	2.94	309.27
4.D.2 - Land Converted to Wetlands	126.82	58.95	0.07	1.29	21.52	1.13	1 795.98
4.D.2.c.i - Forest Land converted to wetlands	*398.67*	*10.84*	*0.02*	*0.29*	*4.91*	*0.26*	*706.53*
4.D.2.c.ii - Cropland converted to wetlands	*-27.43*	*2.54*	*0.00*	*0.09*	*1.49*	*0.08*	*45.01*
4.D.2.c.iii - Grasslands converted to wetlands	*-210.24*	*26.56*	*0.05*	*0.84*	*13.97*	*0.73*	*545.54*
4.D.2.c.iv - Settlements converted to wetlands	*-5.83*	*2.54*	*0.00*	*0.02*	*0.41*	*0.02*	*65.76*
4.D.2.c.v - Other Land converted to wetlands	*-28.35*	*16.46*	*0.00*	*0.04*	*0.74*	*0.04*	*433.14*
4.E - Settlements	**-1 452.75**	**0.73**	**0.40**	**1.24**	**20.73**	**1.08**	**-1 325.73**
4.E.1 - Settlements Remaining Settlements	-3 101.65	0.60	0.39	1.02	17.05	0.89	-2 981.43
4.E.2 - Land Converted to Settlements	1 648.91	0.13	0.01	0.22	3.68	0.19	1 655.69
4.E.2.a - Forest Land converted to Settlements	*1 224.27*	*0.05*	*0.00*	*0.09*	*1.46*	*0.08*	*1 226.97*
4.E.2.b - Cropland converted to Settlements	*606.92*	*0.01*	*0.00*	*0.02*	*0.33*	*0.02*	*607.53*
4.E.2.c - Grassland converted to Settlements	*-166.86*	*0.06*	*0.01*	*0.11*	*1.77*	*0.09*	*-163.60*
4.E.2.d - Wetlands converted to Settlements	*20.38*	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*	*20.42*
4.E.2.e - Other Land converted to Settlements	*-35.80*	*0.00*	*0.00*	*0.01*	*0.09*	*0.00*	*-35.63*
4.F - Other Land	**10 093.11**	**0.00**	**0.91**	**0.00**	**0.00**	**0.00**	**10 334.48**
4.F.1 - Other land Remaining Other land	NO	NO	NO	NO	NO	NO	NO
4.F.2 - Land Converted to Other land	10 093.11	NO	0.91	NO	NO	NO	10 334.48
4.F.2.a - Forest Land converted to Other Land	*1 744.62*	*NO*	*0.01*	*NO*	*NO*	*NO*	*1 747.61*
4.F.2.b - Cropland converted to Other Land	*15.71*	*NO*	*0.00*	*NO*	*NO*	*NO*	*16.69*
4.F.2.c - Grassland converted to Other Land	*7 549.48*	*NO*	*0.75*	*NO*	*NO*	*NO*	*7 749.56*
4.F.2.d - Wetlands converted to Other Land	*749.94*	*NO*	*0.14*	*NO*	*NO*	*NO*	*786.30*
4.F.2.e - Settlements converted to Other Land	*33.34*	*NO*	*0.00*	*NO*	*NO*	*NO*	*34.32*
4.G - Harvested wood products	**-1 718.31**	**NA**	**NA**	**NA**	**NA**	**NA**	**-1 718.31**

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Table A VI. 6: Summary Waste sector emission table for South Africa for 2024

Categories	Emissions [Gg]							Total emissions (Gg CO_2e)
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SO_2	
5 - Waste	**37.05**	**628.95**	**6.03**	**NE**	**NE**	**NE**	**NE**	**19 244.71**
5A - Solid Waste Disposal		**263.46**		**NE**	**NE**	**NE**	**NE**	**7 376.74**
5A1 - Managed Waste Disposal Sites		263.46		NE	NE	NE	NE	7 376.74
5A2 - Unmanaged Waste Disposal Sites		NE		NE	NE	NE	NE	NE
5A3 - Uncategorised Waste Disposal Sites		NE		NE	NE	NE	NE	NE
5B - Biological Treatment of Solid Waste		**64.04**	**3.12**	**NE**	**NE**	**NE**	**NE**	**2 620.15**
5C - Incineration and Open Burning of Waste	**37.05**	**5.97**	**0.14**	**NE**	**NE**	**NE**	**NE**	**240.80**
5C1 - Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE
5C2 - Open Burning of Waste	37.05	5.97	0.14	NE	NE	NE	NE	240.80
5D - Wastewater Treatment and Discharge	**0.00**	**295.47**	**2.77**	**NE**	**NE**	**NE**	**NE**	**9 007.02**
5D1 - Domestic Wastewater Treatment and Discharge		126.89	2.77	NE	NE	NE	NE	4 286.59
5D2 - Industrial Wastewater Treatment and Discharge		168.59		NE	NE	NE	NE	4 720.43
5E - Other (please specify)				**NE**	**NE**	**NE**	**NE**	**NE**

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Annex VII: Supplementary information to facilitate tracking progress on implementation and achievement of South Africa's NDC

The following information is provided to facilitate tracking progress of South Africa's NDC. South Africa's updated NDC (2025) contains Information for Clarity, Transparency and Understanding in Table 3, numbered according to Annex I of decision 4/CMA.1. entry 5(a) in Table 4, that specifies that:

> "Progress and achievement will be accounted for by comparing the target ranges in 2035 with the annual emissions contained in South Africa's GHG inventory for all sectors, excluding emissions arising from natural disturbances in the land sector. Emissions arising from natural disturbances will be disaggregated in the NID for each relevant IPCC category and reported separately, and used as the basis for accounting for implementation and achievement of the NDC targets."

Natural disturbances are estimated in South Africa's national GHG inventory in the LULUCF sector. Natural disturbance includes losses/gains due to wildfires as well as losses/gains due to non-anthropogenic disturbances in forest plantations. It is included for *Forest lands* (4A), *Grasslands* (4C), *Wetlands* (4D) and *Settlements* (4E). The methodology is described in sections 6.6 to 6.11 and the approach to natural disturbance is described in section 6.5.1.

The separation of controlled fires from wildfires has started to be included in this inventory based on data that has become available. The portion of burnt area allocated to controlled fires is likely larger than currently estimated, but these numbers will be updated once more data becomes available. Note that the emissions due to fires (wildfires and controlled) includes the loss of carbon due to vegetation disturbance losses as well as the non-CO_2 emissions.

GHG emissions from natural disturbances, as well as total GHG emissions including land use, with and without natural disturbances, are contained in Table A VII. 1.

Table A VII. 1: GHG emissions from natural disturbances, and total GHG emissions (including land use) with and without natural disturbances.

	2023	2024

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GHG emissions from natural disturbances	34 136.21 Gg CO_2e	15 794.13 Gg CO_2e
Total LULUCF emissions INCLUDING emissions from natural disturbances	-12 678.94 Gg CO_2e	-33 411.95 Gg CO_2e
Total LULUCF emissions EXCLUDING emissions from natural disturbances	-46 815.15 Gg CO_2e	-49 794.13 Gg CO_2e

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DEPARTMENT OF HEALTH

NO. 7538 **29 May 2026**

NATIONAL HEALTH ACT, 2003 (ACT No. 61 OF 2003)

REGULATIONS RELATING TO RENAL DIALYSIS

The Minister of Health intends, in terms of section 90(1)*(q)* of the National Health Act, 2003 (Act No. 61 of 2003), and in consultation with the National Health Council and Office of the Health Standards Compliance, to make regulations contained in the Schedule.

Interested persons are invited to submit any substantiated comments on the proposed Regulations, or any representations they may wish to make in regard thereto, to the Director-General: Health, Private Bag X828, Pretoria, 0001 for the attention of the Deputy Director: Organ Transplant and Renal dialysis, Lindsey Jacobs, or email: lindsey.jacobs@health.gov.za within three months of this Notice.

DR PAKISHE AARON MOTSOALEDI, MP
MINISTER OF HEALTH
DATE: 8/5/2026

SCHEDULE

Definitions

1. In these Regulations any word or expression to which a meaning has been assigned in the Act, has the meaning so assigned, and unless the context otherwise indicates—

"clinical technologist" means a person registered with Health Professions Council of South Africa as a clinical technologist;

"dialysis" means a process of removing waste and excess water from the blood; and includes both haemodialysis and peritoneal dialysis modalities;

"dialysis facility" means any facility that provides any form of dialysis for adults or Children and includes home-based therapies;

"hospital" means a health establishment which is classified as a hospital by the Minister in terms of section 35 of the National Health Act, 2003 (Act No 61. of 2003);

"MEC" means the Member of the Executive Council of a province responsible for health;

"nephrologist" means a physician who has been formally trained in the diagnosis and management of kidney diseases, who is registered as a nephrologist with the Health Professions Council of South Africa;

"nephrology nurse specialist" means a nurse who is registered as such with the South African Nursing Council;

"OHSC" means the Office of the Health Standards Compliance established in terms of section 77 of the Act;

"palliative care" means an approach that improves the quality of life of patients and their families facing the problems associated with life-threatening illness, through the prevention and relief of suffering by means of early identification, assessment and treatment of pain and other problems, physical, psycho-social and spiritual;

"registered nurse" means a person registered as such by the South African Nursing Council;

"specialist physician" means a medical practitioner registered as such with the Health Professions Council of South Africa, with experience in renal care and dialysis;

"staff nurse" means a person registered as such by the South African Nursing Council; and

"the Act" means the National Health Act, 2003 (Act No. 61 of 2003).

Application of regulations

2. These Regulations apply to all public and private health establishments in the Republic of South Africa.

Licensing of renal dialysis facilities

3. (1) No person may establish a renal dialysis facility or conduct dialysis without a license issued by the Provincial Department of Health.

(2) A renal dialysis facility license is required for all dialysis facilities, except the facilities housed in state health establishments, state health establishments must register dialysis facilities with the Provincial Department of Health.

(3) Separate licenses are required for facilities not operating on the same premises even though they belong to the same entity or person.

(4) Dialysis facilities not situated within a licensed health care facility must comply with all the requirements of a dialysis facility contemplated in regulation 8 and all other regulations applicable to medical facilities.

(5) A license is not transferable and is subject to revocation by the Provincial Department that granted it, for failure to comply with all the requirements of a dialysis facility contemplated in regulation 8 and all applicable regulations to such medical facilities.

(6) A facility may be licensed only if a nephrologist or group of nephrologists or where no nephrologist is available a specialist physician with experience in dialysis formally agrees to take responsibility for the care of the patients serviced by the facility.

(7) Each patient must be assigned under the care of a nephrologist or group of nephrologists, physicians or paediatricians with experience in dialysis where a nephrologist is not available.

Application for licence

4. (1) Any person who wishes to establish a renal dialysis facility or conduct dialysis services must apply for a licence to the Head of Department of the Provincial Department of Health on a form obtainable from the Provincial Department of Health.

(2) The application for each renal dialysis facility must contain the following information:

(a) The name, address and telephone number of the renal dialysis facility;

(b) the name and address of the licensee;

(c) the name of the parties with at least five per cent ownership;

(d) the name of the person in charge of the renal dialysis facility;

(e) the name of the person in charge of the nursing services;

(f) the name, practice address and contact details of the nephrologist or specialist physician in charge of the facility;

(g) the name and contact details of the transplant coordinator;

(h) the name and contact details of the responsible clinical technologist (in Nephrology) or nephrology nurse specialist;

(i) the number of home haemodialysis patients to be served from the facility;

(j) the number of patients served by the facility on any form of peritoneal dialysis;

(k) evidence of an arrangement with medical practitioner(s) practising within five kilometres of the renal dialysis facility, who will provide emergency care and resuscitation of patients, if the responsible nephrologist or specialist physician is located off-site;

(l) evidence of an arrangement with the Emergency Medical Services or hospital to transfer and receive the patient for inpatient care;

(m) any other information the Head of Department may consider necessary for the consideration of the application; or

(n) Nephrologist or responsible overseeing medical practitioner

(3) The licensing body needs to be informed of any changes in the information in sub-regulation (1).

(4) The pre-existing dialysis facilities must apply for licences within twelve months of the date of publication of these Regulations.

(5) The Head of Department must grant or refuse the licence within 30 days after the receipt of the application, and if the application for a license is refused, the Head of Department must provide reasons in writing for such refusal.

(6) The applicant whose license has not been granted may lodge an appeal with the MEC within ten calendar days of receiving a notice of the decision from the Head of Department.

(7) The MEC may uphold or set aside the decision of the Head of Department within 30 calendar days of receipt of the appeal from the appellant.

(8) If a renal dialysis facility expands its services an addendum to the existing license must be filed with the relevant Head of Department of the Provincial Department for approval of the expansion.

(9) A license is valid for a period not exceeding four years.

(10) The application must be accompanied by a fee determined by the Provincial Department's office responsible for licensing of facilities.

Requirements for renewal of license

5. (1) Application forms for renewal of a license must be submitted at least 90 calendar days before the expiry date of the license.

(2) The application for renewal of the license must be accompanied by a fee as determined by the Provincial Department's office responsible for licensing of private facilities.

Inspection

6. (1) All renal dialysis facilities must be subjected to inspection by OHSC on a regular basis to a minimum of once every four years and or additional inspections on an *ad hoc* basis based on investigations following complaints or Early Warning System Surveillance to ensure compliance with these Regulations and Norms and Standards Regulations as published on Government Notice No. R67 in *Regulation Gazette No.* 41419 of 2 February 2018.

(2) A certificate of compliance or non-compliance must be issued by the OHSC on successful completion of its inspection.

(3) The inspections may be conducted as frequently as is necessitated by circumstances or clinical needs or as directed by the provincial authorities or deemed necessary by OHSC.

Suspension or revocation of license

7. (1) Where a non-compliance with these Regulations is found, the applicant or person responsible for the renal dialysis facility must be notified of the violation and must be given a period of 90 calendar days to take corrective measures.

(2) If non-compliance threatens the safety of patients or staff, the license must be withdrawn with immediate effect by the Provincial Department of Health.

(3) If the applicant or person responsible for the renal dialysis facility fails to take corrective measures as contemplated in sub-regulation (1), the certificate of compliance issued by OHSC and license may be suspended or revoked.

Application for change of license

8. (1) The license may not be transferred to any party when the renal dialysis facility ceases to operate.

(2) When a license is revoked it must be returned to the Provincial Department of Health within one month of the revocation.

(3) Whenever the ownership of the renal dialysis facility changes, the new owner must submit an application for a new license within 90 calendar days of such change.

(4) Failure by the new owner to acquire a license will result in the closure of the renal dialysis facility by the Provincial Department of Health.

(5) Should any licencing conditions change, the Provincial Department of Health must be notified to ensure that the facility remains compliant with the licensing conditions.

Requirements for dialysis facilities

9. (1) Every dialysis facility must comply with the guidelines for dialysis facilities in the following areas:

(a) Infection prevention, control and surveillance;

(b) sterilisation service;

(c) the provision of water for dialysis according to the Association for the Advancement of Medical Instrumentation dialysis water standards and should maintain a documented water quality monitoring and maintenance programme.

(d) the management of waste products (disposables and fluids);

(e) the supply and storage of pharmaceuticals and dialysis consumables;

(f) all requirements relating to food and beverage supply;

(g) fully equipped resuscitation trolley and dialysis chairs or beds designed to lie the patient flat for resuscitation; Cardiopulmonary Resuscitation staff training and certification

(h) the acquisition of assets, equipment and consumables;

(i) laundry and linen supply;

(j) cleaning services;

(k) engineering service including preventive and maintenance services;

(l) security of patients, staff and equipment;

(m) fire extinguishers, fire hydrants and appropriate signage, exits, evacuation plan, emergency vehicles access;

(n) medical record management;

(o) communication systems;

(p) dialysis quality assurance programme which includes monitoring of dialysis adequacy, infection rates, vascular access outcomes and other relevant clinical indicators determined by the Director-General;

(q) occupational safety;

(r) each facility must a contingency plan in the event of any interruption of dialysis services that could severely influence a patient's clinical outcomes; and

(s) patient confidentiality must be maintained, and safe storage of personal information and medical records as per relevant legislation.

(2) The dialysis facility must provide—

(a) restricted access to the dialysis treatment area;

(b) isolation cubicles for treatment of patients with contagious diseases or for arrangements for the transfer and management of patients requiring isolation;

(c) If peritoneal dialysis is offered, a dedicated area to consult with patients on this treatment must be provided for; and

(d) access for an ambulance as well as have access for stretchers and wheelchairs.

(3) A valid licence and the OHSC certificate of compliance must be displayed conspicuously.

Staff complement

10. (1) A nephrologist must be assigned to a renal dialysis facility.

(2) Where a nephrologist is not available, a specialist physician with credentialing in dialysis must be in charge of the renal dialysis facility.

(3) A nephrology nurse specialist must be in charge of the nursing component of a dialysis facility.

(4) There must be one registered nurse who is adequately trained in nephrology available, together with trained assistants or enrolled nurses; the nephrology nurse specialist to patient ratio should be one for every five patients receiving haemodialysis.

(5) There must be at least one clinical technologist (in Nephrology) available for each renal dialysis facility.

(6) Peritoneal dialysis nurses need to be specially trained in this speciality area.

(7) The patient-to-nurse ratio in the peritoneal dialysis facility must not be less than 1: 20 patients.

(8) All the facilities must designate a recipient transplant facilitator.

Clinical support services

11. Each renal dialysis facility must have access to a psychosocial service, palliative care services, a dietician as well as transplant services to address the patients' relevant needs of the patients and their families.

Shared management or transfer agreement

12. (1) Each dialysis facility must have access to a vascular surgeon or an experienced surgeon to create permanent dialysis access, including arterio-venous fistula, arterio-venous graft, tunnelled venous catheter, and tunnelled peritoneal dialysis catheter.

(2) When a patient is transferred from one renal dialysis facility to another, irrespective of whether the renal dialysis facility is private or state owned, appropriate arrangements must be made before the patient is transferred.

(3) The transfer of patients contemplated in sub-regulation (2) must be accompanied by a written comprehensive clinical report, including:-

(a) relevant clinical information, including transplant waitlisting;

(b) the prescribed medication;

(c) the dialysis prescription and the details of dialysis access;

(d) the recent laboratory and other relevant test results, including recent (less than three months) hepatitis B, C virus and HIV status tests; and

(e) the current attending doctor's name and contact details.

Patient's rights and responsibilities

13. (1) All renal dialysis facilities must have written policies, protocols and documentation on procedures, which must be available on request to patients, their guardians and next of kin.

(2) A patient must be—

(a) fully informed of their rights and their responsibilities prior to receiving dialysis;

(b) fully informed of the treatment options that are available including peritoneal dialysis, haemodialysis and transplantation.

(c) afforded the opportunity to participate in the planning of their treatment;

(d) treated with consideration, respect and full recognition of their rights and individual needs;

(e) afforded an opportunity to be assessed for eligibility for kidney transplantation and must be informed about the potential benefits of kidney transplantation; and

(f) given the right to request withdrawal from dialysis treatment.

(3) A patient entering into renal dialysis treatment must sign a form in which their consent to therapy is given.

Chronic dialysis priority setting in state health establishments

14. Where public health establishments with renal dialysis facilities are limited and prioritisation is practised, preference should be given to patients with a better

prognosis in accordance with national clinical guidelines or approved clinical protocols by the Director-General.

Establishment and composition of the Assessment Committee for chronic dialysis where prioritisation is practised

15. (1) A public health sector renal dialysis facility must establish an Assessment Committee for chronic dialysis where prioritisation is practised.

(2) The Assessment Committee must be comprised of at least a Nephrology Nurse, a Social Worker, a Medical Manager and a Nephrologist.

(3) A quorum for the committee meeting must be at least three members, including the Nephrologist or a medical practitioner with experience in renal care.

(4) The functions of the Assessment Committee are to ensure—

(a) that the clinical assessment and the decision for admission or prioritisation to the renal replacement programme (chronic dialysis and transplantation) are fair and in accordance with the criteria set out by the Director-General;

(b) that the decision of the Assessment Committee and the reasons for exclusion are conveyed to the patient or the family as soon as possible by the doctor caring for the patient in terms and language that he or she understand, and that the appeals process is explained as well;

(c) that the meeting is minuted and all decisions with reasons are clearly stated in the minutes;

(d) that the attendance register is signed by all attendees; and

(e) that there is referral pathway for palliative care if the patient is rejected for the chronic dialysis program.

Appeal procedure

16. (1) If the patient or his or her spouse or partner or parent or guardian or the siblings or children of the patient is dissatisfied with the decision of the Assessment Committee, he or she may lodge an appeal to the Chief Executive Officer of the institution within 10 working days of being informed of the committee's decision.

(2) On lodging or making a representation, the appellant or person making representation must set out clearly the basis for the appeal or representation.

(3) The CEO must—

(a) request the Assessment Committee to provide reasons for its decision;

(b) convene a meeting of the Assessment Committee to review the decision of the Committee and make an executive decision based on the recommendations of the Assessment Committee.

(c) finalise the appeal within 10 calendar days; and

(d) inform in writing the Assessment Committee and the patient or family of the decision.

Documentation and medical records

17. (1) All facilities providing dialysis must keep the medical records on a system designed to provide readily available information on each patient.

(2) All procedures, blood results, test results, treatment, clinical notes, must be adequately documented.

(3) The dialysis facility records system must provide information on:-

(a) the number of patients currently on chronic dialysis;

(b) the number of patients refused acceptance to the chronic dialysis programme and the reasons therefor;

(c) the number of patients referred and transplanted; and

(d) mortality and morbidity data.

(4) Service records of all equipment and dialysis water system

Reporting

18. (1) The facility manager must inform the patients on dialysis that all dialysis facilities are required to provide identifiable patient data to the National Department of Health, or a juristic person assigned by the department.

(2) All facilities performing chronic dialysis or kidney transplantations must submit requisite patient data and a complete questionnaire to the National Department of Health on an annual basis or within a timeframe determined by the National Department of Health or whenever there are changes to the treatment regime.

Short title

19. These Regulations are called the Regulations Relating to Renal Dialysis, 2026.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING

NO. 7539 **29 May 2026**

AMENDMENT TO THE REGULATIONS ON THE ASSESSMENT PROCESSES AND PROCEDURES FOR COMMUNITY EDUCATION AND TRAINING, NATIONAL QUALIFICATIONS FRAMEWORK, LEVEL 1

I, Mr Kgwaridi Buti Manamela, Minister of Higher Education and Training in terms of the *Continuing Education and Training Act, 2006 (No. 67 of 2008)* as amended, and as read with section 25 (2) (d) of the *Further Education and Training Amendment, 2013 (Act No. 1of 2013)* hereby amend the *Regulations on the Assessment Processes and Procedures for Community Education and Training, National Qualifications Framework, Level 1 (Government Gazette No. 36463 of 15 May 2013)* for public comments.

This gazette intends to:

1. convert the status of the June examinations into a supplementary examination;

2. repeal paragraphs of the Regulations as they pertain to the external assessment and examinations processes and procedures for the exit examination at NQF level 1 as contained in the Schedule. These paragraphs have been updated through the *National Policy Pertaining to the Conduct, Administration and Management of the examinations in Colleges established in terms of the Continuing Education and Training act, 2006 (Act no 16 of 2006), Gazette No* 45649, 17 December 2021 (National Policy).

Submissions and inputs should be submitted to the Chief Director: Education, Training, Development and Assessment via email to: *Diale.D@dhet.gov.za* not later than thirty (30) days after publication of this notice. Enquiries can be directed to the following official: Mr David Diale on cell: 067 986 4072.



MR KGWARIDI BUTI MANAMELA, MP

MINISTER OF HIGHER EDUCATION AND TRAINING

DATE: 02 / 02 / 2026

SCHEDULE

CONVERSION OF THE JUNE EXAMINATION INTO A SUPPLEMENTARY EXAMINATION

1. The *Regulations on the Assessment Processes and Procedures for Community Education and Training, National Qualifications Framework, Level 1* provide for the assessment processes for Basic Adult Education sub-levels 1-3 and NQF level 1.

2. The Regulations provide directives for assessment of programmes for Adult Education and Training (AET) programmes from sub-levels 1-3 and at NQF level 1.

3. The Regulations recognize two full examinations, one in May/June and the other in October/November annually. All the examination and quality assurance processes need to be adhered to in line with the National Policy and the Directives for Quality Assurance of Umalusi, the Quality Council.

4. A new National Policy on examinations has been developed which updates examinations activities for all examinations undertaken by the Department of Higher Education and Training ("the Department") as an Assessment Body, quality assured by Umalusi.

5. The *National Policy pertaining to the conduct, administration and management of College examinations established, declared or registered in terms of the Continuing Education and Training Act, 2006 (Act No. 16 of 2006)* has updated Chapters 3 and 4 of the Regulations pertaining to external assessment and examinations processes and procedures for the exit examination at NQF level 1.

6. Paragraphs 3.2 (4), 3.3, 3.4 (6), (10), (11) and 3.6 (2) of Chapter 3 are deleted. The whole of Chapter 4 of the Regulations is deleted.

7. The need to amend the Regulations stems from the current practices of CET Colleges of using the June examinations as a supplementary examination for November candidates. Whilst the Department and Umalusi approach the June examination as a full examination and therefore prepare processes accordingly, the number of candidates does not justify continuing with the June examination as a full examination.

8. Current institutional practices in CET Colleges utilise the June examination as a supplementary examination. The GETC: ABET: Academic Curriculum qualification, the current policy and practices regarding Site Based Assessment reinforce the need for the June examinations to be declared a supplementary examination. All candidates writing the June examinations do so without being required to re-do Site Based Assessment tasks.

9. The status of the June examination is therefore converted into a supplementary examination with effect from June 2026.

10. The Chief Directorate: National Examinations and Assessment will put in place a management plan, including a communications strategy for the conversion of the June examinations into a supplementary examination.

DEPARTMENT OF WOMEN, YOUTH AND PERSONS WITH DISABILITIES

NO. 7540 **29 May 2026**

SOUTH AFRICA SIXTH PERIODIC REPORT ON THE IMPLEMENTATION OF THE CONVENTION ON THE ELIMINATION OF ALL FORMS OF DISCRIMINATION AGAINST WOMEN (CEDAW)

The Minister of Women, Youth and Persons with Disabilities intends to present the South Africa Sixth (6) Periodic Report on the implementation of the Convention on the Elimination of Discrimination against Women (CEDAW) to the United Nations Committee on the Elimination of Discrimination against Women during June 2026. An explanatory summary of the report is hereby published in accordance with section 9 (e) of the Promotion of Access to Information Act, 2000.

The report is drafted in terms of Article 18 of the Convention on the Elimination of All Forms of Discrimination against Women.

Article 18 provides that-

(a) Every State party, upon ratifying or acceding to the Convention, undertakes, to submit, within one year of the Convention's entry into force for that State, an initial report on the legislative, judicial, administrative or other measures it has adopted to give effect to the provisions of the Convention and progress made in this respect; and thereafter periodic reports at least every four years and further whenever the Committee so requests.

A copy of the report has been attached for public comments until 12 June 2026. All the comments must be submitted to Mr. Mulisa Magidi, Department of Women, Youth and Persons with Disabilities, 268 Lilian Ngoyi Street, Pretoria, Tel: (012) 359 0396 or Mulisa.Magidi@dwypd.gov.za.

REPUBLIC OF SOUTH AFRICA

SOUTH AFRICA'S 6th PERIODIC REPORT ON THE IMPLEMENTATION OF THE CONVENTION ON THE ELIMINATION OF ALL FORMS OF DISCRIMINATION AGAINST WOMEN

This gazette is also available free online at **www.gpwonline.co.za**

INTRODUCTION

Background and Scope of the Report

1. The Government of the Republic of South Africa submits this report in accordance with Article 18 of the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW).

2. This 6th Periodic Report for the Republic of South Africa focuses on the implementation of the Convention on the Elimination of All Forms of Discrimination Against Women for the period 2015 - 2024.

3. The reporting timeframes for the current Periodic Report on the Implementation of the Convention coincides with significant developments in the national gender policy space , including the implementation of the National Strategic Plan on Gender Based Violence and femicide (NSP-GBVF, 2020 – 2030), the implementation of the Gender Responsive Planning, Budgeting, Monitoring, Evaluation and Auditing Framework (2019), 30 years of democracy (1994 -2024) in South Africa as well as the 30 Years of Beijing declaration and Platform for Action. The African Union Convention on Ending Violence Against Women and Girls (AU-CEVAWG), adopted in February 2025 and other global, Continental and regional instruments have been key in improving status of women and women's rights in the country. These played an important role in informing the principle of the Constitution of the republic and subsequent legislative frameworks particularly on the protection and promotion of women empowerment and rights.

4. This report builds upon South Africa's 5th Periodic Report (2009–2014) and incorporates recommendations from the CEDAW Committee's Concluding Observations, highlighting progress made toward achieving substantive equality between women and men.

5. The current report responds to the concluding observation issued by the Committee after the consideration of the 5th South African CEDAW Report: Progress made on the Implementation of the Convention (2009 – 2014). The

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current report gives an account on the progress made, achievements and challenges in the implementation of the Convention for the period (2015 -2024).

6. The report provide response to the General Recommendations where applicable.

7. The report is organised as follows: Introduction; Background and Scope of the Report; response to general recommendations; Progress on the Implementation of the recommendations; and Conclusion

Overview

8. The results of the 2022 Census show higher percentage of females compared to male in South Africa. The results show that the female population was 31 948 745 (51,5%) while the male population was 30 078 757 (48,5%) in 2022. The demographic trend shows that the population of Sout Africa has always reflected a high number of women from 1996 (51,9), 2001 (52,2%), and 2011 51.5%.
9. The Census data (2022) shows a higher distribution among the younger and youthful age cohorts compared to the elderly age cohorts. A slightly higher number of males were observed at ages 0–4 years, while the number of females was higher than males at advanced ages, showing a typical declining proportion of males with advancing age compared to that of females.
10. Gauteng is the only province where the proportion of females has been consistently below 50% since 1996. Limpopo (52,8%) and Eastern Cape (52,6%) had the highest proportion of females, more than the other seven provinces and the national percentage (51,5%).
11. More than two-fifths (42,4%) of the households in South Africa were headed by females in 2024. Female-headed households were most common in Eastern Cape (48.8%), KwaZulu-Natal (46.8%) and Mpumalanga (46.7%), and least common in Gauteng (37,3%) and North West (38,8%).
12. Approximately 13,9% of South African households were multi-generational, with three generations living together, while 4,2% were skip-generation households, where grandparents lived with their grandchildren (Stats-SA, GHS 2023). Skip-generation and triple-generation households are predominantly found in rural areas (27,9%) while in urban areas such structures amounted to 13,7%.

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Approximately 6,7 million grandparents stayed with 9,7 million children aged 0–17 in 2023. More than half (69,3%) were grandmothers. Furthermore, there were 3,4 million head of households' grandparents who lived with nearly 8 million children aged 0–17. Most of these were grandmothers (64,5%), while grandfathers made up 35,4%. This indicates that grandmothers play a crucial role in caregiving both at younger and older ages compared to grandfathers.

Constitutional and Legal Framework

13. South Africa's Constitution of 1996 remains the supreme law, guaranteeing equality and non-discrimination (Section 9) and affirming the right of everyone to equal protection and benefit of the law. The Constitution provides explicit recognition of gender equality as a foundational value of the Republic.

    Key legislative and policy instruments supporting gender equality include:

    a) The Promotion of Equality and Prevention of Unfair Discrimination Act (PEPUDA), 2000. This Act prohibits unfair discrimination, harassment, and hate speech. It applies across sectors (employment, education, healthcare, etc.). The Act also establishes Equality Courts for accessible justice
    b) The Employment Equity Act, 1998 promotes affirmative action in workplaces and ensures representation of women in employment and leadership
    c) The Domestic Violence Amendment Act, 2021 protects victims of domestic abuse and expanded protections under recent amendments to strengthen enforcement.
    d) The Criminal Law (Sexual Offences and Related Matters) Amendment Act, 2022 criminalises sexual offences and protects victims and strengthened in 2022 amendments to improve victim protection
    e) Maintenance Act, 1998 is intended to ensure the effective recovery of maintenance payments, primarily for children, by providing faster, more efficient legal mechanisms (especially benefiting women and children)
    f) The National Gender Policy Framework, 2000 outlines South Africa's vision for gender equality and provides a base for a comprehensive, multi-sectoral approach to achieving gender equality and mainstreaming gender issues into all government policies, practices, and programs in the country.

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g) The National Strategic Plan on GBVF (2020–2030) provide guidance in coordinating national response to Gender Based Violence focusing on Legal reforms, victim support and prevention strategies.

h) The National Development Plan 2030 (NDP Vision 2030) is South Africa's overarching framework aimed at eliminating poverty and reducing inequality by 2030. The NDP Vision 2030 prioritises the significant role of women, youth and people with disabilities in our society. Within this vision, women empowerment and gender equality are treated as cross-cutting priorities which should be mainstreamed across all sectors including economic, social, political, and institutional for developmental future and all programmes of government.

i) The Medium-Term Strategic Framework (MTSF) 2019 -2024 serves as the government's five-year implementation plan for the National Development Plan. In recognition of the multitudes of challenges confronting women, youth and people with disabilities in South Africa, the MTSF 2019 - 2024 emphasised these as cross-cutting focus areas for RSA developmental vision. This was reaffirmed by the President's declaration that in 2019, we will intensify the fight against gender-based violence and create safer communities and responsive social systems.

j) The Medium-Term Development Plan (MTDP) 2024–2029, which serves as the implementation framework for the 7th Administration of South Africa, places women's empowerment and gender equality at the centre of its developmental agenda, transitioning from the previous Medium Term Strategic Framework (MTSF). The plan, aligned with the Government of National Unity's (GNU) Statement of Intent and the National Development Plan (NDP) 2030, seeks to accelerate economic inclusion, combat gender-based violence, and mainstream gender across all government programmes

14. These frameworks collectively reinforce South Africa's commitment to addressing systemic gender inequalities, gender-based violence, and women's empowerment in all spheres.

Sustainable Development goals (SDGs)

15. South Africa has made significant progress in meeting the requirements of SDG goal 5 target, through the establishment of strong constitutional and legal frameworks. Section 9 of the Constitution explicitly prohibits discrimination based

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on sex and gender. The country has also enacted laws that criminalise gender-based violence, including sexual offences and domestic violence, and promote women's rights in areas such as employment, property ownership, political participation, and family life. In addition, institutions like the Commission for Gender Equality have been established to monitor compliance and support enforcement of gender equality measures. While South Africa's legal and institutional frameworks align well with the SDG target, challenges remain in ensuring effective implementation and enforcement across all sectors.

16. South Africa have made positive gains in the country's ability to report on the SDGs, notwithstanding the various data challenges. In the first SDG Country Report produced in 2019, South Africa was able to report on 64% of SDG indicators. Since then, there has been a noticeable improvement over time, increasing to 72% in 2023 and 89.0% in the 2025 reporting cycle. It is important to note that while the data coverage of SDG indicators for 2025 increased to 89.0%, the proportion of these indicators that have updated data points available is 80.6%. One of the reasons is the lack of new reported data points since the 2019 report because of the periodicity of certain surveys.

Parliament / Legislatures and other Institutional Mechanisms

17. The South African Parliament plays a central and constitutional role in promoting women empowerment and gender equality through law-making, oversight, budgeting, and public participation. Between 2021 and 2025, Parliament has taken several concrete steps especially in addressing gender-based violence (GBV), economic inequality, and representation of women.
18. The Joint Multi-Party Women's Caucus (MPWC) in South Africa is a cross-party parliamentary body that focuses on mainstreaming gender equality, influencing legislation, and strengthening oversight on women's issues across both the National Assembly and the National Council of Provinces. The Multiparty played a critical role in legislative influence, oversight and accountability, advocacy/ programmes, and institutional strengthening. This includes elevating Gender Based Violence as a central parliamentary oversight priority, especially in response to rising femicide and violence cases; convened sessions with the South African

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Police Service (SAPS) to assess progress on GBV cases, policing capacity, and victim support systems; monitored and influenced women's participation in electoral processes and political structures and conducted public hearings and dialogues.

19. Parliament launched the Women's Charter for Accelerated Development in 2021 which is a national framework developed through consulting women across all provinces. It builds on earlier charters (1954 and 1994) and sets a 25-year vision for improving the lives of women in South Africa. It is meant to guide government planning, budgeting, and legislation so that women's needs are fully included. As encapsulated in the Women's Charter for Accelerated Development (2021), some of the key issues for priority action hence include: effecting specific gender sensitive amendments to development policy design, budget policy and legislative framework design, including all government's strategic development programmes (which are key for anchoring mandatory, gender sensitive state actions and processes).

Institutional Mechanisms

20. The National Gender Machinery (NGM) continues to serve as the coordination mechanism for implementing CEDAW. It comprises of government, parliament, independent bodies and civil society.
21. The Minister in the Presidency Responsible for Women, Youth and Persons with Disabilities is the Executive Authority of the NGM. The DWYPD under the stewardship of the Minister, is the coordinating agent of the NGM. The Department of Women, Youth and Persons with Disabilities (DWYPD) serves as the lead coordinating ministry whilst the Commission for Gender Equality (CGE) as one of the independent oversight bodies.
22. The Gender Focal Points (GFPs) across all government departments; and municipalities serves as the institutional mechanisms for the promotion of women empowerment and gender equality.
23. The South African Local Government Association established the SALGA Women's Commission, to oversee gender transformation in local government; and established Multi-Party Women's Commission in municipalities as oversight structures for gender transformation; and a network of civil society and private sector partners promoting gender equality initiatives.

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24. The institutional framework has been strengthened through:
    a) The National Council on Gender-Based Violence and Femicide Act 09 of 2024, which establishes the National Council on Gender-Based Violence and Femicide. The Council will oversee the implementation of the National Strategic Plan in Gender Based Violence Femicide (2020 -2030).
    b) Increased budget allocations for gender-responsive programmes; and
    c) The integration of Gender Responsive Planning, Budgeting, Monitoring, Evaluation and Auditing (GRPBMEA) in government planning cycles.
25. In **response to recommendation 28 (a)** regarding **adequate human, technical and financial resources** to the Department of Women, Youth and Persons with Disabilities, Government taken steps during the reporting period (2019–2024) to strengthen the institutional capacity of the Department of Women, Youth and Persons with Disabilities (DWYPD) to effectively coordinate, monitor and evaluate the implementation of gender equality commitments, including obligations under the Convention, the budget allocation to DWYPD has remained relatively modest but stable over the Medium-Term Expenditure Framework (MTEF) period, with marginal increases to support core programmes.

Financial Year	Adjusted Budget	Actual Expenditure
2020/21	R620 976 000	R602 401 000
2021/22	R1 195 508 000	R1 164 423 000
2022/23	R991 714 000	R983 259 000
2023/24	R993 944 000	R991 625 000
2024/25	R1 020 712 000	R1 011 019 000
2025/26	R1 361 686 0000	R1 356 798 000 (Preliminary Expenditure)

26. Regarding Human Resources, the DWYPD has maintained a relatively small but specialised workforce. As of 31 March 2025, the Department's staff establishment comprised 140 approved posts, of which 125 were filled and 15 vacant, reflecting a vacancy rate of 10,7%. The staff complement includes Policy analysts and gender specialists, Monitoring and evaluation experts, Programme and stakeholder coordination officials, Administrative and corporate support staff.
27. The Department has made progress in strengthening its technical capacity through development and rollout of the Gender Responsive Planning, Budgeting, Monitoring, Evaluation and Auditing (GRPBMEA) Framework, monitoring tools for

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the NSP-GBVF, and Capacity building for mainstreaming which is also rolled-out across government.

28. In response to **recommendation 28(b) on number of Gender Focal points, The National Gender Policy Framework** makes provision for the establishment of gender units with GFPs in all government departments and local government. According to its integrated approach, each provincial and local GFP maintains the autonomy to determine its own programme towards gender equality, guided by the "generic" principles outlined in the Policy Framework, and informed by the specific needs of the local contexts where they are located. The NGM Diagnostic Review Report demonstrate that Gender Focal Points are neither positioned to serve as the strategic interface between women's empowerment and government planning and implementation, nor as an effective interface between government and communities.
29. The Department of Public Service and Administration continues to encourage departments to implement the Gender Responsive Planning, Budgeting, Monitoring, Evaluation and Auditing framework, which requires that Gender Focal Persons be appointed at the Director level and report to the Office of the Director General. This provides a clear governance framework for strengthening the authority, institutional positioning, and participation in decision-making of Gender Focal Persons within departments. Progress remains uneven across departments, as this provision has not yet been fully implemented, and Gender Focal Persons are still largely designated at the Deputy Director level. The current focus, therefore, remains on reinforcing compliance with the prescribed institutional arrangement to strengthen gender mainstreaming capacity and participation in departmental decision-making structures.

Socio-Economic Context

30. Between 2015 and 2024, South Africa experienced both advances and challenges in achieving gender equality:
    a) South Africa is among the better-performing countries globally in female political representation. Women's representation in Parliament stood at 43.45% following the 2024 National Elections.

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b) Access to education for girls continued to improve. South Africa has achieved near gender parity in education, particularly in basic and tertiary enrolment. Women increasingly outperform men in higher education participation.

c) The gain in education is not translating into equal labour market outcomes. The skills mismatches and structural unemployment limit returns on education. This shows that education alone has not been sufficient to overcome systemic gender inequality in economic participation.

d) Women remain disproportionately affected by unemployment and economic exclusion. Women's unemployment remained high (35.4% in 2024), and participation in the labour force also remains unequal

e) The challenge of gender-based violence and femicide (GBVF) persists at higher rates. GBV was declared a national disaster in 2025 under the National Disaster Management Act. This is a recognition that dealing with this scourge demands exceptional measures. This classification strengthens the mandates of the respective government departments dealing with the scourge.

f) The COVID-19 pandemic (2020–2022) exacerbated gender inequalities, particularly in informal employment and care responsibilities.

g) South Africa's National Development Plan is geared towards addressing the triple challenge of reducing poverty, unemployment and inequality. Women are disproportionately affected by poverty, unemployment, unpaid care work, gender-based violence (GBV), poor access to economic opportunities, and unequal leadership representation.

h) The current reporting period is taking place a year after South Africa's G20 presidency in 2025. South Africa positioned the Empowerment of Women Working Group (EWWG) as a key platform to advance a practical, development-oriented agenda on gender equality. South Africa framed this work within the broader G20 Presidency theme of "Solidarity, Equality, Sustainability", and anchored the EWWG around three policy priorities:

   (i) The care economy (paid and unpaid care work and household responsibilities)

   (ii) Promoting financial inclusion of and for women

   (iii) Addressing gender-based violence and femicide (GBVF)

i) Government of South Africa resolved to dedicate the next five years (2024 – 2029) to actions that will advance three strategic priorities. These are; (i) to

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drive inclusive growth and job creation;(ii) to reduce poverty and tackle the high cost of living; and (iii) to build a capable, ethical and developmental state.

31. The government's response emphasized social protection, economic empowerment, and inclusion through programmes such as the Women's Economic Assembly (WECONA), Women Empowerment Fund, and Expanded Public Works Programme (EPWP) for women.
32. Social protection measures have mitigated extreme poverty but has not reduced structural inequality. A large proportion of households depend on grants, which are often accessed and managed by women. They play a central role in household survival but remain economically vulnerable.

PART I ARTICLE 1 -6

Article 1: Definition of discrimination against Women

33. The Constitution of the Republic of South Africa fully incorporate the definition of discrimination as espoused by the Convention. As reported in the previous reports, the Constitution provides for the enactment of national legislation to prevent or prohibit unfair discrimination and to promote the achievement of equality. Key legislations that provide for the define discrimination include the following:
34. Discrimination is defined in the anti-discrimination law of the country, **Promotion of Equality and Prevention of Unfair Discrimination Act** (PEPUDA) (Act 4 of 2000) as a" any act or omission, including a policy, law. rule. practice, condition or situation which directly or indirectly (a) imposes burdens, obligations or disadvantage on; or (b) withholds benefits, opportunities or advantages from, any person on one or more of the prohibited grounds. The "prohibited grounds listed in the anti-discrimination law of South Africa includes: (a) race, gender, sex, pregnancy, marital status. ethnic or social origin, colour, sexual orientation, age, disability, religion, conscience. belief, culture. language and birth; or (b) any other ground where discrimination based on that other ground - (i) causes or perpetuates systemic disadvantage: (ii) undermines human dignity; or (iii) adversely affects the equal enjoyment of a person's rights and freedoms in a serious manner that is comparable to discrimination on a ground in paragraph.
35. In Response **to recommendation 20 (a)** regarding the adoption of comprehensive gender equality law, the Republic of South Africa is in the process in the process

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of developing the Promotion of Women's Rights, Empowerment and Gender Equality Bill. This Bill which will be introduced in parliament according to section 73 of the Constitution of the Republic of South Africa, 1996, (the Constitution) in 2026. This legislation will give effect to section 9 of the Constitution of the Republic of South Africa, 1996, in so far as the empowerment of women and gender equality is concerned; to establish a legislative framework for the empowerment of women; to align all aspects of laws and implementation of laws relating to women empowerment, and the appointment and representation of women in decision making positions and structures.

36. The objects of this legislation (Act) are to give effect to the letter of the Constitution, in particular: the equal enjoyment of all rights and freedoms by every person; the promotion of equality, specifically gender equality; to prohibit discrimination on the basis of gender and to make it an offence to discriminate on the basis of gender; to facilitate compliance by designated entities with provisions of this Act; to give effect to the country's commitments in terms of applicable international conventions; and to facilitate the implementation of the relevant legislation to promote women empowerment, appointment and representation of women in decision – making position and structures.

37. With regard to the **definition of discrimination against women that covers both direct and indirect discrimination** in the public and private spheres, including intersecting forms of discrimination, in accordance with articles 1 and 2 of the Convention, Section 9 (Equality Clause) of the Constitution prohibits direct and indirect discrimination by the state (public sector) and by private persons or organizations (private sector).
38. The Promotion of Equality and Prevention of Unfair Discrimination Act (PEPUDA), 2000 gives effect to Section 9 of the Constitution and applies to both public and private sectors. This legislation prohibits unfair discrimination on the grounds of gender, sex, pregnancy, marital status, and more. It covers discrimination in employment, education, health care, housing, and access to services and establishes Equality Courts to hear complaints of discrimination.

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39. **In response to recommendation 20 (b) on the question of substantive equality into law and strengthening existing legislations**, Section 9(2) of the Constitution of the Republic explicitly promotes substantive equality, allowing for affirmative action and measures designed to protect or advance disadvantaged groups. It states: "Equality includes the full and equal enjoyment of all rights and freedoms. To promote the achievement of equality, legislative and other measures designed to protect or advance persons disadvantaged by unfair discrimination may be taken."

40. Substantive equality is operationalised through legislations such as Promotion of Equality and Prevention of Unfair Discrimination Act (PEPUDA), 2000, Employment Equity Act (EEA), 1998, Broad-Based Black Economic Empowerment Act (BBBEE), 2003.

Article 2: Duty of state and measures to eliminate discrimination

41. The South African Constitution protects all individuals from discrimination. Chapter 2 of the Constitution contains a Bill of Rights. Regarding equality and non-discrimination, section 9 provides specifically that: (9)

(1) Everyone is equal before the law and has the right to equal protection and benefit of the law.

(2) Equality includes the full and equal enjoyment of all rights and freedoms. To promote the achievement of equality, legislative and other measures designed to protect or advance persons, or categories of persons, disadvantaged by unfair discrimination may be taken.

(3) The state may not unfairly discriminate directly or indirectly against anyone on one or more grounds, including race, gender, sex, pregnancy, marital status, ethnic or social origin, colour, sexual orientation, age, disability, religion, conscience, belief, culture, language and birth.

(4) No person may unfairly discriminate directly or indirectly against anyone on one or more grounds in terms of subsection

42. Furthermore, Section 9 of the Constitution provides for the enactment of national legislation to prevent or prohibit unfair discrimination and to promote the

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achievement of equality; This implies the advancement, by special legal and other measures, of historically disadvantaged individuals, communities and social groups who were dispossessed of their land and resources, deprived of their human dignity and who continue to endure the consequences.

43. Sections 9(3) and 9(4) prohibit direct or indirect discrimination (policies or laws which, though neutral in their formulation, have a discriminatory impact on certain individuals or groups of individuals) on a host of grounds. The grounds on which discrimination is expressly prohibited in terms of Section 9(3) includes race, gender, sex, sexual orientation, pregnancy, marital status, ethnic or social origin, colour, age, disability, religion, conscience, belief, culture, language and birth. However, it must be noted that this list is by no means exhaustive and there is nothing to preclude discrimination on any additional ground that is not included within the ambit of Section 9(3).

44. The Republic of South Africa demonstrated the duty of the state to eliminate discrimination against women during the current reporting period by developing new legislations and strengthening existing legislations protecting women from violence and inequality, implementing interventions to promote and protect the rights of women in social, economic and decision making.

Legislative Measures

a) The **Promotion of Equality and Prevention of Unfair Discrimination Act, 2000 (PEPUDA or the Equality Act, Act No. 4 of 2000)** is a comprehensive South African anti-discrimination law. It prohibits unfair discrimination by the government and by private organisations and individuals and forbids hate speech and harassment.
b) To promote equality and prevent unfair discrimination at workplace, South African government enacted the **Employment Equity Act, 1998 (Act 55 of 1998).** The Act prohibits discrimination based on various grounds, including gender, and

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mandates affirmative action to address past disadvantages experienced by designated groups, primarily women and previously disadvantaged racial groups.

The Chapter on Unfair Discrimination provides that no person may discriminate against an employee on, among others, the grounds of sex, gender, family responsibility, and pregnancy and HIV status. The Act prohibits testing of an employee's HIV status unless permission is granted by the Labour Court. Most of those suffering from HIV are women. The definition of family responsibility includes same sex partnerships and partnerships outside of marriage, the definition of pregnancy includes circumstances relating to termination of pregnancy and intended pregnancy.

The Act explicitly provides that harassment, including sexual harassment, is a form of unfair discrimination. This is the first time in our law that there is a direct, legislated remedy for sexual harassment.

The Chapter on Affirmative Action expressly includes women as a designated group in respect of whom positive steps must be taken to ensure their equitable representation in the workforce and eradication of all barriers to equal participation and advancement in the workplace.

c) **Basic Conditions of Employment Act, 1997 (Act 75 of 1997)** regulates conditions in the workplace such as hours of work and leave. It provides that an employee is entitled to at least four months maternity leave at any time from four weeks before the expected date of birth. The employee may not return to work for six weeks after the birth of the child unless she receives medical clearance. Paternity leave of three days is also provided. Protection is provided for the health of pregnant women. Employers are prohibited from requiring or permitting a pregnant or nursing employee from performing work that is hazardous to her health or that of her child. If pregnant workers cannot do their usual work because it is dangerous for them or their unborn child, employers must find other work for them to do. The Act requires the Minister to issue a Code of Good Practice on the Protection of Pregnant Employees during Pregnancy. These provisions fulfill the CEDAW obligation to provide special protection to women during pregnancy in

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types of work proved to be harmful to them. This improves job security for women, thus reducing the vulnerability to poverty and workplace violence such as sexual harassment.

d) **Prevention and combating of Hate Crimes and Hate speech Act No 16 of 2023**. This Act criminalizes hate crimes and hate speech and establishes measures to prevent and combat them. Its purpose is to give effect to the country's constitutional and international obligations regarding discrimination based on factors like race, religion, and sexual orientation. The Act defines hate speech and hate-crimes, sets out penalties, and includes provisions for enforcement and victim support.

e) **Other instruments & bodies** — Labour Relations Act (labour remedies), Sexual Offences legislation (criminal law response to GBV), the Commission for Gender Equality (monitoring, investigations), and international commitments (e.g., CEDAW reporting).

45. **On the number and outcome of cases in which provisions of the Convention have been invoked, applied or referred to annually in court proceedings, the following are examples of such cases.**

The table below shows some examples of known cases with reference to the Convention (CEDAW):

Year	Known Cases Involving CEDAW References	Outcome
2022	Women's Legal Centre Trust v President (Muslim marriages) — CEDAW was analyzed and used to argue the state's obligations regarding equality for women in marriage contexts.	The Constitutional Court confirmed Parliament's obligation to address discriminatory gaps in marriage recognition
2023	EB (born S) v ER (born B) and Others; KG v Minister of Home Affairs and Others [2023] ZACC 32 - Constitutional Court case involving property rights and	Constitutional Court confirmed discrimination; ordered legislative remedy

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	discrimination in marriage dissolution. CEDAW was cited by the Commission for Gender Equality as part of arguments about state obligations under Article 16	
2025	Zondi v S (AR333/2024) [2025] ZAKZPHC 108 (24 October 2025): The court explicitly referenced South Africa's international obligations under the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) in the context of legislative efforts to combat gender-based violence (GBV).	The High Court dismissed an appeal against a sentence for domestic violence offenses, specifically assault with intent to do grievous bodily harm and contravention of a protection order. The appellant in Zondi v S appealed the severity of the sentence he received from the Regional Court for domestic violence charges, including assault with intent to do grievous bodily harm. The High Court emphasized the commitment within South African law to address domestic and gender-based violence. The court noted that the Domestic Violence Act considers the state's international obligations to end violence against women and children, including those under CEDAW.

Detailed information on the cases:

46. The case between the Women's Legal Centre Trust v President of the Republic of South Africa and Others (CCT 24/21) [2022] ZACC 23; 2022 (5) SA 323 (CC); 2023 (1) BCLR 80 (CC) (28 June 2022), the Constitutional Court recognised international

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law and gender equality principles (including CEDAW) in interpreting domestic equality protections related to Muslim marriages and discrimination.

47. This application was brought by the Women's Legal Centre Trust concerning the persisting non-recognition of marriages solemnised in accordance with the tenets of Sharia law (Muslim marriages), which has resulted in the infringement of fundamental rights of parties to Muslim marriages, and Muslim women and children, for far too long. The Women's Legal Centre Trust has asked this Court to confirm an order of the Supreme Court of Appeal that declared certain provisions of the Marriage Act [1] and the Divorce Act [2] unconstitutional.

In a detailed judgment, the High Court analysed some of the difficulties faced by women married according to Sharia law, as well as the children born in such marriages. The High Court held that compared to women in civil and customary marriages, women in Muslim marriages are unfairly discriminated against on the listed grounds. The High Court held further that the fact that women in Muslim marriages have the option in law to register their marriages and still choose not to, does not absolve the President and Cabinet of their constitutional duty to protect their rights. The High Court reasoned that the lack of recognition infringes on the dignity of Muslim women. When a husband in a Muslim marriage obtains a unilateral divorce through the Talãq, this leaves most women in Muslim marriages without adequate safeguards to obtain the kind of relief granted upon divorce in a civil court.

The High Court held further that children born of Muslim marriages do not enjoy the same protections and privileges as children born in civil or customary marriages. In the case of a divorce where children born in civil or customary marriages are involved, the courts assume an automatic judicial oversight role and are obliged to consider the best interests of the child. This is different for children born of Muslim marriages, who are not provided with the same automatic court supervision. Therefore, the Court concluded, the non-recognition of Muslim marriages infringes the best interests of the child.

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The High Court found that there is systemic violation of the rights to equality, human dignity, access to courts, and children's rights. Furthermore, the erosion of these rights triggers duties imposed upon the state under section 7(2), which require the state to respect, protect, promote and fulfil the rights in the Bill of Rights. The question it had to consider was whether the state has an obligation to regulate Muslim marriages comprehensively rather than it happening in a piece-meal fashion in the courts.

In answering whether there is an obligation on the state to enact legislation to address the hardships faced by women in and children born of Muslim marriages, the High Court considered South Africa's obligations under international law. It analysed the United Nations Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), the International Covenant on Civil and Political Rights (ICCPR), the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol) and the SADC Gender and Development Protocol (SADC Protocol), which have been signed and approved by Parliament and ratified, but not domesticated, through an enactment under section 231 of the Constitution. Having found that there is an obligation on the state to enact legislation to address the hardships faced by women in and children born of Muslim marriages, the High Court concluded:

"While the State has the authority to determine how it fulfils its section 7(2) duty, this must necessarily be in line with the Constitution. In this instance, given the nature of the rights violations, in the context of the complexity and the importance of marriage, the only reasonable means of fulfilling the section 7(2) duty is through the enactment of legislation.

This interpretation of section 7(2) is aligned with the international obligations that South Africa has taken. As was held in Glenister, the conclusion that in the specific context of this matter the only reasonable means of fulfilling the section 7(2) duty is through the enactment of legislation, may be found without resort to South Africa's international obligations. But to do so would be to disregard section 39(1). Moreover, these international obligations whilst not creating binding and

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enforceable rights within South Africa, lend much interpretive weight to what is reasonable under section 7(2)."

Example 2 of the reference Case

48. **Zondi v S (AR333/2024) [2025] ZAKZPHC 108**

49. The appellant in Zondi v S appealed the severity of the sentence he received from the Regional Court for domestic violence charges, including assault with intent to do grievous bodily harm. The High Court emphasized the commitment within South African law to address domestic and gender-based violence. The court noted that the Domestic Violence Act considers the state's international obligations to end violence against women and children, including those under CEDAW.

50. The court referenced a South African Law Reform Commission paper that cited a UN CEDAW Committee call for South Africa to reform its domestic violence legislation, providing context for the country's legislative actions to protect victims. While CEDAW was mentioned to contextualize the severity and legislative intent of minimum sentences for domestic violence offenses, it was not the deciding factor in the appeal. The appeal focused on whether "substantial and compelling circumstances" justified a deviation from the minimum sentence.

51. The appellant argued that traditional compensation (payment of two goats) and time in custody should be considered substantial and compelling circumstances. However, the High Court rejected this, stating that traditional arrangements cannot undermine the dignity of abused women or the purpose of minimum sentencing legislation for GBV. The appeal against the sentence was dismissed, and the original sentences were upheld, as the court found no error by the lower court and no compelling reasons to reduce the sentence.

52. This case illustrates how the South African judiciary incorporates international human rights standards in applying domestic law, particularly in the ongoing effort to combat gender-based violence.

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Women's Access to Justice

53. South Africa continued to strengthen measures aimed at enhancing women's access to justice, with particular emphasis on addressing gender-based violence and femicide, domestic violence, and sexual offences. This was undertaken through legislative reform, institutional strengthening and the implementation of the National Strategic Plan on Gender-Based Violence and Femicide (2020–2030).
54. Key measures included the strengthening of specialised justice mechanisms and survivor-centred services, including Thuthuzela Care Centres, Sexual Offences Courts, and integrated support services intended to improve reporting, case management, prosecution and victim support.
55. At the end of the 2024/25 reporting period, there were 65 Thuthuzela Care Centres (TCCs). These centres are a critical part of South Africa's anti-rape strategy, aiming to reduce secondary victimisation and to build a case ready for successful prosecution as part of the government's commitment to integrated service delivery.
56. The online application for protection orders is a significant contribution to reducing secondary victimisation and facilitating access to justice.
57. Efforts to combat sexual violence, especially against women and children include the reintroduction of the Sexual Offences Courts in the country with the aim to (i) reduce secondary victimisation often suffered by the victims when they engage with the criminal justice system, particularly the court system; (ii) reduce the turnaround time in the finalisation of these cases; and (iii) improve the conviction rate in sexual offence cases. As of April 2022, 116 regional courts were upgraded to Sexual Offences Courts
58. Despite the reported progress and developments, implementation gaps, capacity constraints and service delivery challenges continued to impede the full and effective realisation of women's rights in practice especially in resource-poor contexts, such as rural areas. These include delays in the investigation and finalisation of cases, inconsistent implementation and enforcement of protection measures, limited access to legal, psychosocial and court support services, particularly in rural, poor and underserved communities. The absence of fully equipped GBV desks, specialised services (especially for people with disabilities), and safe access for LGBTQIA+ persons at several points remains a challenge and widens the gap. Rising accounts of secondary victimisation have also been noted.

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59. In **response to recommendation 22 (a)** on ensuring that Legal Aid South Africa has adequate human, technical and financial resources to deliver on its mandate, Legal Aid SA has a national footprint of 64 Local Offices and 64 Satellite Offices managed by six Provincial Offices. The Local Offices and Satellite Offices provide court coverage of the criminal courts nationally. The National Operations Department, headed by the Chief Operations Officer, is responsible for the implementation and oversight of the Act within Legal Aid SA.

60. On financial resources, Legal Aid South Africa faces financial constrains due to mandated annual 10% budget cut which has resulted in the reduction of budget for the MTEF period 2024/2025 – 2025/2027. The budget cut and shortfall remain a high risk that may hinder Legal Aid South Africa from executing its mandate. The MTEF Allocation indicates budget reductions for Legal Aid South Africa of R229 million in 2024/25, R239 million in 2025/26 and R250 million in 2026/27.

	2023/2024	2024/2025	2025/2026	2026/2027
Original MTEF allocation	R2,189,449,000	R2,398,856,738	R2,471,781,820	R2,591,977,428
Baseline reduction	R186,683,000	R228,777,000	R239,024,000	R249,975,00
Percentage reduction	8,5%	9,5%	9,7%	9,6%
Tolerable reduction	5,0%	5,0%	5,0%	5,0%
Excess	3,5%	4,5%	4,7%	4,6%
Percentage excess	70,6%	90,7%	93,0%	93,0%
Source	**Legal Aid SA Strategic Plan 2025 - 2030**			

61. In terms of human resources, Legal Aid SA renders legal representation at State expense, where substantial injustice would otherwise result, as contemplated in the Constitution. The Entity's Planned Court Coverage Plan ensures that Legal Practitioners are available at all courts to ensure that all accused persons who qualify for assistance in legal representation for sexual offence matters can access legal representation. Experienced Legal Practitioners with at least five years of post-admission experience are assigned to courts where sexual offence matters are adjudicated. Legal Aid SA covers all identified Sexual Offences Courts on a 'practitioner per court' model.

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The table below demonstrate that there has been a slight increase in the number of sexual offence cases from the previous financial year, not only in actual numbers (26,311) but also in terms of the percentage of sexual offence matters measured against the total matters for Legal Aid SA (from 6.41% to 7.57%). It is still, however, still lower than the 2021/2022 financial year.

Sexual Offences matters over the past 4-year period

Province	2021/2022		2022/2023		2023/2024		2024/2025	
	Sexual Offences Matters	Total Legal Aid SA Criminal Matters	Sexual Offences Matters	Total Legal Aid SA Criminal Matters	Sexual Offences Matters	Total Legal Aid SA Criminal Matters	Sexual Offences matters	Total Legal Aid SA Criminal Matters
Eastern Cape	4,825	45,962	3,251	43,559	3,487	43,943	4,415	45,045
Free State/ North-West	3,763	41,387	2,889	40,768	3,276	43,539	4,377	47,479
Gauteng	2,794	52,488	2,272	54,039	2,323	52,411	3,070	59, 782
KwaZulu - Natal	4,110	47,914	3,666	52,254	3,941	54,838	5,114	60,529
Limpopo/ Mpumalanga	3,542	35,356	3,082	36,992	3,132	38,156	4,088	41,905
Northen Cape/ Western Cape	5,425	83,233	4,445	89,238	4,200	84.,602	5,247	93,031
Total	**24,549**	**306,340**	**19,605**	**315,750**	**20,359**	**317,488**	**26,311**	**347,771**
% of total	**7,98**		**6,21%**		**6,41%**		**7,57%**	

Article 3 - Equality - Guarantee of Basic Human Rights and Fundamental Freedoms

62. The Republic of South Africa remains fully committed to the implementation of Article 3 and reports herein on measures adopted, progress achieved, challenges encountered and future priorities during the reporting period.
63. The Constitution of the Republic of South Africa, 1996, establishes equality, human dignity and non-sexism as founding values. Section 9 guarantees equality before the law and prohibits discrimination on the grounds of sex, gender, pregnancy, marital status and related grounds.

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64. To realise the implementation of Article 3 of the Convention, South Africa has enacted comprehensive legislations.

65. While several legislations have been highlighted in the previous reports, the following significant gender legislation and frameworks were introduced during the current reporting period, most notably related to addressing the scourge of gender-based violence (GBV) and reinforcing the existing national policy framework including:

a. **The Gender Responsive Planning, Budgeting, Monitoring, Evaluation and Auditing Framework (GRPBMEA)**. The framework was approved by Cabinet in 2019 and sets out the country's approach to mainstreaming gender across the public policy cycle. The framework describes the problem statement, provides a comprehensive overview of the policy and legislative landscape, articulates the approach to GRPBMEA and identifies implementation priorities and the roles and responsibilities of critical departments in this regard. Fundamentally, the GRPBMEA is about turning policy commitments into actions and results by integrating them into government policy cycle.

b. **National Strategic Plan on Gender-Based Violence and Femicide (NSP on GBVF):** This is a comprehensive, multi-sectoral national framework for tackling all forms of violence and abuse against women and children. Since its adoption in 2020, several new interventions have been implemented including: (i) extensive legal reform; (ii) support for survivors through the provision of evidence kits at police stations; (iii) psychological and social services; (iv) the establishment of a GBVF Response Fund; (v) support for Thuthuzela and Khuseleka Care Centres, which provide vital services for GBV survivors; and (vi) dedicated financial resources to the implementation of the six pillars of the plan, including the economic empowerment of women.

c. **National Council on Gender-Based Violence and Femicide Act, 9 of 2024**: This crucial legislation was enacted in May 2024 to provide a statutory framework for establishing the National Council on Gender-Based Violence and Femicide (NCGBVF). The Council is tasked with providing strategic leadership and overseeing the implementation of the NSP on GBVF.

d. **Criminal Law (Sexual Offences and Related Matters) Amendment Act (Amendments):** Various amendments have been made to existing laws, including the Criminal Law (Sexual Offences and Related Matters) Amendment

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Act Amendment Act 13 of 2022, The Criminal and Related Matters Amendment Act 12 of 2022, and The Domestic Violence Amendment Act 14 of 2022, to enhance victim protection, improve court processes, and ensure stricter sentencing for perpetrators of GBV.

e. **Dedicated Gender Based Violence desks:** Government is making progress in establishing dedicated desks at police stations in GBVF hotspots. The desks are staffed by police officers who are specifically trained to provide victim-centred assistance and support.

f. **Medium-Term Strategic Framework (MTSF) 2019-2024:** Gender was specifically prioritised as a cross-cutting focus area within this national planning framework, aiming to mainstream gender considerations into all government programs and interventions, with a strong emphasis on women's economic empowerment and transforming unequal gender relations.

66. Government continues to undertake legislative, administrative and judiciary measure towards the realisation of equality between men and women.

Mechanisms to promote and protect equality and discrimination against women and girls.

67. The South African government has adopted a multi-layered approach which include legal, institutional, policy-driven, and programmatic measures to promote gender equality and combat discrimination and violence against women and girls since the last reporting period.

68. As reported in the previous section, government focused on strengthening legislative frameworks through amendments and new laws, especially targeting gender-based violence (GBV) and introduction of new legislations. Specifically, the National Council on Gender-Based Violence and Femicide (NCGBVF) Act 9 of 2024 which is a landmark piece of legislation in South Africa aimed at strengthening the national response to gender-based violence and femicide (GBVF) through the establishment of a statutory body to provide strategic leadership in eliminating GBVF.

69. In response to **recommendation 10(a) (CEDAW/C/ZAF/5) regarding awareness raising of women's human rights** among traditional and community leaders and the general public, the Department of Women, Youth and Persons with Disabilities in collaboration with the Department of Justice and Constitutional Development

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have partnerships with traditional leadership institutions, civil society, faith-based organisations, schools and local communities towards the implementation of the National Strategic Plan on Gender-Based Violence and Femicide (2020 -2020).

70. South Africa has also prioritised the engagement of traditional leaders and traditional institutions. This has included training and sensitisation of Houses of Traditional Leaders on gender-based violence and femicide, consultative engagements with traditional leaders, and community imbizos aimed at strengthening awareness of women's rights and addressing harmful social norms.
71. Government used annual national public campaigns to increase awareness of women's rights and challenge discriminatory social norms. Government has consistently implemented and supported nationwide advocacy under the 16 Days of Activism for No Violence Against Women and Children, within the 365-day programme of activism rather than a once-off annual event. These campaigns are used to communicate that violence against women is a human rights violation, to promote help-seeking, and to mobilise communities, men and boys, local leaders and institutions
72. Furthermore, government is implementing the National Intervention Strategy on Sexual Orientation, Gender Identity, Expression and Sex Characteristics (NIS SOGIESC) 2023–2027 (2023-2027) which is a key policy framework guiding South Africa's coordinated, multi-sectoral response to violence, discrimination, and inequality experienced by persons of diverse SOGIESC. The Department of Justice and Constitutional Development provides targeted training initiatives to support the effective implementation of this strategy.

73. During the 2024/2025 financial year, Department of Justice and Constitutional Development delivered training to strengthen the capacity of the Provincial Task Teams by promoting a deeper understanding of the Strategy, encouraging interactive and participatory learning approaches, and fostering collaboration. Further objectives of the training included the integration of National Intervention Strategy on Sexual Orientation, Gender Identity, Expression and Sex Characteristics principles at the service delivery level, raising awareness and promoting equality across the public service, and improving the mapping and prosecution of SOGIESC-based hate crimes. By strengthening the identification, documentation, and prosecution of such offences at municipal, provincial and

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national levels, the training contributed to ensuring the equal enjoyment of rights and protections for all, irrespective of sex, gender, or sexual orientation. A total 204 participants were trained on the National Intervention Strategy on Sexual Orientation, Gender Identity, Expression and Sex Characteristics during the 2024/2025 financial year.

Article 4: Special measures aimed at accelerating equality between men and women

74. Republic of South Africa prioritise Gender Equality and Women Empowerment through the enactment of progressive legislations and promotion of human rights. This is demonstrated through the ratification of several international, continental and regional instruments.
75. Between 2016 and 2024, South Africa implemented several special measures and legislative reforms aimed at accelerating gender equality, focusing particularly on combating gender-based violence (GBV), promoting economic empowerment, and increasing representation in decision-making.
76. Promotion of and implementation of the **Gender-Responsive Planning, Budgeting, Monitoring, Evaluation, and Auditing (GRPBMEA)** framework across the different spheres of government is one of the special measures to accelerate equality between men and women. Currently, the Department of Women, Youth and Persons with Disabilities in collaboration with the Department of Planning, Monitoring and Evaluation and the National Treasury has put in place the Guidelines on assessment of draft strategic plans and annual performance plans for all government departments. The Guidelines assist departments to align the Strategic Plans and Annual Performance Plans to the priorities and rights of WYPD. The Strategic Plans and Annual Performance Plans of all departments are assessed for responsiveness to gender, youth and disability.
77. GRPBMEAF is implemented across all spheres of government with all National Departments submitting reports periodically on the implementation of the different pillars of the framework.
78. National Treasury is championing the implementation of **Gender Responsive Budgeting** in collaboration with the DWYPD, DPME and Statistics South Africa. The Gender Responsive Guidelines have been developed and are currently being

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rolled out. The tools included Gender Expenditure Tagging, Gender Budget Statements, Gender Impact Assessments. Government of South Africa is piloting the GRB with 11 National Departments during the 2025/26 financial years.

40% Procurement Target

79. Government of South Africa is committed to utilise procurement to drive women's empowerment. This commitment is demonstrated by the President's pronouncement in 2020 of a **40% procurement target for all government procurement to be allocated for Women Owned Businesses** (WOBs). This commitment requires national, provincial, and local government departments to create economic opportunities for women, with monitoring and reporting mechanisms implemented to track progress.

(i) The enactment of the **Public Procurement Act 28 of 2024**, marks a significant milestone towards the incorporation of gender equality and empowerment provisions into the legal framework. The Act prioritises procurement from businesses owned by women, youth, and persons with disabilities, making inclusion a statutory consideration in awarding government contracts. This Act also create a legal basis for affirmative procurement set-asides, strengthen support for inclusive participation in public tenders and provides a framework to operationalise the 40 % target.

(ii) **The Women's Economic Assembly** (WECONA) was launched in 2021 to enable women-owned enterprises to participate in local industry value chains. The WECONA plays a pivotal role in promoting women's economic empowerment by embedding them into essential value chains within sectors such as agriculture, manufacturing, automotive and other sectors. Through collaboration with provincial governments and private-sector leaders, WECONA creates and sustains critical procurement and supplier opportunities. WECONA's impact aligns directly with the goal of reaching 40% preferential procurement for women-owned enterprises.

(iii) **Presidential Employment Stimulus**: The Presidential Employment Stimulus (PES) is a large-scale government initiative launched in October 2020 by President Cyril Ramaphosa. It was introduced as part of South Africa's

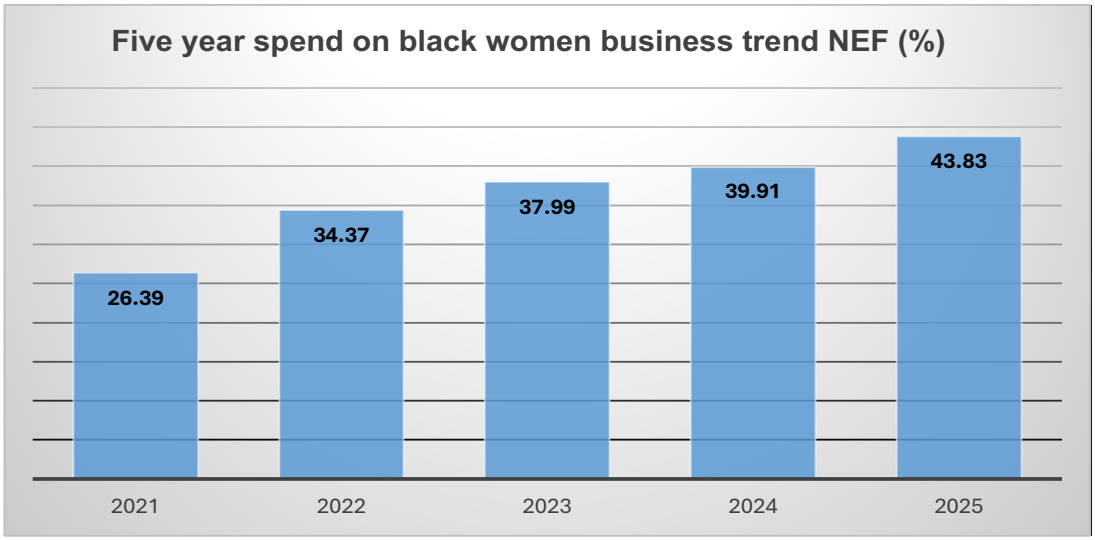
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Economic Reconstruction and Recovery Plan (ERRP) to respond to the deep economic and labour market fallout caused by the COVID-19 pandemic. The programme is coordinated centrally by the Presidency and implemented through a 'whole of government' approach, with various national departments, provinces, municipalities, and partners (civil society, business) involved. The Presidential Employment Stimulus and Presidential Youth Employment Intervention have made a difference in the lives of many thousands of women in the country. These initiatives have enabled the most rapid expansion of public employment in South African history. Reports show that 66% of Presidential Employment Stimulus beneficiaries are women and 70% of the Presidential Youth employment Intervention opportunities are secured by young women. Approximately 1.7 million beneficiaries have been reached.

(iv) **National Empowerment Fund (NEF):** The NEF is dedicated to advancing economic transformation by increasing support for black-owned enterprises, particularly those led by women, youth, and people living with disability. Through targeted funding, the NEF fosters a more inclusive economy by helping these groups access financial resources, participate in key sectors, and contribute to national growth. The NEF Women Empowerment Fund is aimed at accelerating the provision of funding to businesses owned by black women using a range of funding instruments. The NEF disbursed 38.6% of its fund to businesses owned by women, youth and people living with disability during the 2024/2025 financial year. These groups often face compounded challenges, including limited access to finance and markets.

The graph below depicts the procurement trend from 2021 to 2025. The data shows that there has been an increase in the procurement from majority black-women-owned business from 26.39% in 2021 to 43.83% in 2025. This demonstrates efforts to support and empower black-women-owned businesses (National Empowerment Fund Integrated Report, 2025).

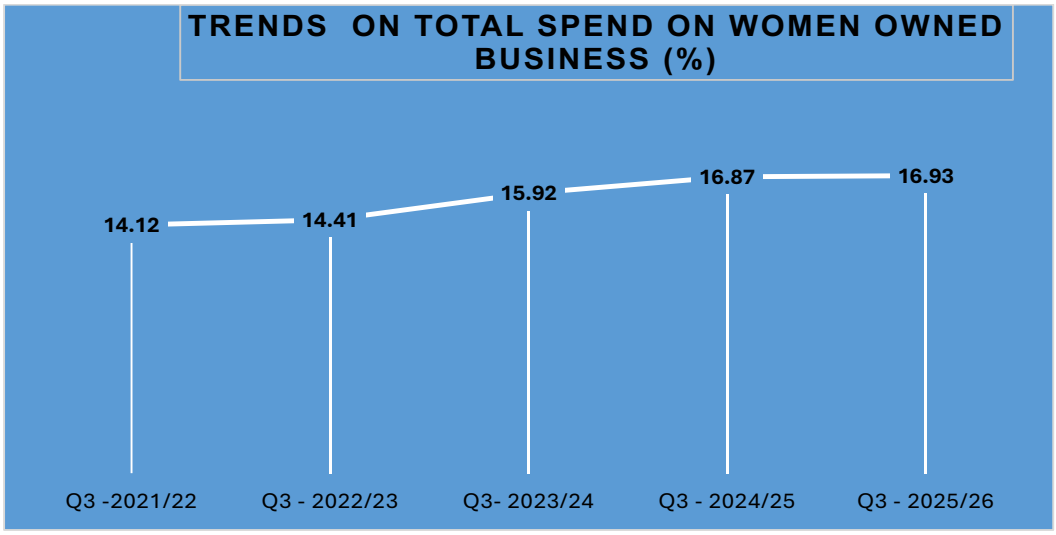
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NEF

Progress

80. Despite commitment made by the President in 2020 and various initiatives available data shows that less than one-fifth of procurement spend benefited women-owned enterprises. Data on the graph below demonstrate spending on women-owned businesses remains limited, accounting for only 17% of total expenditure (National Treasury).



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81. To address the triple challenge of poverty, inequality and unemployment in South Africa, the government has committed to the Economic Reconstruction and Recovery Plan (ERRP), which includes the economic empowerment of women, the youth and persons with disabilities. At local government level, government has introduced the District Development Model (DDM) which is centred on empowering the marginalised population by advocating for integrated government coordination in addressing economic, environmental and social challenges over a prolonged period which transcend municipal, provincial and national election cycles.

82. Government of the Republic of South Africa acknowledges that women in different socio-economic domains, geographic locations, and sexual orientation experience barriers to access opportunities. However, significant strides have been made in other domains such as education, where gender parity is reached and in closing the gender gap in rates of adult literacy. In terms of representation in decision-making positions, significant progress has been made in reaching gender equity in the public sector. For example, in 2019, females in senior management accounted for 42,4%, and those in middle management positions accounted for 45,2% which increased to 45,2% for senior management accounted and 41,6 % for middle management positions in 2024.

Article 5: Measures to address Sex Role Stereotyping and prejudice

83. The National Strategic Plan on Gender Based Violence and Femicide (2020 – 2030) provides direction on addressing issues of sex role stereotyping and prejudice through Pillar Two: Prevention and Rebuilding Social Cohesion. Under this Pillar, there are specific outcomes that guides all implementing stakeholders to address stereotyping and prejudice. These include objective 2.2: Changed behaviour and social norms within key groups because of the rollout of evidence-based prevention interventions; and Objective 2.3: Shifts away from toxic masculinities towards embracing positive alternative approaches for expressing masculinities and other sexual and gender identities, within specific communities/groups.

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84. South Africa is implementing the **Revised National Intervention Strategy on Sexual Orientation, Gender Identity, Expression, and Sex Characteristics (SOGIESC): 2023–2027**. This is an intersectional, survivor-focused, and evidence-driven policy approved by Cabinet in August 2023. It aims to prevent and respond to violence, discrimination, and hate speech against persons of diverse sexual orientation, gender identity, expression, and sex characteristics (SOGIESC). The strategy strengthens institutional, legislative, and, and, accountability mechanisms, elevating the National Task Team (NTT) to Deputy Minister level to coordinate a multi-sectoral approach. The Strategy is aligned with the National Strategic Plan on Gender-Based Violence and Femicide (NSP GBVF) and acknowledges the layered vulnerabilities experienced by persons of diverse SOGIESC—particularly those who also face marginalisation due to an intersection of race, class, disability, nationality, or migration status.
85. The National Intervention Strategy on SOGIESC is not a government document alone it is a community-owned instrument. Its implementation is driven by the National Task Team (NTT), Provincial Task Teams (PTTs), and the Rapid Response Team (RRT), supported by subcommittees focusing on legal reform, public education, data monitoring, and social cohesion. The strategy creates space for meaningful participation by civil society, intergovernmental forums, Chapter 9 institutions, and affected communities themselves.
86. A total of 13 activities were undertaken to enhance the effectiveness of the established SOGIESC National and Provincial Task Teams were undertaken during the 2024/2025 financial year. These include Nine workshops on the revised National Intervention Strategy on SOGIESC with Provincial Task Teams (NC, FS, EC, KZN, MP, GP, LP, NW and WC) and one quarterly National Task Team meeting (DOJ&CD Annual Report, Vote 25, 2024/2025).
87. South African Justice System plays a critical role in preventing prejudice based on gender stereotyping. For example, through the case of: *VJV and Another v Minister of Social Development and Another (CCT 94/22) [2023] ZACC 21; 2023 (10) BCLR 1250 (CC); 2023 (6) SA 87 (CC) (29 June 2023).* The Constitutional Court handed down judgment in an application for confirmation of constitutional invalidity granted by the High Court of South Africa, Gauteng Division, Pretoria (High Court). The High Court declared section 40 of the Children's Act 38 of 2005 (Children's Act) unconstitutional to the extent that it excludes permanent life partners as the

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recipients of automatic parental rights and responsibilities arising from the birth of children born because of artificial fertilisation. It ordered that the words "permanent life partner" be read in after the word "spouse" and "husband", wherever such words appear in section 40 of the Children's Act (impugned provisions). The applicants, two women in a permanent life partnership, held a desire to have their own children and to establish their own family. choice made by married partners. Its impact rendered it manifestly unfair, and the Court concluded that the impugned provisions resulted in unfair discrimination based on marital status.

88. In instances where the Marriage legislation discriminates against women, the Courts intervened to the provisions unconstitutional. For example, *in Jordaan and Others v Minister of Home Affairs and Another (CCT 296/24) [2025] ZACC 19*, the South Africa's Constitutional Court delivered a landmark ruling declaring that men have the right to adopt their wives' surnames upon marriage, striking down legislation that the court found constituted unfair gender discrimination. While acknowledging that the law deprived men of naming choices, the Constitutional Court emphasised that the discrimination had far more profound implications for women in South African society. "The discrimination is far more insidious for women. It reinforces patriarchal gender norms, which prescribe how women may express their identity, and it makes this expression relational to their husband, as a governmental and cultural default." The Constitutional Court's decision represents a significant step toward gender equality in South African family law, dismantling legal structure rooted in patriarchal traditions.

Crime against Women

89. The challenge of crime and violence against women violates their human rights and directly undermines their fundamental freedoms and dignity. While the South African Police Service are implementing the Integrated Crime and Violence Prevention Strategy (2022) to reduce contact crime against women and children; there has been an increase in the reported incidence of contact crime against women 18 years and above over the past years. The reported the reported incidence of contact crime against women increase Increased, by 15,6% from 155 062, in 2020/21 to 179 208, in 2021/22; increased, by 8,1% from 179 208, in 2021/22 to 193 669, in 2022/23, and increased, by 4,6% from 193 669, in 2022/23 to 202 633, in 2023/24.

Actions prioritized by South Africa to address gender-based violence

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90. In 2020, South Africa adopted a National Strategic Plan on Gender Based Violence and Femicide (2020 – 2030) (referred to as the NSP on GBVF) as a society-wide programme to end gender-based violence and femicide. The Plan is organized around six pillars, which are aimed at: (i) Accountability, coordination and leadership; (ii) prevention; (ii) strengthening the criminal justice response; (iv) providing support, care and healing to survivors; (v) Economic power; and (vi) research and evidence- based monitoring. The NSP on GBVF provides a multi-sectoral, coherent strategic policy and programming framework to ensure a coordinated national response to the crisis of GBVF by South Africa collectively.
91. **End Gender Based Violence and Femicide (GBVF) 100-Day Challenges in municipalities**
92. The End GBVF 100-Day Challenges use a structured approach to accelerate and localise the implementation of the National Strategic Plan to end Gender-Based Violence and Femicide. Teams set ambitious 100-day goals and developed innovative plans through intense collaboration, continuous innovation and disciplined implementation. The movement is supported by various stakeholders, that is government, civil society and the private sector.

93. A 100-Day Challenge lasts 100 days and consists of a clear goal, a dedicated team and a focused plan. It is a structured project with defined stages and outcomes. Key takeaways include commitment to ambitious but believable goals, achieving real impact within 100 days, inclusive participation, experimentation, adaptive leadership and healthy competition between teams. 100-Day Challenges harness the urgency of crisis conditions without creating a crisis, encouraging intense collaboration, frequent innovation and rapid implementation.

94. The participation of the municipalities in the 100-Day Challenges Programme emanates from the 2023 SALGA Women's Commission (SWC) National Lekgotla resolution adopted on 28 September 2023. The resolution committed SALGA to supporting municipalities to participate in the 100-Day Challenge as a mechanism to support the localisation of the implementation of the National Strategic Plan on Gender-Based Violence and Femicide (NSP on GBVF). The programme has demonstrated significant scale-up, with municipal participation increasing from 13

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municipalities in 2023, 38 in 2024 to 50 municipalities in 2025 across all nine provinces.

95. Municipal commitments include formal agreements, budget alignment, communication support and participation in monitoring and reporting. Key achievements included development of integrated GBVF work plans and transition from 100-day plans to 365-day implementation cycles. Impact examples included increased youth participation in positive activities, improved victim support services and strengthened collaboration with other role players. Municipal initiatives established GBV hotlines and help desks operating 24/7, adopted trial-and-error approaches to improve referral systems and achieved improved accountability and service coverage. Results showed improved GBVF-related performance, system insights, transformative leadership experiences and sustained improvements beyond the 100-day period.

96. The following actions were prioritised in line with the pillars of the NSP: (i) accountability has been strengthened across government system for implementation through institutionalisation of the NSP on GBVF and enforcement of compliance with monthly reporting by government departments to the President; (ii) establishment of an Inter-Ministerial Committee on GBVF which provides political guidance and oversight; (iii) GBVF Response Fund established and functional; (iv) END GBVF established and functional as a multi-sectoral structure driving collaborative implementation; (iv) ring-fenced funding for secretariat functions towards the establishment of a National Council on Gender Based Violence and Femicide since 2020 –R5 Million per financial year since 2020; (v) Parliamentary oversight framework in place; (vi) establishment and revitalisation of existing coordination structures at provincial, district and local levels established in some areas.

97. Critical priority actions taken in the last five years by South Africa to address GBVF included strengthening of certain legislations as well as introducing new laws to protect women and children from abuse and violence. In January 2022, the President assented to three pieces of legislation targeted at strengthening the country's response to the increasing scourge of GBVF: (i) the Criminal Law (Sexual Offences and Related Matters) Amendment Act; (ii) the Criminal and Related Matters Amendment Act; and (iii) the Domestic Violence Amendment Act.

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98. **In Response to recommendation 12. (a)** on **the establishment of the National Council on Gender Based Violence and Femicide as well as resourcing**, South Africa has made substantial legislative and institutional progress towards the establishment of the National Council on Gender-Based Violence and Femicide (NCGBVF) as a permanent statutory mechanism to coordinate the national response to gender-based violence and femicide. The enactment of the National Council on Gender-Based Violence and Femicide Act, 2024 (Act No. 9 of 2024) into law on 24 May 2024 which subsequently came into operation on 15 November 2024 serves as a key milestone. The commencement of the Act gave legal effect to the establishment of the Council as a statutory body mandated to provide strategic leadership, coordination, oversight, monitoring and accountability in the prevention of and response to GBVF in South Africa.
99. Following the enactment and commencement of the legislation, South Africa moved into the operationalisation phase of the NCGBVF. Progress has included the initiation of processes to appoint the Council's governing structures and to transition from an interim coordination arrangement to a fully functional statutory institution. Parliament's Portfolio Committee on Women, Youth and Persons with Disabilities has played an oversight role in this regard, including overseeing processes relating to the appointment of members to the Council. Parliament finalised the interviews for candidates to serve on the National Council in March 2026. This represents a significant step towards constituting the Council's leadership and enabling it to begin functioning in accordance with the Act. On the question of resources to ensure that the National Council is able to fulfil its critical functions, National Treasury has approved the Council as a separate sub programme with ring-fenced funds from 1 April 2026.
100. In response to the call for the establishment of a permanent national multi-sectoral coordinating body, the President assented and launched the National Strategic Plan on Gender-Based Violence and Femicide (NSP-GBVF) in April 2020. To formalise the NSP-GBVF, the National Council on Gender-Based Violence and Femicide Act, Act 9 of 2024, was signed into law on 24 May 2024 and came into operation on 15 November 2024. The Act establishes the Council as a statutory body responsible for providing strategic leadership and co-ordination in the prevention of, and response to GBVF. The Council acts through its Board, comprising seven (7) representatives from civil society and the private sector to be

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appointed by the President from a list of persons recommended with a supporting vote of a majority of the members of the National Assembly, and eight (8) representatives from specific defined organs of state nominated by their respective ministers. Parliament advertised the positions from civil society and the private sector, conducted interviews, undertook security clearances and recommendations have been made to the President.

101. Processes have been undertaken to have the National Council classified as a national public entity in terms of the Public Finance Management Act, 1999. Regulations are being drafted as intended in the Act to prescribe norms and standards for the co-ordination and accountability of provincial and local GBVF structures.

102. National Treasury issued a 2026 MTEF Preliminary Allocation in which allocations have been made to operationalise and strengthen the capacity of the National Council on Gender-Based Violence and Femicide over the medium-term framework, namely R48.085 million in 2026/27, R49.976 million in 2027/28, and R52.186 million in 2028/29.

103. An Induction Manual has been developed as recommended in the King V Code on Corporate Governance to familiarise new members with the complex legal, regulatory, and political environment in which Council will operate.

104. In response to **recommendation 12(b)** on the resourcing for implementation of the National Strategic Plan on Gender Based Violence and Femicide, the funds are made available through the voted funds of different line function departments which are the implementing departments inline with their mandate. The Gender Based Violence Private Sector Fund 1 which was launched by the President on the 3rd of February 2021 to raise, manage and allocate resources effectively to strengthen the national response to GBV is responsible for disbursing financial resources to civil society.

105. Notably, the National Council on Gender-Based Violence and Femicide Act was assented into law by the President on 24 May 2024. This landmark legislation is a critical step forward in ensuring the safety and protection of women and children from abuse and violence, as it seeks to facilitate the establishment of a National Council as a statutory body charged with providing strategic leadership in the fight against gender-based violence and femicide in South Africa. This multi-sectoral Council will draw on the expertise of all stakeholders, which includes government,

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civil society, labour, business/corporate South Africa, researchers, academics and others, to strengthen national efforts to combat gender-based violence, using a more inclusive, focused and better resourced approach.

106. The **classification of Gender Based Violence and Femicide as a National Disaster in November 2025** is a major milestone which recognises that dealing with this scourge demands exceptional measures. This classification strengthens the mandates of the respective government departments, such as Social Development, Justice, Health, Police and Basic Education, to tackle GBVF. The classification will allow for expanded access to shelters, safe spaces, psycho-social counselling and community-based prevention programmes. It will enable faster emergency resource allocation for survivor services, enhanced monitoring and reporting mechanisms, and strengthen oversight.

107. **South Africa has also placed priority on accelerating prosecution on GBVF cases in the country.** In terms of increased prosecution of perpetrators for rape and other forms of GBV by gender/ sex, age and disability shows that: (i) conviction rate for femicide prosecutions stood at 91.9% in 2022/2023; and (ii) the conviction rate for sexual offences was 74.9% 2022/2023, while the conviction rate in intimate partner femicide was at 92.2% in 2022/2023. The table below shows Gender Based Violence and Femicide conviction rates.

	2020/2021	**2021/2022**	**2022/2023**
Conviction rate in femicide prosecution	231 (94.3%)	396 (94.3%)	91.9% 475/517
Conviction rate in intimate partner femicide prosecution	190 (93.1%)	316 (93.8%)	92.2% 356/386
Conviction rate in sexual offences	75.8% 2 539/3 349	74.2% 3 402/4 584	74.9% 3 451/4 606

108. In response to Concluding Observation (CEDAW/C/ZAF/5) and **recommendation contained in para 10 (b)** on systematic training for judges, prosecutors, police officers and other law enforcement officers, training is offered by different institutions in line with their mandate. The South African Judicial Education Institute (SAJEI) provide judicial education to judges, magistrates and those who aspire to be judicial officers. During the 2024/2025

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reporting period, a total of 450 Magistrates, 163 court administrators and 884 justice and court administrative personnel received training on the sexual offences and related matters.

109. The National Prosecuting Authority provided sexual offences training to a total of 1103 officials during the 2024/2025 financial year as detailed below:

Training interventions	No of sessions	No Officials
Sexual offences	3	175
Trafficking in persons	3	192
Ad hoc training	22	264
Human Trafficking institute	1	112
TCC Stakeholders	20	187
Military police	1	35
Court Preparation	2	138
Total	**52**	**1103**

Source: SORMA Annual Reports

110. All prosecutors are trained to implement the Sexual Offences and Related Matters Act and ensure impactful prosecutions which has resulted in the National Prosecuting Authority consistently achieving a target of 70% conviction rate.

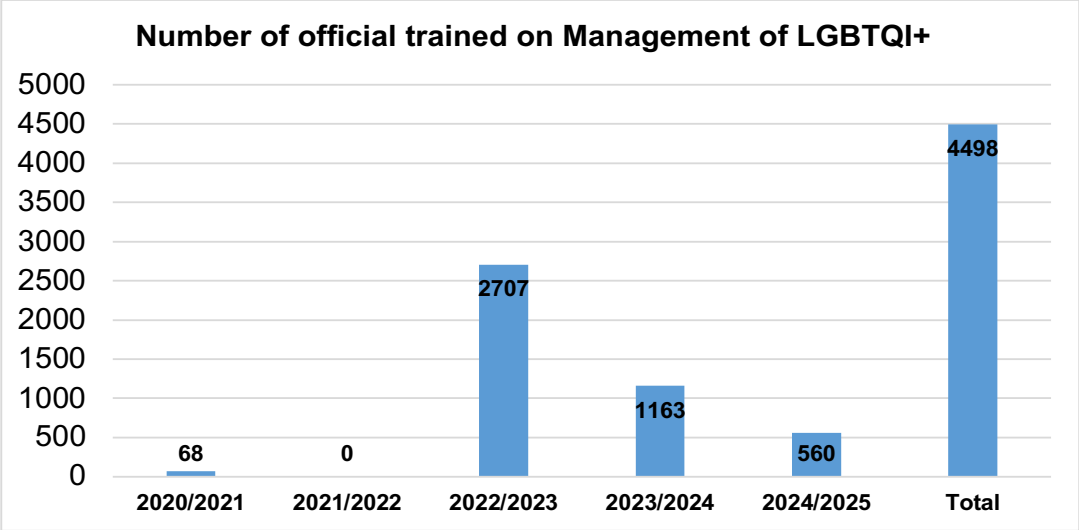
Convictions on Sexual offences cases

Financial Years	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025
Conviction %	75.8%	74.2%	74.9%	72.3%	70.5%
Actual convictions	2539	3402	3451	3813	3724
Finalised cases	3349	4564	4606	5276	5283

Source: SORMA, 2024/2025

111. The Department of Correctional Services provide training to correctional service officials on the management of Lesbians, Gays, Bisexual, Transgender, Intersex, and Queer, Asexual Plus (LGBTIQA+) inmates. The graph below shows that a cumulative number of 4 498 correctional service officials received training on LGBTQI+ management between the financial year 2020/2021 and 2024/2025.

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Source: SORMA Annual Reports, 2020/21 – 2024/25

112. In response to Concluding **Observation (CEDAW/C/ZAF/5) and recommendation contained in para 10 (c)** regarding strengthening of victim support services, the National Strategic Plan on Gender Based Violence and Femicide (2020-2030) is the point of departure for South Africa. In this regard, the Department of Social Development (DSD) provides psychosocial services to victims of crime and violence. This is in line with the Pillar 4 (Response, Care, Support and Healing) of the NSP-GBVF. The main intervention under this pillar is strengthening existing response, care and support services in ways that are victim centred, and survivor focused and trauma informed to facilitate recovery and healing.

113. The National Prosecuting Authority working with our partners in government and through innovative partnerships with the private sector has resulted in the accelerated expansion of Thuthuzela Care Centres (TCCs) to 66 facilities nation-wide. The integration of survivor-centred services has reduced secondary trauma, improved conviction rates and enhanced the success of prosecutions. Over the 2024/2025 reporting period, 44 147 victims were supported through the multi-sectoral TCC model, ensuring the uncompromising priority of justice for victims of sexual and domestic violence.

114. The South African Police Service and the NPA, through its Sexual Offences and Community Affairs Unit, has prioritised DNA backlogs, initially in respect of gender-based violence and femicide matters, and later expanded to include

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murder matters. The initiative has, since its implementation in October 2020, reaped substantial successes: to date, a total of 58 177 DNA reports have been sent to court prosecutors to expedite cases. This has also given rise to a prioritisation project targeting serial rapists, linked through DNA, across the country.

115. Regarding the issue of adequately funded shelters and safe houses, the Department of Social Development carries the responsibility to establish Shelters for victims of crime and violence particularly abused women and their children. These include the establishment of White Doors (safe places of hope) and Khuseleka One Stop Centres. The Sheltering services are provincial located and managed. Together with the Department of Public Works and Infrastructure (DPWI), the Department of Social Development is progressing with identification of infrastructure/buildings to be handed over for the purpose of GBV as part of the Emergency Response Plan on GBV led by the Presidency. The Strong intersectoral collaboration led the Department of Public Works and Infrastructure (DPWI) resulted in 46 buildings made available for shelters and interim housing for survivors of Gender Based Violence.

Summary of the Sheltering Service (2024/2025)

Province	Number of Shelters	Number of White doors	Number of Khuseleka	No of admissions
Gauteng	17	44	-	1456
Western Cape	31	-	01 (Civil Society)	2050
Mpumalanga	26	01	-	295
KwaZulu-Natal	46	10	-	2386
North West	17	01	01 (State owned0	4946
Eastern Cape	15	146	01 (State owned)	1485
Northern Cape	09	02	-	199
Limpopo	02	1	01 (State owned)	672
Free State	07	01	-	186
Total	**170**	**206**	**04**	**13 675**

Source: SORMA Annual Report – 2024/2025 (Department of Social Development pp27)

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116. The establishment and rollout of Rapid Response Teams (RRTs) at the local level are reported to be mechanisms for providing timely responses to victims. Despite these efforts, the lack of standardisation and norms guiding shelters across the country, coupled with uneven service delivery and limited access to specialised services, remains a challenge for survivors and continues to be a point of contention for affected communities.

117. In **response to recommendation 14 (b)** on the adoption of legislation to specifically criminalise domestic violence and femicide, the Domestic Violence Amendment Act 14 of 2021 was signed into law in January 2022. The Domestic Violence Amendment Bill amends the Domestic Violence Act 116 of 1998 to address practical challenges, gaps and anomalies which have manifested since the Act came into operation in December 1999. In particular, the amended legislation includes new definitions, such as “controlling behaviour” and “coercive behaviour”, and expands existing definitions, such as “domestic violence”, to include spiritual abuse, elder abuse, coercive behaviour, controlling behaviour, and/or exposing/subjecting children to certain of listed behaviours. The Domestic Violence Amendment Bill also introduces online applications for protection order against acts of domestic violence and imposes obligations on functionaries in the Departments of Health and Social Development to provide certain services to victims of domestic violence. The Amendment Bill also aligns the Domestic Violence Act with the provisions of the Protection from Harassment Act 17 of 2011.

118. **In response to recommendation 14 (c)** regarding the adoption of the domestic Violence bill, the Criminal and related matters bill and Criminal Law (sexual offences and Related Matters) Amendment Act bill, all the amendment bills were signed into law in January 2022. The enacted legislation is a deliverable from the National Strategic Plan of Gender-based Violence and Femicide, which was called for at the November 2018 Presidential Summit against Gender-Based Violence and Femicide (GBVF).

119. **In response to recommendation 14 (d)** on ensuring that all cases of domestic violence and femicide are investigated and prosecuted including issuance of protection orders, South Africa has strengthened measures to ensure that domestic violence and femicide cases are reported, investigated, prosecuted and adjudicated in accordance with national law and policy. The Domestic Violence Act, as amended, together with related legislation and the National Strategic Plan on

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Gender-Based Violence and Femicide, provides for the protection of victims, the duties of police officials, and accountability for perpetrators. The Domestic Violence Amendment Bill amends the Domestic Violence Act 116 of 1998 to address practical challenges, gaps and anomalies which have manifested since the Act came into operation in December 1999. The Domestic Violence Amendment Bill also introduces online applications for protection order against acts of domestic violence and imposes obligations on functionaries in the Departments of Health and Social Development to provide certain services to victims of domestic violence.

120. However, despite this progress, challenges remain, including underreporting, case attrition and implementation gaps.

121. On the issue of provision of statistical data on scope and extent of domestic violence and other forms of gender-based violence as highlighted in **recommendation 14 (e),** South Africa's First South African National Gender-Based Violence Study was released by the Human Science Research Council at the end of 2024. This report detailed the prevalence of physical, sexual, emotional, psychological and economic violence experienced by women across all nine provinces.

Article 6: Trafficking in Women and exploitation of prostitution

122. The republic of South Africa adopted the Prevention and combating of Trafficking in Persons National Policy Framework in April 2019. This framework seeks to ensure all government departments and other engaged stakeholders from civil society are collectively guided in the implementation of anti-trafficking responses and of their statutory responsibilities. In particular, the NPF intends to support the implementation of the Prevention and Combating of Trafficking in Persons, 2013 (Act No. 7 of 2013), as reported in the 5th periodic report. As a strategic planning tool, the national policy framework is also key to secure political and financial support and to ensure rational use of resources and effective responses. The framework included an integrated Strategy and Action Plan (2019 – 2022).

123. South Africa have adopted an integrated and collaborative approach to address trafficking in persons. Through this approach, South Africa identified 234 identified victims of trafficking who were rescued and assisted during the 2024/2025 financial

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year. A National Intersectoral Committee on Trafficking in Persons (NICTIP) is in place and convenes quarterly and comprises relevant government departments and civil society organisations. In addition, there are Provincial Task Teams and Rapid Response Teams that are operational in all nine provinces - supporting localised anti-trafficking responses. The Frontline personnel are trained using integrated Standard Operating Procedures to ensure uniform victim identification and referrals.

124. Multi-disciplinary victim support services - comprising psychosocial, medical, legal and shelter support - are available to all identified victims. The Department of Social Development, the National Prosecuting Authority's Thuthuzela Care Centres and our civil society organisations play an invaluable role in victim support.

125. Through a network of accredited shelters and designated safe houses, protection and accommodation is available to trafficking victims. Government, with the assistance of civil society and other stakeholders, have intensified the coordinated efforts to prevent and combat trafficking. These initiatives are bearing fruit, as South Africa was upgraded to Tier Two in the 2024 US Department of State's Trafficking in Persons Report.

126. About 32 new trafficking prosecutions involving 57 accused persons have been instituted during the 2025/2026 financial year. There are 67 ongoing trafficking cases involving 156 accused persons and 428 charges - across various courts in South Africa.

127. In the 2024/25 financial year, 23 TIP cases, involving multiple accused persons, were finalized with a verdict. In 11 cases the accused persons were convicted of 146 Trafficking in Persons counts. In ten cases, the accused were convicted of other offences. Thirty-four (34) sentences of life imprisonment were imposed for ten accused. Sentences of 20 years were imposed for a further eight accused and two accused persons received sentences of ten years. This means that 20 convicted persons received long-term prison sentences of 10 years or more for TIP convictions.

128. In May 2025, the High Court convicted three perpetrators of trafficking in persons for the purpose of exploitation and kidnapping of Joshlin Smith. The Court found that she was sold for slavery or practices like slavery and handed down sentences of life imprisonment for human trafficking and 10 years for kidnapping to all three convicted persons.

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129. Prevention through education and community empowerment is critical to curbing trafficking in persons. To suppress trafficking in women and exploitation, the National Prosecuting Authority provides several public education and awareness programs through out the country. During the 2024/2025 financial year, a total of 991 sessions were coordinated focusing on different subject matters including trafficking in persons specifically for sexual exploitation of victims including children.

Article 7: Elimination of Discrimination against women in Political and public life

130. Gender equality is a constitutional human right in South Africa. The Constitution of the Republic of South Africa, 1996 (the Constitution), is the overarching legal framework which protects the rights of the citizens. Section 9 of the Bill of Rights (Chapter 2 of the Constitution) stipulates the intent of promoting women's economic emancipation and participation. The Constitution is supported by various Acts of Parliament and other legal policy instruments related to women's empowerment and gender equality as reported in South Africa's 5th CEDAW Report.

131. On the issue of women's participation and representation in political levels, the Electoral Code of Conduct of the South African Electoral Act (Act 73 of 1998) (Section 2) states that every registered party and every candidate must: (i) respect the right of women to communicate freely with parties and candidates; (ii) facilitate the full and equal participation of women in political activities; (iii) ensure the free access of women to all public political meetings, marches, demonstrations, rallies and other public political events; and (iv) take all reasonable steps to ensure that women are free to engage in any political activities.

132. South Africa signed and ratified the SADC Declaration on Gender and Development which requires States Parties to endeavour by 2015, at least fifty percent of decision-making positions in the public and private sectors are held by women including the use of affirmative action measures. South Africa has aligned itself to the 50/50 gender parity principle for women at all political and decision-making levels in the country. The current draft bill on the Promotion of Women's Rights, Empowerment and Gender Equality in South Africa. The Bill is intended to give effect to section 9 of the Constitution of the Republic of South Africa, 1996, in

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so far as the empowerment of women and gender equality is concerned; to establish a legislative framework for the empowerment of women; to align all aspects of laws and implementation of laws relating to women empowerment, and the appointment and representation of women in decision making positions and structures.

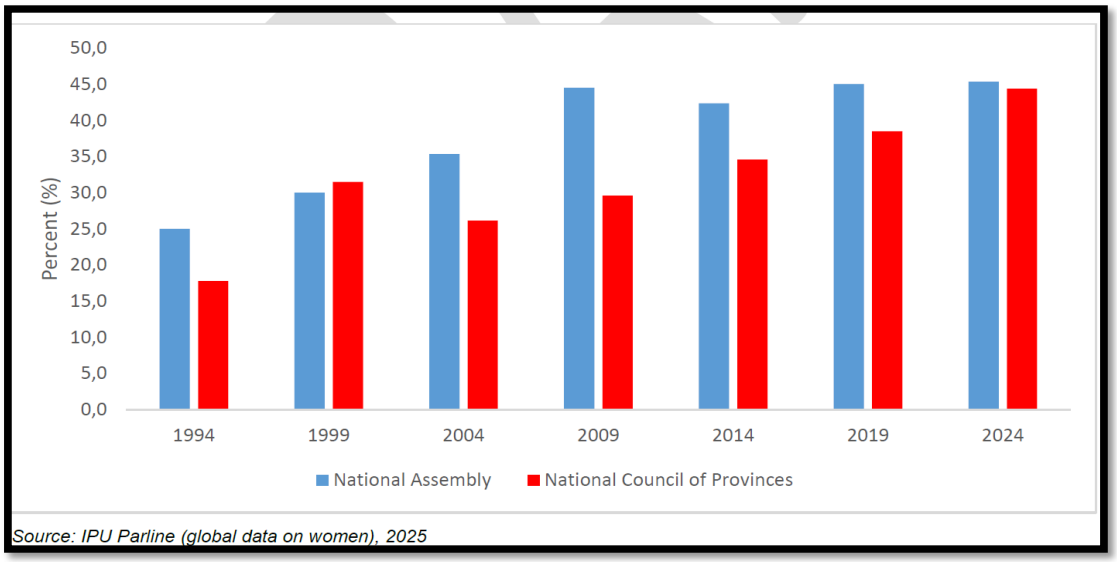
133. South Africa has made considerable success in advancing women's representation and gender equality across the state machinery. There has been a steady increase in the number of women elected as Speakers, Ministers, Deputy Ministers, Premiers, Members of Parliament, Mayors, Councillors, and Chairpersons of Portfolio Committees in the National and Provincial Legislatures.

Women in Politics in South Africa. 2004-2024					
	2004	**2009**	**2014**	**2019**	**2024**
Women MPs	33%	43%	40%	46%	43%
Women in the NCOP	41%	30%	28%	36%	44%
Women MPLs	30%	41%	37%	46%	38%
Women in Cabinet	4%2	41%	41%	50%	44%
Women deputy ministers	60%	39%	44%	46%	40%
Women Premiers	44%	55%	22%	22%	22%
Women voters	55%	55%	56%	55%	55%

134. There has been a steady increase in the representation of women holding seats in National Parliament in South Africa. Unfortunately following the 2024 elections, there is a 3% regression from 2019 in the representation of women holding seats. South Africa has 43.5% of seats in parliament taken up by women following the 2024 elections. South Africa had achieved 50% parity in terms of representation of women Ministers following 2019 national elections. However, representation of women Ministers stood at 44% following the 2024 National Elections.

Women's proportional representation in National Assembly and National Council of Provinces

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135. The graph above shows that women's representation in national assembly and national council of provinces is rapidly growing and approaching parity. This graph demonstrates a positive trajectory towards gender equality. Women's representation in national assembly grew from 25.0% in 1994 to 45.4% in 2024. The largest growth is observed between the 2004 and 2009 elections, where the share of women in national assembly grew by 9.1 percentage points. Representation in the national council of provinces, mimics a similar trend to that of national assembly, women's representation rose from 17.8% in 1994 to 44.4% in 2024, with the biggest rise occurring during the 1994 and 1999 election years, with a 13.7 percentage point increase.

Percentage of seats held by women in Local Governments

	2018	2019	2020	2021	2022	2023
Western Cape	32,4	33,6	34,0	39,3	39,0	38,0
Eastern Cape	42,3	43,7	41,7	43,7	43,0	43,1
Northern Cape	37,1	36,7	38,2	44,9	40,9	41,6
Free State	34,4	38,1	37,5	36,1	33,3	34,8
KwaZulu-Natal	36,6	36,6	37,4	35,7	32,5	32,9
North West	36,6	36,8	36,8	39,8	37,2	37,6
Gauteng	42,8	43,5	41,7	38,8	36,1	46,7
Mpumalanga	37,9	38,5	38,5	41,8	38,7	38,4

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Limpopo	39,7	39,8	39,6	43,9	39,9	40,6
RSA	38,9	39,3	38,8	40,1	37,5	39,0

Source: Non-financial Census of Municipalities 2023, Stats SA

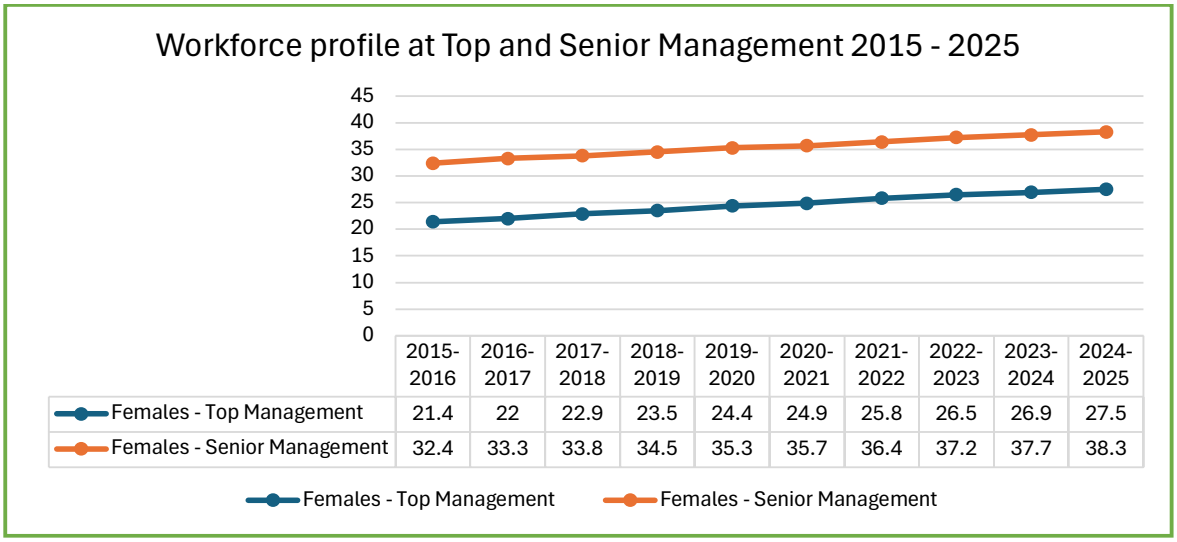
136. According to table above show that there has been a steady increase in women's political participation in local government since 2018. There are provincial differences with some provinces showing higher levels of women's political representation in local government, such as Northern Cape and the Eastern Cape, both at over 40.0% in 2023.

137. There has been a substantial increase in representation of women in the Judiciary in South Africa. As of August 2025, approximately 37,5% of Constitutional Court judges are women, 47,8% of Supreme Court of Appeal judges are women and 43,6% of High Court Judges are women. Out of a total of 1717 permanent magistrates, 54% are women. At senior level, of the 9 Regional Court Presidents, 5 are women and of the 311 Regional Magistrates, 163 are women. When it comes to our judges, of a total of 248 judges, 122 are women which equates to 49%. African women make up 25% of our total judiciary.

138. For the first time in the history of South Africa, the President of the Republic of South Africa appointed a female Chief Justice, Judge Mandisa Maya on 24 July 2024. The highest-ranking legal position in the country is held by a woman.

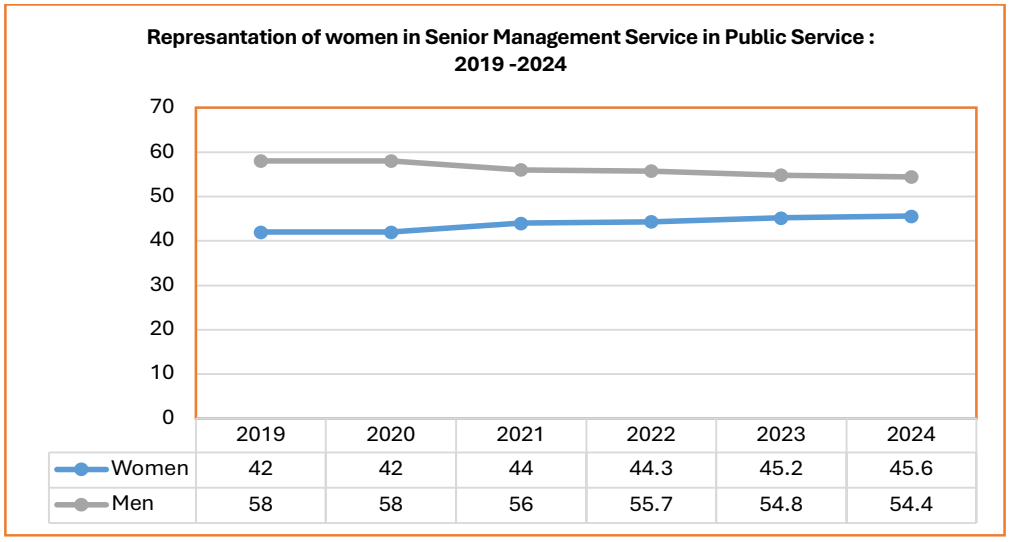
139. Important strides have also been made in increasing the number of women in senior management positions in the public service. The graph below depicts the workforce profiles at top management and senior management level. The graph shows that there is a steady increase year on year on female representation at Top Management and Senior Management level demonstrating progress in this regard.

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Source: The Commission for Employment Equity (Cee) - Annual Report 2024/25

140. There is a steady increase in the representation of women in the Senior Management Services in the Public Service over the past five years. The graph below demonstrates narrowing of gender gaps regarding representation of women in senior management within the public service in South Africa.



141. **In response to recommendation 32**, regarding the adoption of temporary special measures, such as statutory quotas and the preferential recruitment of women, to increase the participation of women in political and public life, education and employment, a key development in this area is update on the Employment Equity (EE) Amendment Act and its implications. The Proclamation Notice on the

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commencement date of the Employment Equity Amendment Act, No. 4 of 2022 (EE Amendment Act, 2022) was signed by the President in November 2024 and published in the Government Gazette in December 2024. Subsequently, the EE Amendment Act, 2022 came into effect from 1 January 2025. The key objectives and implications of the EE Amendment Act, 2022 include the regulation of sector specific Employment Equity numerical targets in order to ensure the equitable representation of suitably qualified people from the designated groups as well as promulgation of section 53 of the Employment Equity Act for the issuing of the Employment Equity Compliance Certificate as a prerequisite for access to state contracts and doing business with any organ of state.

Article 8: Participation at the international level

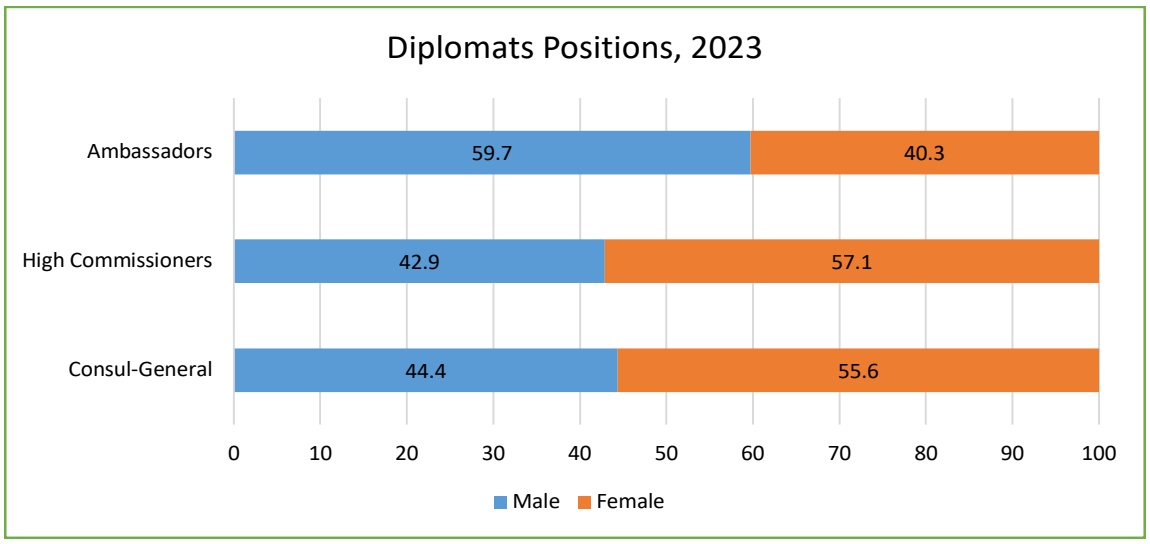
142. South Africa's participation at international level is guided by the National Action Plan on Women, Peace and Security (2020–2025) which outlines commitments to advance women's meaningful participation in peace processes and international decision-making. The National Action plan focuses on advancing women's leadership in diplomacy, peace negotiations, and international institutional roles.

143. South Africa has actively participated in international platforms aimed at advancing the interests of women. South Africa's involvement in multilateral forums (UN, AU, SADC) and peacekeeping highlights the country's strategy to mainstream women's voices in global governance and security dialogues.

144. The graph below demonstrates the levels of representation of women in diplomatic positions. Data shows that females account for the majority of Consul General and High Commissioners while majority of ambassadorial positions are held by males (59,7%).

145. There has been an increase in the representation of women as ambassadors from 40,3% in 2023 as reflected in the graph below to 45,7% in 2024 demonstrating South Africa's commitment to promoting women's meaningful participation at the international level.

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146. South Africa also boosts several noteworthy South African women whose influence spans diplomacy, international organizations, peace and policy. These includes amongst others, Dr. Naledi Pandor who was the Long-serving Minister of International Relations and Cooperation, shaping South African foreign policy through major global events and multilateral forums; Phumzile Mlambo-Ngcuka who served as Executive Director of UN Women (UN Under-Secretary-General level) which is one of the highest international roles by a South African woman.

Article 9: Nationality

147. The rights of women to nationality are protected by a progressive, gender-neutral legal framework that prohibits discrimination based on sex or gender, ensuring that women have equal rights to acquire, change, retain, or pass on their nationality to their children. The primary laws governing this are the Constitution of 1996 and the South African Citizenship Act 88 of 1995.

148. ***Case of Jordaan and Others v Minister of Home Affairs and Another (2025):***

This application concerns the constitutionality of section 26(1)(a)–(c) of the Births and Deaths Registration Act 51 of 1992 (the Act). This section regulates the amendment of the forenames and surnames of South African citizens and is linked to regulation 18(2)(a) of the Regulations on the Registration of Births and Deaths, 2014 (Regulations).

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The Constitutional Court confirmed that section 26(1)(a) -(c) of the Births and Deaths Registration Act 51 of 1992 is unconstitutional. The law unfairly discriminated based on gender, as it permitted women to change their surnames upon marriage, but required men to prove "good cause". This ruling upholds the rights to equality and dignity, allowing all spouses, regardless of gender, to choose their surname.

149. South Africa has made some strides in increasing accessibility to birth registration and identity documents through the Department of Home Affairs (DHA). The expansion of mobile unit outreach, bolstered by a budget allocation for additional units in the fiscal year 2022/2023, reflects a move towards enhancing service delivery and potentially aiding in improving access to birth registration and identity documents. These mobile units are critical in rural and informal urban areas where access to government services can be particularly challenging.

150. South Africa is one of the few countries in Africa that provides, in its 1996 Constitution, for every child to have the right to a nationality. South African citizenship is governed at the statutory level by the South Africa Citizenship Act No. 88 of 1995, as amended most recently in 2010.

151. Birth registration is a prerequisite to obtain documentation that proves nationality, which facilitates access to economic participation and access to other rights in South Africa. Births must be registered within 30 days in terms of the Births and Deaths Registration Act, 1992 (Act No: 51 of 1992 as amended in 2010 and its Regulations). The table below shows the distribution of birth registration by the number of days it took to register a birth over the period 2020 to 2024

Distribution of birth registrations by number of days it took to register birth, (2020 -2024)

Number of days	Number of birth registration					Percentage (%)				
	2020	2021	2022	2023	2024	2020	2021	2022	2023	2024
0-30 days	710 814	811 622	778 716	752 412	718 486	70.8	74.6	78.0	80.7	83.2
31-364 days	248 209	214 578	157 565	116 335	84 014	24.7	19.7	15.8	12.5	9.7
1 – 14 years	31 332	44 278	44 456	49 770	46 496	3.1	4.1	4.5	5.3	5.4
15 yrs & older	12 952	17 048	17 625	13 621	14 862	1.3	1.6	1.8	1.5	1.7
Total	**1 003 307**	**1 087 526**	**998 362**	**932 138**	**863 858**	**100**	**100**	**100**	**100**	**100**

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152. The table above demonstrate that majority of birth registration is occuring within 30 days in line with the Birth and Death Registration Act. The table also demontrate a significant increase in birth registration within 30 days from 70.8% in 2020 to 83% in 2024. The increase could be attributed to improved services.

153. The law provides for mothers and fathers to have equal rights to transmit citizenship to their children and spouses. The registration of births in South Africa is governed by the Births and Deaths Registration Act, 1992 (Act No. 51 of 1992). The law also provides that a child born in South Africa is a South African citizen by birth if "he or she does not have the citizenship or nationality of any other country or has no right to such citizenship or nationality" and the birth is registered in accordance with the Births and Deaths Registration Act.

154. Until 2010, the law provided for citizenship to be attributed at birth to the children of permanent residents born in South Africa; since 2010, the law only provides for a child born in South Africa to be able to acquire citizenship at majority, subject to certain conditions, including registration of birth.

155. The recent Gauteng High Court ruling in M.M.E and Others v Director General, Department of Home Affairs and Another (21970/2021) [2025] ZAGPPHC 202 (12 March 2025) represents a pivotal moment in reinforcing the constitutional rights of children. Section 28(1)(a) of the Constitution states that every child has the right to a name and nationality from birth. This decision reaffirms South Africa's constitutional duty to prevent statelessness and protect children's right to nationality.

156. Challenges also remain in instances were children born in South Africa and do not acquire the nationality of one of their parents at birth have struggled to obtain South African citizenship. Parents who lack identity documents may be unable to register the births of their children, putting those children at risk of being unable to assert their citizenship.

Article 10: Education

157. The National Development Plan: Vision 2023 asserts that "education, training and innovation are central to South Africa's long-term development. They are core

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elements in eliminating poverty and reducing inequality and the foundation of an equal society. Education empowers people to define their identity, take control of their lives, raise healthy families, take part confidently in developing a just society, and play an effective role in the politics and governance of their communities".

158. South Africa has made progress in introducing policies to facilitate gender equality and equity in education, since the dawn of democracy. There are, however, different opinions and perceptions on the impact of these policies and programmes. By 2009, South Africa succeeded in securing the universal enrolment of all children of primary school–going age, as well as gender parity, in schools across the country. Over the years, the number of women in education has been increasing, and they now represent a substantial portion of the student population in various fields of study.

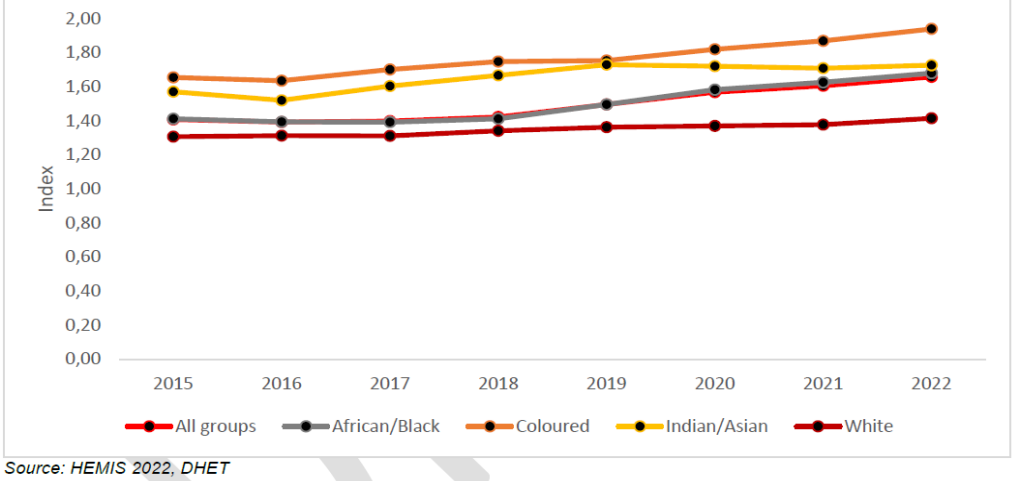
159. South Africa's education policy framework is firmly rooted in the Constitution of the Republic of South Africa (1996), which guarantees the right to basic and further education. This right is operationalized by the South African Schools Act (1996), which created a uniform system for governance and access, and has been strengthened through the Basic Education Laws Amendment Act (2024). The latter has modernized admissions, governance, and home education policy, while introducing compulsory Grade R, thereby extending access to foundational learning. In line with the NDP Vision 2030 and the MTDP 2024 – 2029 prioritizes consolidation of literacy and numeracy gains, strengthening teacher professional development, improving school infrastructure, and enhancing school safety. In the post-school sector, emphasis is being placed on work-integrated learning, apprenticeships, and stronger linkages between education and the labour market.

160. Policy coherence is provided through the National Education Policy Act (1996), which guides standards and monitoring across the sector. The national curriculum, delivered under the Curriculum and Assessment Policy Statement, ensures consistency across provinces, while targeted reforms are improving early grade reading and numeracy. The Early Grade Reading Programme, supported by assessments, represents a key intervention for strengthening learning outcomes at the foundation phase. The No-Fee School Policy (2006) covers most public schools, complemented by fee- exemption mechanisms in fee-paying schools. The National School Nutrition Programme (1994 to present) provides daily meals to millions of learners per day, directly addressing hunger and improving attendance,

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concentration, and educational outcomes. The Learner Transport Scheme and infrastructure investment, including through the Accelerated Schools Infrastructure Delivery Initiative, have reduced access barriers and improved safety, particularly in rural and under- resourced areas.

Figure 4.5.1: Gender Parity Index (GPI) for tertiary education by race



Source: HEMIS 2022, DHET

161. The graph above shows that the Gender Parity Index for tertiary education has been consistently reported above 1, ranging from 1.20 to 1.70 for all population groups, meaning that women were more likely than men to be enrolled in a tertiary institution between 2015 and 2022. The sustained female predominance in tertiary education enrolment may be attributed to the progressive implementation of gender-sensitive educational policies and initiatives aimed at promoting female participation in higher education. The data underscores the importance of continued efforts to ensure balanced educational opportunities for all.

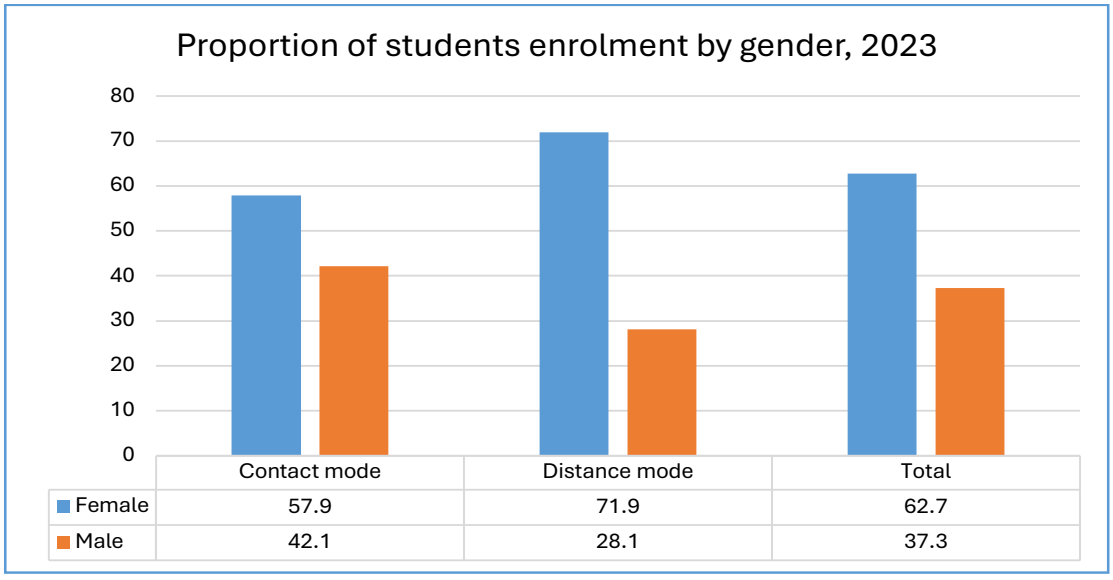
162. The Gender Parity Index in the Technical and Vocational Education and Training (TVET) colleges shows comparatively high female participation rate since from 2014 to 2021.

163. In 2023, almost two-thirds of students in TVET colleges were female (360 378 or 63.9%), while males accounted for 203 711 (36.1%). Female enrolment exceeded that of males in almost all programmes, except for skills programmes, where 1 759 more males than females enrolled. The highest female proportion was observed in Level 5 and 6 Qualifications (79.0%), while males' proportion was higher in skills programmes (62.6%). The largest gender gap was observed in Report 191, where 100 231 more females than males enrolled.

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Access to Higher Education

164. In 2023, females made up 62.7% of total enrolments in public HEIs, compared to 37.3% for males. Female enrolment was higher than male enrolment in both contact and distance mode of learning. The difference was particularly notable in the distance mode, where the proportion of females exceeded that of males by 43.8 percentage points.



	Contact mode	Distance mode	Total
Female	57.9	71.9	62.7
Male	42.1	28.1	37.3

165. In 2023, female enrolment reached 671 988, which was 272 730 higher than male enrolment (399 258). Female enrolment exceeded male enrolment across all fields of study, with the largest gap in the Other Humanities field of study, where 106 752 more females than males were enrolled. It should also be noted that nearly three quarters of enrolments in the Education field of study were females (74.0% or 137 132), compared to 26.0% (48 160) males. Similarly, in the Other Humanities field of study female enrolment was higher 68.0% (201 335) compared to 32.0% (94 583) males.

Number of students enrolled in public HEIs by gender, field of study and qualification type, 2023

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Qualification Type	Female					Male					Unspecified gender	Total enrolment
	SET	Business and Management	Education	Other Humanities	Total	SET	Business and Management	Education	Other Humanities	Total		
Occasional	877	773	126	1 541	**3 317**	916	628	38	555	**2 137**	4	**5 458**
Undergraduate Certificates and Diplomas	37 944	76 537	11 594	46 383	**172 458**	41 444	39 046	2 018	21 190	**103 698**	7	**276 163**
Undergraduate Degree	88 717	59 699	104 337	125 969	**378 722**	78 871	39 908	36 152	57 879	**212 809**	239	**591 770**
Advanced Diploma and Postgraduate Certificate in Education	4 929	8 602	7 109	2 026	**22 666**	5 383	4 772	3 743	1 184	**15 081**	4	**37 751**
Postgraduate below Master's Level	10 711	15 580	9 404	11 976	**47 671**	8 244	10 644	3 531	4 677	**27 096**	36	**74 803**
Master's Degrees	15 665	5 935	3 089	9 804	**34 494**	13 113	5 307	1 584	5 695	**25 698**	103	**60 295**
Doctoral Degrees	6 024	1 528	1 473	3 636	**12 660**	6 285	1 956	1 095	3 404	**12 739**	76	**25 475**
Total	**164 867**	**168 653**	**137 132**	**201 335**	**671 988**	**154 255**	**102 261**	**48 160**	**94 583**	**399 258**	**469**	**1 071 715**

University graduation rates

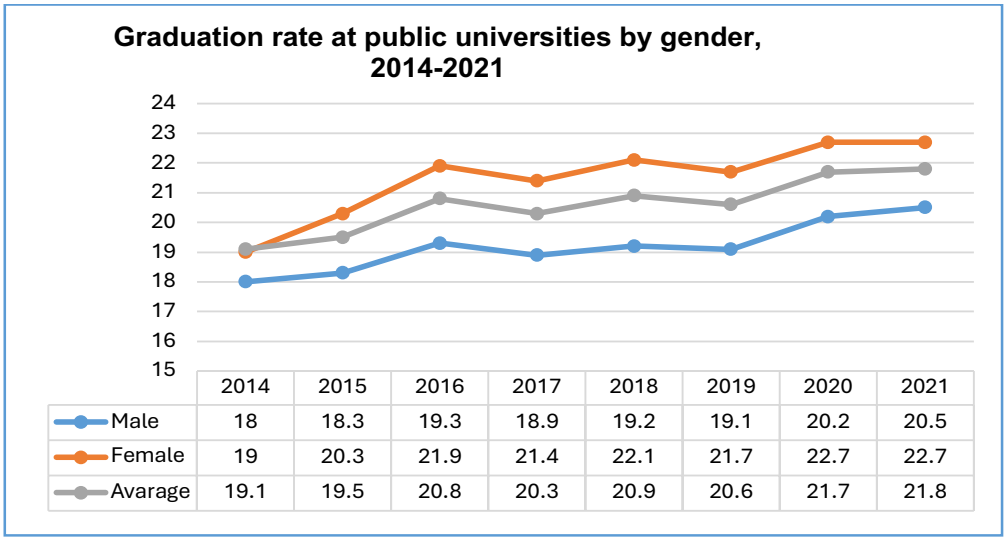
166. Graduation rates (for universities) and certification rates (for TVET colleges) are two indicators of success in the Post-School Education and Training (PSET) system. In 2023, almost two thirds of the graduates were females (65.4% or 144 287), while 34.6% (76 389) were males. The number of female graduates were higher in almost all qualification types (except doctoral degrees), with the largest gender disparities observed for undergraduate degrees (33 691) and undergraduate certificates and diplomas (17 086).

167. Male graduates for doctoral degrees outnumbered females by 134. However, a sizable portion of both male and female graduates obtained their doctoral degrees in the Science, Engineering and Technology field of study (953 and 811 respectively). In 2023, the number of female graduates exceeded male graduates by 67 898. Across all fields of study, female graduates out-numbered males, particularly in the Education and Other Humanities, where 22 065 and 23 790 more females than males completed their degrees.

168. Over 77% of graduates in the Education field of study were females (31 312 out of the overall total of 40 562). In addition. more than 70% of graduates in the Other Humanities field of study were also female (40 259 out of the overall total of 56 771). Female graduates in the Science, Engineering and Technology field of study surpassed males by 6 777, while the gender disparities were more pronounced in

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the Other Humanities and Education fields of study, with 23 790 and 22 065 more females than males respectively



	2014	2015	2016	2017	2018	2019	2020	2021
Male	18	18.3	19.3	18.9	19.2	19.1	20.2	20.5
Female	19	20.3	21.9	21.4	22.1	21.7	22.7	22.7
Avarage	19.1	19.5	20.8	20.3	20.9	20.6	21.7	21.8

Article 11: Employment

169. South Africa's approach to promoting sustained economic growth and decent work is firmly anchored in the Constitution of the Republic of South Africa (1996), which guarantees the right to fair labour practices and underpins socio-economic policy. These commitments are operationalized through the NDP Vision 2030 and the MTDP 2024–2029, which emphasize inclusive growth, job creation and productivity improvements.

170. Employment creation is supported through large-scale public programmes such as the Expanded Public Works Programme (2004 to present) and the Community Works Programme (2010 to present). Complementing these, the Jobs Fund (2011) has channelled billions of rand into matched-funding initiatives that support enterprise development, work seeker support, infrastructure, and institutional strengthening. Targeted youth employment interventions address persistent structural exclusion from the labour market. The National Youth Policy (2020–2030), the Integrated Youth Development Strategy (2011), and the Youth Employment Accord (2013) guide youth inclusion. The Presidential Youth Employment Intervention (2020) integrates public and private initiatives, with

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programmes such as the Basic Education Employment Initiative and the National Pathway Management Network reducing youth unemployment. The Harambee Youth Employment Accelerator (2011) further enhances pathways into the labour market by brokering partnerships between government, business, and civil society.

171. The Tourism Act (2014), the National Tourism Sector Strategy (2016) and the Tourism Sector Masterplan 2023–2026 advance sectoral growth, while the White Paper on the Development and Promotion of Tourism (2024) sets long-term sustainability priorities. The Integrated National Export Strategy (2019) supports competitiveness, value addition, and expanded market access for South African products. The Financial Sector Regulation Act (2017), Competition Act (1998), and Companies Act (2008) provide a framework for market efficiency and consumer protection, while the Broad-Based Black Economic Empowerment Amendment Act (2003) advances equity and participation. The National Small Enterprise Amendment Act (2024) strengthens support for small enterprises and cooperatives, with the Co-operative Amendment Act (2013) improving governance and accountability.

172. Unemployment especially among youth and women remains relatively high, underscoring the need for labour-absorbing growth and stronger pathways into the labour market. Government reforms under the Economic Reconstruction and Recovery Plan (ERRP), supported by the NDP and MTDP, focus on boosting industrialisation, improving the business environment, enhancing skills development, and supporting SMMEs and the informal sector. At the same time, efforts to advance decent work, strengthen labour protections and promote inclusive participation in the economy remain central to achieving the socio-economic empowerment of women.

Wage Discrimination

173. In South Africa, **wage discrimination** continues to be the biggest challenge to the working woman. This form of inequality in the country has been overt and practiced indiscriminately and with impunity, because the workforce is skewed towards men and lies fundamentally in the hands of men, mainly white males. Wage discrimination continues despite prohibition under the Labour Relations Act, no 66 of 1995 and the Wage Act, no 5 of 1957. However, both acts had little impact over the past two decades as they related only to minimum wages.

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Median monthly earnings of female and male employees by occupations, 2019–2023

Occupation	2019		2020		2021		2022		2023	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Managers	R24 000	R20 000	R22 000	R21 000	R25 000	R20 000	R25 000	R18 000	R25 000	R21 000
Professionals	R27 000	R23 000	R25 000	R23 000	R25 000	R23 000	R26 000	R21 000	R27 000	R24 000
Technicians	R17 000	R16 000	R16 800	R18 000	R16 500	R17 000	R17 000	R18 000	R19 500	R19 500
Clerks	R8 000	R7 000	R8 667	R7 500	R8 500	R7 500	R8 000	R6 800	R10 000	R7 300
Sales	R5 000	R3 500	R5 200	R3 900	R5 500	R3 800	R5 500	R4 000	R6 000	R4 500
Skilled Agriculture	R3 100	R2 500	R3 500	R2 200	R4 333	R3 200	R4 000	R4 000	R4 000	R4 000
Craft	R5 200	R3 800	R6 000	R4 117	R5 850	R4 100	R6 006	R4 900	R6 400	R4 500
Operators	R5 500	R4 000	R5 633	R4 333	R5 633	R4 333	R6 000	R5 000	R6 390	R5 300
Elementary	R3 250	R2 817	R3 467	R3 000	R3 500	R3 033	R3 792	R3 500	R4 100	R3 500
Domestic workers	R2 000	R2 000	R2 340	R2 200	R3 000	R2 167	R2 000	R2 400	R1 950	R2 500

Source: Quarterly Labour Force Survey (QLFS) 2023, Stats SA

174. South Africa introduced multiple mechanisms to eliminate discrimination within the employment environment. These includes the labour courts, equality courts, Commission for Gender Equality, Commission for Conciliation, Mediation and Arbitration (CCMA) in line with the constitutional and legal obligations. Section 10 of the Employment Equity Act provides that dispute arising from Chapter II, Prohibition of Unfair Discrimination, may be referred to the Commission for Conciliation, Mediation and Arbitration (the "CCMA") for conciliation. Section 10(6) of the EEA provides that if a dispute remains unresolved after conciliation, a party may refer it to the Labour Court for adjudication. If the employee alleges sexual harassment, that employee also has the option to refer the dispute to the CCMA for arbitration. The table below provides statistics on Employment Equity case referrals:

Employment Equity Act Referrals by Issue				
Issue	**Mar 2022**	**March 2023**	**March 2024**	**January 2025**
Prohibition of unfair discrimination - Pregnancy	33	.	28	31
Prohibition of unfair discrimination - Age	28	13	41	31
Prohibition of unfair discrimination -Disability	22	4	47	39
Protection of employee rights	23	.	87	77
Prohibition of unfair discrimination -Race	49	11	105	85
Sexual harassment	80	.	168	157

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Equal pay for work of equal value - arbitrary ground	359	346	381	325
Prohibition of unfair discrimination - arbitrary ground	1087	.	1595	1518

Source: Commission on Employment Equity Annual Reports – 2022 - 2025

175. The statistics above provide an overview of the number of EEA cases and their breakdown referred to the CCMA from 01 April 2021/ 31 March 2022 reporting period to 01 April 2024 to 31 January 2025 reporting period. Issues of unfair discrimination on arbitrary ground constitute most employment equity act referrals followed by issues on equal pay for work of equal value, and sexual harassment.

176. On the issue of the **promoting the economic empowerment of women in South Africa,** the National Development Plan: Vision 2030 (NDP) indicates that women make up a large percentage of the poor, particularly in rural areas, and therefore takes gender, race and geographic location as intersecting variables, into account, proposing a range of measures to advance women's equality. The NDP recommends that: (i) public employment should be expanded to provide work for the unemployed, with a specific focus on youth and women; (ii) the transformation of the economy should involve the active participation and empowerment of women. Although the country's institutional framework and its broad economic and social trends have contributed to gradual deracialisation, and to improve the lives of women, persisting discrimination, patriarchal attitudes and poor access by women to economic opportunities, persists – thus keeping women very much on the margins of mainstream economy.

177. South Africa has several measures put in place to address the economic empowerment of women, including laws such as the Broad Based Black Economic Empowerment Act, no 53 of 2003, and related regulations: the Mineral and Petroleum Resources Development Act 28 of 2002 and related Codes outlining quotas for women in the mining sector. Public Procurement Act 28 of 2024 establishes a unified framework for South African state procurement, prioritizing women's economic empowerment through mandatory set-asides and preferential treatment. It addresses historical disparities by enabling, in sections 17-19, the reservation of contracts for women-owned businesses.

178. **Domestic workers** in South Africa receive protection through sectoral determinations under the Basic Conditions of Employment Act in 2002, and in 2020

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the law was amended to enable domestic workers to claim from the Compensation fund for work related injuries or illness.

179. **The Basic Conditions of employment Act 75 of 1997** guarantees paid maternity leave, including antenatal, post-natal and family leave. The purpose of this Act is to align the minimum terms and conditions of employment for workers, with the constitutional right to fair labour practices as set out in Section 23(1) of the Constitution. It should inform the basis of any employment contract. In addition to providing the minimum employment standards, the BCEA also ensures fair treatment within the workplace.

Article 12: Health

180. The South African government has put in place several transformative policies and legislations aimed at advancing women's empowerment and gender equality. As such, there has been some notable progress in some indicators suggesting improvement in the quality of life of women over the years. South Africa's health system is anchored in the Constitution of the Republic of South Africa (1996), which enshrines the right of everyone to access healthcare services, including reproductive health care. The National Health Act (2003) operationalizes this right by establishing a unified national health system and clarifying the responsibilities of national, provincial, and local government in ensuring equitable access and accountability across the health sector. Building on this framework, the Presidential Health Compact (2019) committed government, civil society and stakeholders to a programme of system-wide reform focused on quality, equity and efficiency in line with the NDP Vision 2030.

181. The government's 5-year implementation plan for the National Development Plan (Vision 2030) which is the Medium-Term Strategic Framework implemented from 2019 to 2024 prioritized strengthening primary health care as the foundation of the system, integrating responses to both communicable and non-communicable diseases, and accelerating digital health innovations. Priorities include improving maternal and child health outcomes, enhancing community level responsiveness, and narrowing inter-provincial disparities in access and quality.

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182. The National Health Insurance Act (2023) aims to establish the National Health Insurance Fund to promote strategic purchasing of health services, reduce financial barriers, and guarantee equitable access to essential care. These reforms will be supported by fiscal allocations to stabilize health services, sustain public sector capacity, and protect key programmes, including those vulnerable to reductions in international donor funding.

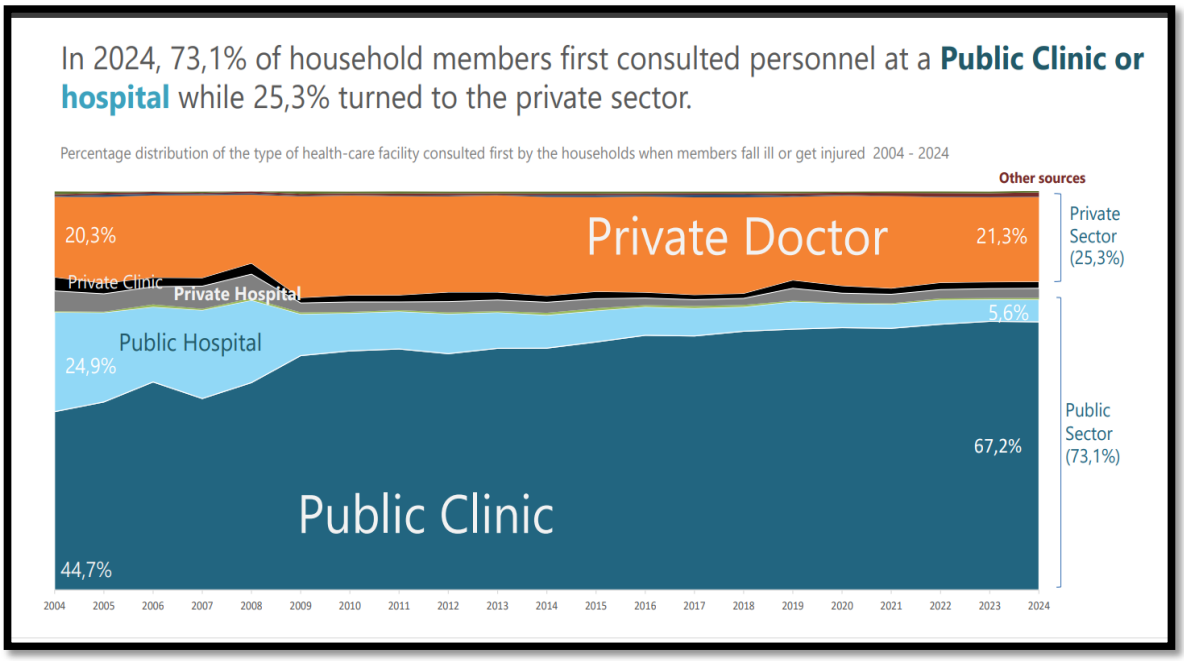
183. The National Strategic Plan for HIV, Tuberculosis and STIs 2023–2028 integrates prevention, testing, treatment and stigma reduction. Laboratory capacity under the National Health Laboratory Service Act (2000), combined with medicines regulation under the Medicines and Related Substances Act (1965), provide an institutional backbone for ensuring quality care and maintaining resilient systems.

184. The National Strategic Plan for the Prevention and Control of Non-Communicable Diseases 2022– 2027 adopts a people-centered and integrated approach, addressing conditions such as diabetes, hypertension, and cancers through strengthened primary health care.

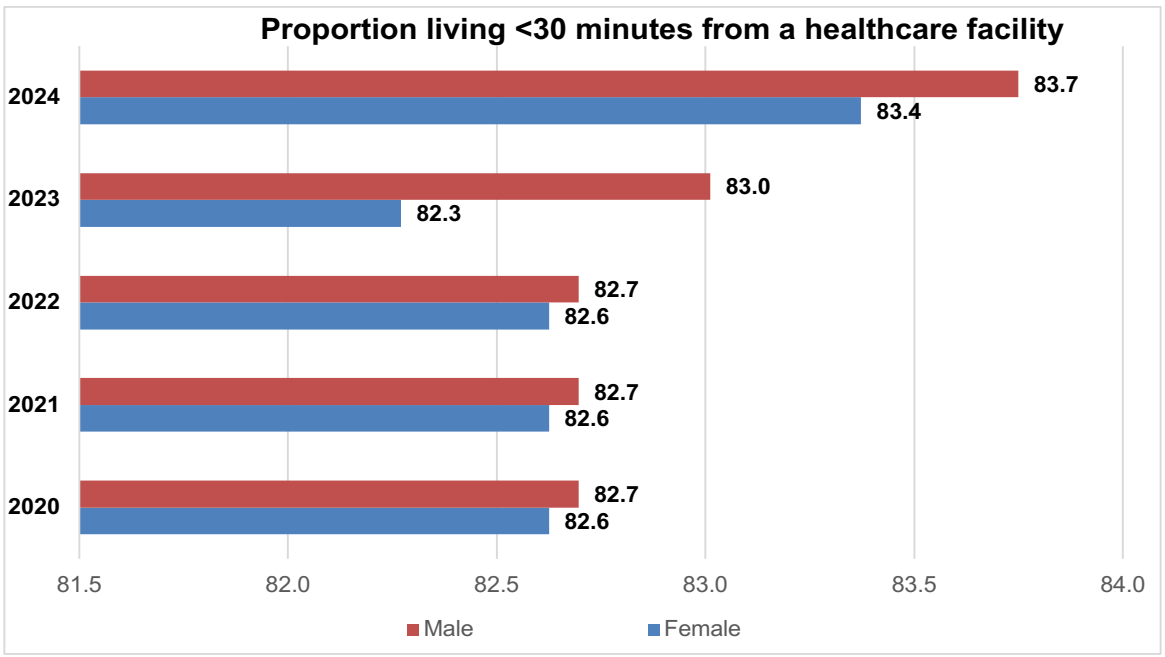
Access to healthcare

185. The type of healthcare facility consulted by household members is influenced by factors such as households' proximity to facilities as well as personal preferences based on factors such as affordability and the perceived quality of services. The graph below presents the type of healthcare facility that households generally visit first when household members fall ill or have accidents. The Graph shows that majority of South Africans visit public medical facilities when they need medical help.

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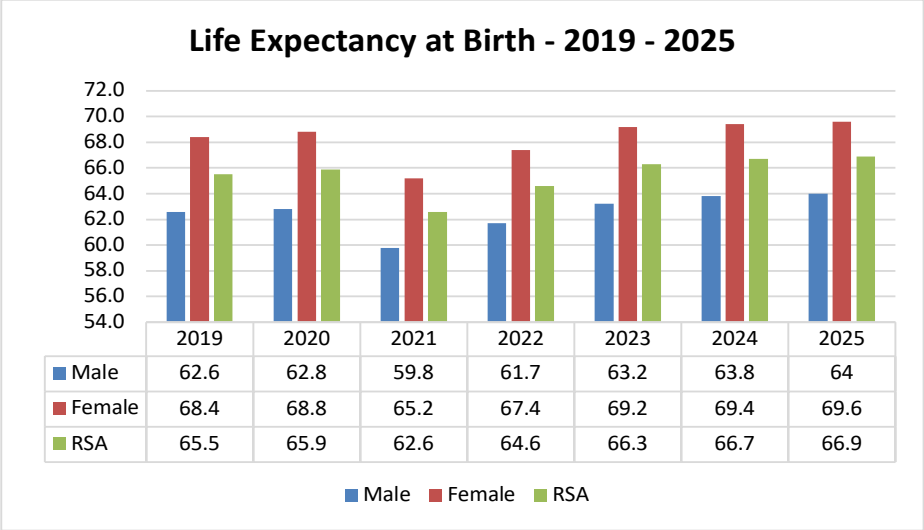


186. Nationally, 73,1% of households said that they would first go to public clinics, hospitals or other public institutions, while 25,3% of households said that they would first consult a private doctor, private clinic or hospital. The use of public health facilities was least common in Western Cape (54,8%) and Gauteng (67,0%), and most common in Limpopo (84,9%), Mpumalanga (81,4%) and Eastern Cape (80,4%).



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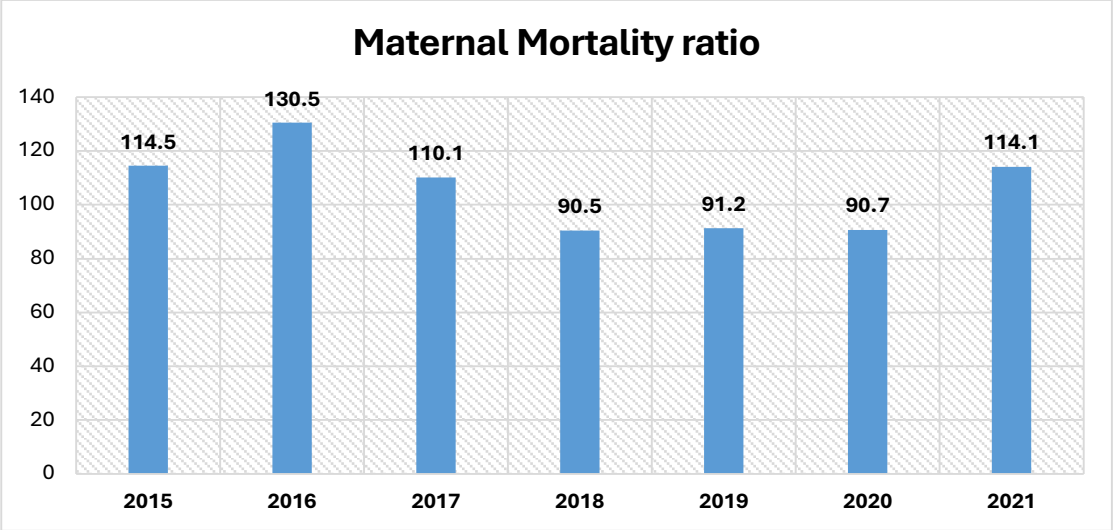
187. However, because of the COVID-19 pandemic, life expectancy dropped by 3.5 years to 62.0 years in 2021, but there has been a rebound in 2022, and total life expectancy slowly began improving again, reaching 62.8 years in 2022, compared to 62.0 years in 2021. Overall, males' life expectancy stood at 60.0 years in 2022, while life expectancy for women is 65.6 years. These milestones are a result of the successful implementation of programmes to fight HIV/AIDS and TB, as well as improvements in the socioeconomic conditions of South Africans, including the social safety net provided by the government to fight poverty and ameliorate poverty-related ill-health.



	2019	2020	2021	2022	2023	2024	2025
Male	62.6	62.8	59.8	61.7	63.2	63.8	64
Female	68.4	68.8	65.2	67.4	69.2	69.4	69.6
RSA	65.5	65.9	62.6	64.6	66.3	66.7	66.9

188. South Africa has generally observed a downward trend in the maternal mortality ratio (MMR) before increasing noticeably in 2021. MMR was estimated at 144.8 deaths per 100 000 live births in 2015 and reached 90.5 deaths per 100 000 live births in 2018. The estimates remain constant at 91.2 and 90.7 deaths per 100 000 live births in 2019 and 2020, respectively. The increase to 114.1 deaths per 100 000 live births in 2021 is attributed to the overall increase in pregnancy, childbirth and puerperium deaths. In the same period, the country also observed an increase in COVID-19 deaths. Ideally, these figures should translate into a much lower maternal mortality ratio. This indicates that more targeted interventions are required to reach the 2030 target of reducing the maternal mortality ratio to less than 70 deaths per 100 000 live births.

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Source: Mortality and Causes of Death 2021, Stats SA

Proportion of women of reproductive age (aged 15–49 years) who have their need for family planning satisfied with modern methods.

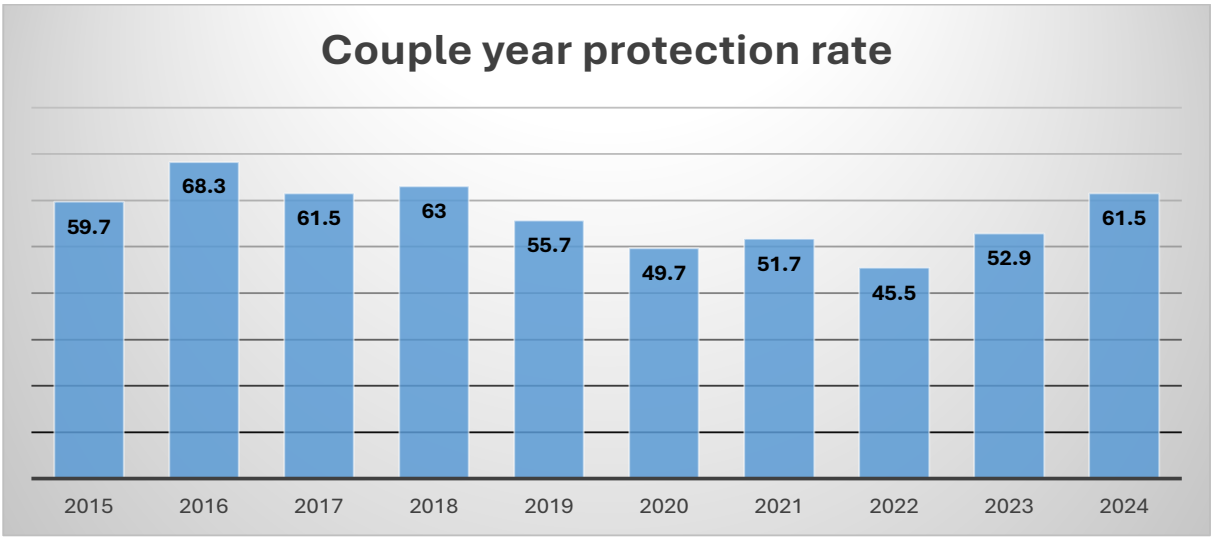
189. The South African Demographic Health Survey show that the overall use of modern contraception was 75.7% in 2016, with a wide range of methods being utilised. The use of the pill, injectable contraceptives and sterilisations has declined since 1998, while the use of male condoms for contraception has increased. In 2017, 15.0% of women and their partners used male condoms as their contraceptive method (Stats SA, 2017). Despite the relatively high contraceptive prevalence rate there are still problems with service delivery, equitable access, and correct, consistent, and continuous use of contraception, especially among certain groups such as young or rural women (Harries et al., 2019).

Sexual and Reproductive Health and Rights (SRHR)

190. South Africa set a target is to ensure, by 2030, universal access to sexual and reproductive health-care services, including family planning, information and education, and the integration of reproductive health into national strategies and programmes. The Couple Year Protection rate (CYPR) is an important indicator used to assess the effectiveness of family planning programmes. The graph above demonstrates that the CYPR increased from 59.7% in 2015 to 61.5% in 2024. Observing the trend over the past decade, South Africa reported the highest CYPR

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in 2016, where 68.3% of eligible couples were effectively protected against childbirth by one or other approved methods of family planning.



Source: District Health Information System 2015–2024, DoH

191. **In response to recommendation 54(a)** on women's access to sexual and reproductive health services such as safe abortion and post-abortion services, South Africa's laws and policies support a rights-based framework for its sexual and reproductive health programme that is aligned with the United Nations Sustainable Development Goals and the global Family Planning 2020 framework. Additionally, the South African government has ratified regional and international agreements regarding reproductive health and rights, including at the International Conference on Population and Development (1994) and the Maputo Plan of Action (2006).

192. Government introduced the National Clinical Guideline for Implementation of the Choice on Termination of Pregnancy Act in 2019. The guidelines were introduced to address the barriers for access to high quality legal services including poor general provider knowledge on termination of pregnancy, lack of training and mentorship, and the inadequate availability of relevant medicines and equipment. The guidelines were introduced to standardise and expand service delivery and reaffirming all citizens' right to comprehensive reproductive health care.

193. This guideline is a critical piece of the broader effort to take a comprehensive approach to reproductive health in South Africa, which not only improves population health, but follows human rights principles to enhance access, choice,

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and dignity for individuals who seek care. In addition, the South Africa National Integrated Sexual and Reproductive Health and Rights (SRH&R) Policy (2019) provides a comprehensive, rights-based framework aimed at improving the quality and accessibility of sexual health services. It promotes informed decision-making, covering contraception, HIV/STI services, maternal health, and LGBTQI care, ensuring services are non-judgmental and address, including for adolescents and key populations.

194. As of December 2024, a total of 346 healthcare facilities comply with Section 3(1) (a-k) of the Choice of Termination of Pregnancy Act, Act no 92 of 1996 as amended in 2008 across South Africa as shown in the table below:

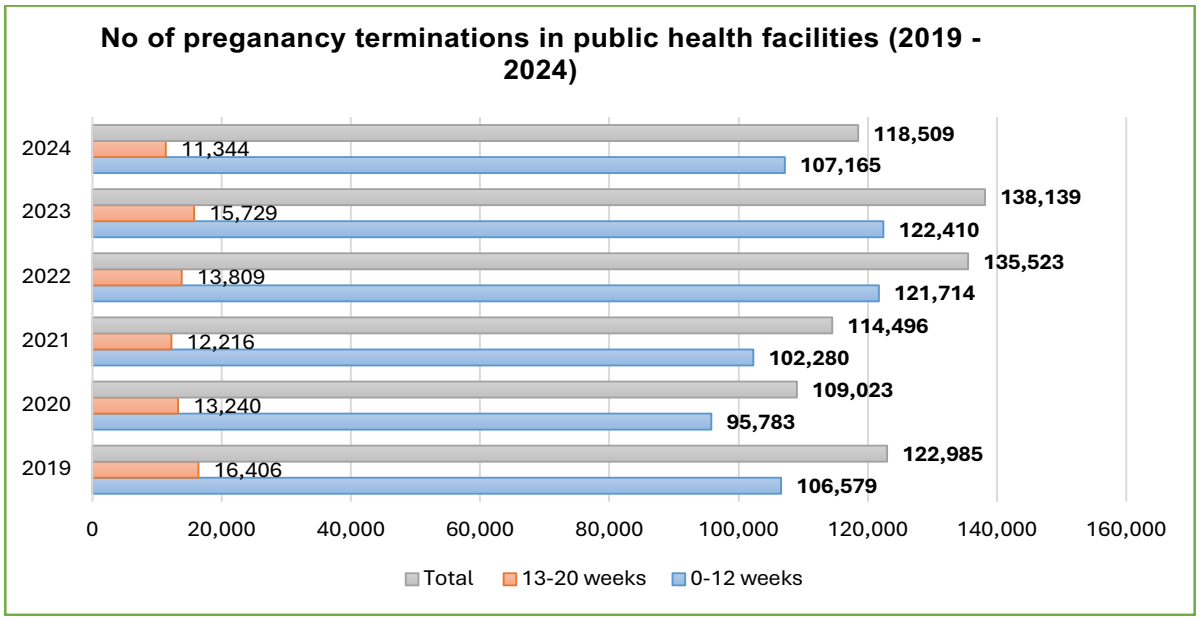
Province	**Number of Public health facilities complying with Choice of termination of pregnancy Act**
Eastern Cape	37
Free State	14
Gauteng	49
KwaZulu Natal	63
Limpopo	51
Mpumalanga	35
Northern Cape	7
North West	33
Western Cape	57
South Africa	**346**

195. According to the Choice of Termination of Pregnancy Act, doctors and nurses are not obliged to provide termination of pregnancy. However, according to the Act, all health care providers are obliged to refer clients to a facility where the service is rendered, and to provide any emergency treatment which is needed because of a termination of pregnancy, irrespective of where the termination was performed. The Act obliges health care workers to give accurate information on termination of pregnancy services and refer clients to a Termination of Pregnancy Clinic. Failure to do this can result in the health care provider facing a penalty of imprisonment of not less than ten years.

196. The number of terminations of pregnancy provided in public health facilities, disaggregated into gestational stages (0-12 weeks and 13 -20 weeks). The table below provides the number of terminations of pregnancy provided in public health

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facilities, disaggregated into gestational stages (0-12 weeks and 13 -20 weeks) from 2019 – 2024:



Source: District Health Information System

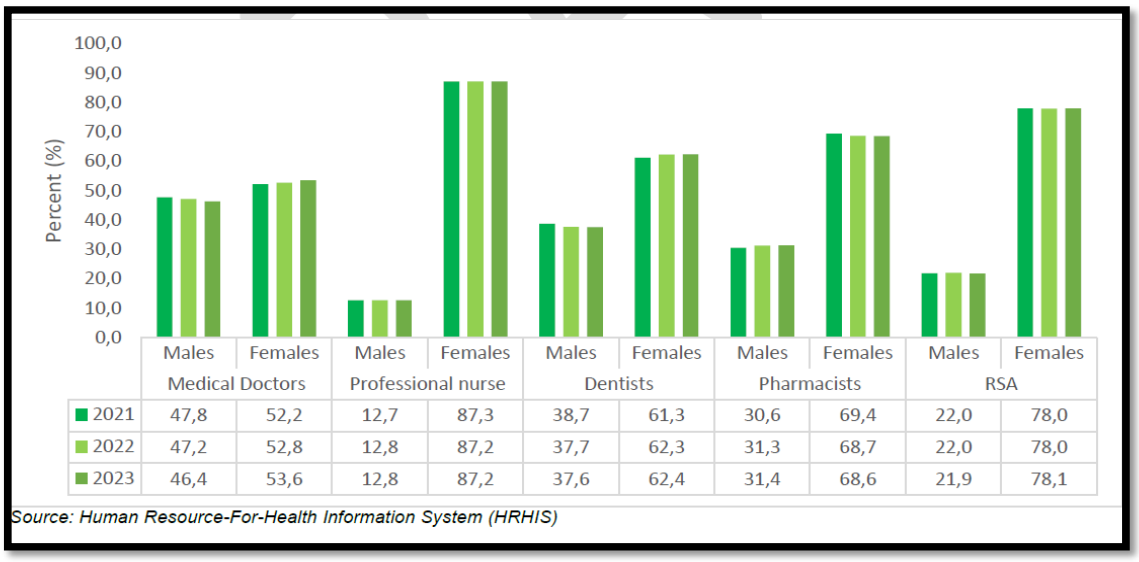
The graph above show that a total of 118 509 pregnancy terminations were performed in public health facilities in 2024. The highest number of terminations of pregnancy in public health facilities for the period 2019 – 2024 was recorded in 2023 where a total of 138 139 pregnancies were terminated in public health facilities.

197. In response **to recommendation 54 (c)** regarding forced sterilisation of women living with HIV and AIDS, South Africa affirms that forced or coerced sterilisation constitutes a violation of women's human rights, including the rights to dignity, bodily integrity, equality, and access to healthcare. practices. In this regard the Sterilization Act, no 44 of 1998 provides for the right to sterilization; to determine the circumstances under which such sterilization may be performed and the circumstances under which sterilization may be performed on persons incapable of consenting or incompetent to consent due to mental disability; and to provide for matters connected therewith. The promotion of this right is based on the non-derogable rights outlined in the Constitution in particular the rights to bodily and psychological integrity of persons which include the right to make decisions concerning reproduction and the right to security in and control over their bodies.

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Health workforce

198. South Africa's health workforce is predominantly female, with women comprising at least 78.0 per 10 000 population over the period 2021 and 2023. The female distribution varies across the different occupations, with the majority being professional nurses at over 87.0 per 10 000 population for the period 2021–2023. Female pharmacist distribution stands at 68.6 per 10 000 population, followed by dentists at 62.4 per 10 000 population and medical doctors at 53.6 per 10 000 population, over the 2023 period as reflected in the graph below:



	Medical Doctors		Professional nurse		Dentists		Pharmacists		RSA	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
2021	47,8	52,2	12,7	87,3	38,7	61,3	30,6	69,4	22,0	78,0
2022	47,2	52,8	12,8	87,2	37,7	62,3	31,3	68,7	22,0	78,0
2023	46,4	53,6	12,8	87,2	37,6	62,4	31,4	68,6	21,9	78,1

Source: Human Resource-For-Health Information System (HRHIS)

Article 13: Economic empowerment of women and social benefits

199. This article requires member states to implement measures to eliminate discrimination against women in other areas of economic and social life.

Government initiatives for advancing women's economic empowerment procurement regulation

200. The Procurement Act 28 of 2024 in section 17 requires that procuring institution must set aside in preference of a category of persons previously disadvantaged including women. The data below shows majority ownership for companies on the central supplier database as well as past few years spending for female owned companies.

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201. This section addresses the ownership gap as eluded under status of women economic empowerment. It is important to note that government spending on female owned businesses depends on the number of businesses registered on the Central Supplier Database (CSD).

OWNERSHIP AND SPENDING FOR COMPANIES DOING BUSINESS WITH GOVERNMENT

Figure 3. Spending on female owned companies

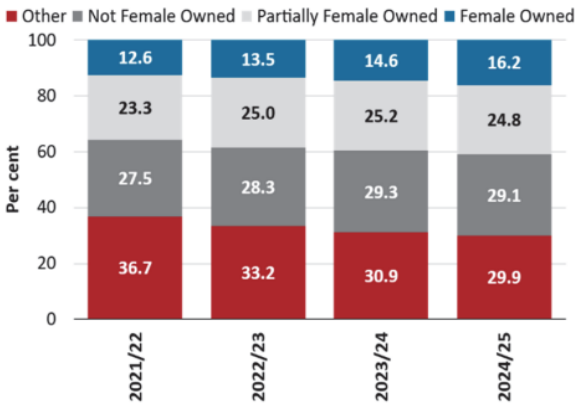
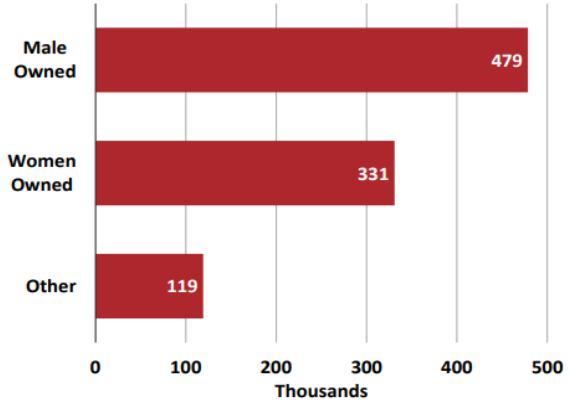


Figure 4. SA Majority company ownership



Other incl: Organs of State, Foreign Companies, and Companies not owned by individuals
Source: National Treasury

Right to family benefits

202. The Promotion of Equality and Prevention of Unfair Discrimination Act of 2000 prohibit policies and practices that discriminate against women. Notably, Sections 6 and 8(c) and 8(d)) mention those related to the inheritance of family property and any inequitable "traditional, customary or religious practice which impairs the dignity of women and undermines equality between women and men."

203. Section 6 of the Recognition of Customary Marriages Act,99 provides for the legal capacity of women to be equal to that of their husband. This section provides that: “A wife in a customary marriage has, on the basis of equality with her husband and subject to the matrimonial property systems governing the marriage, full status and capacity, including the capacity to acquire assets and dispose of them, to enter

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into contracts and litigate, in addition to any rights and powers that she might have at customary law".

204. The legislature has therefore given effect to section 10 of the Constitution, by dignifying women through allowing them to have equal legal status and capacity as their counterparts. Therefore, women also have legal capacity to enter transactions independently and can acquire and dispose of assets. Women are entitled to inherit property under customary law. The Recognition of Customary Marriages Act makes all customary marriages automatically in community of property unless the parties declare otherwise. This means that the assets and income of both spouses are merged into one estate, and both husband and wife have equal powers to manage the estate. In dissolution of the marriage, each spouse has an equal right to the estate. Thus, women are guaranteed an equal share in all property held by the couple during the marriage.

205. Section 10 of the Constitution provides that everyone has inherent dignity and the right to have their dignity respected and protected. As a result, it is submitted that the perpetual minority and legal incapacity of married women, as well as the subjection of women to the husband's marital power are no longer features of customary law.

206. Government of South Africa adopted a White Paper on Families in 2013 which was revised in 2021. This serves as a policy framework developed by the government to strengthen families as the foundation of society. It recognises that families are central to social development, but also deeply affected by historical inequalities, poverty, and changing social dynamics.

Right to participate in recreational activities, sports and all aspects of cultural life

207. Government of South Africa has introduced the legislative measures to address longstanding structural inequalities faced by women and girls in sport. The approval of the Women in Sport Policy by Cabinet in December 2024 is an important milestone, which demonstrate South Africa's commitment and determination to build a sporting environment that celebrates the achievements of women and position them as equal contributors to sporting excellence.

208. The policy addresses multiple areas of gender disparity, including participation, leadership, governance and visibility. The policy recognises that increased

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participation of women in sport and in leadership positions will reduce and ultimately contribute to eradicating gender inequality and various forms of discrimination against women. It also promotes equity by ensuring that women receive respect and recognition on the professional front, including equal remuneration as their male counterparts. The policy outlines a set of measures that will promote and support women in sport and ensure that programmes are in place to address gender disparities in sporting codes and structures.

209. Increasing participation in sport is a major challenge because local government (municipality) continue to fail to provide basic sport facilities as well as maintain existing sport facilities to promote sport development. Those who suffer most are women and girls in rural and peri-rural communities where there is a lack of usable sport facilities in schools where the majority of those not being given opportunities to participate in sport are found. This requires additional legislative measures to ensure that all spheres of government, local, provincial and national are mandated and capacitated to take steps to address the introduction and maintenance of sport facilities.

210. The aim of this policy is to increase active participation of women in sport at all levels; Expand women's roles in leadership, governance, coaching, and officiating structures; Achieve equity in remuneration, sponsorship, and resource allocation for women athletes compared with male peers and addressing barriers such as lack of funding, inadequate infrastructure and visibility in sport media.

211. Whilst the Policy is an important milestone it does require the addition of some practical additions and guidelines for stakeholders to ensure that it can and will be implemented and enforced across the board in all areas of sport. Further legislative measures will be required to introduce monitoring provisions and sanctions for non-compliance. The Policy needs to be implemented to ensure that its aims and objectives achieved. This requires an implementation plan with clear timelines.

212. The Department of Sports, Arts and Culture implements different interventions aimed at women and gender equity in sport, such as: Allocating scholarships and targeted programmes for women in sport. Supporting district and community sport leagues with gender-focused participation efforts. Recruiting sport ambassadors –

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including former female athletes to support mentorship and community outreach programmes targeted at girls and women.

Article 14: Rural women empowerment

213. Government of South Africa introduced the Comprehensive Rural Development Programme (CRDP) in 2009 to empower women in South Africa's rural areas. The Comprehensive Rural Development Programme (CRDP) is a strategic initiative that aligned with the United Nations' Sustainable Development Goals (SDGs), ensuring a coordinated approach to achieving sustainable development and rural transformation in South Africa.

214. The National Rural Youth Service Corps (NARYSEC) is a flagship programme implemented through the Department of Rural Development and Land Reform contributions towards alleviating the high levels of unemployment among young people in rural area. This program equips unemployed youth (aged 18–35) with skills, improving household income, and fostering community service, aiming to reduce poverty and create jobs. It provides character building, technical training, and entrepreneurial opportunities, transitioning participants into the workforce, particularly in agriculture.

215. The graph below shows that 9249 young people from rural areas trained through NARYSEC between 2021/22 and 2024/2025 financial years. Female youth constitute the majority (56.3%) of those who benefitted from the NARYSEC programme over the past five years.

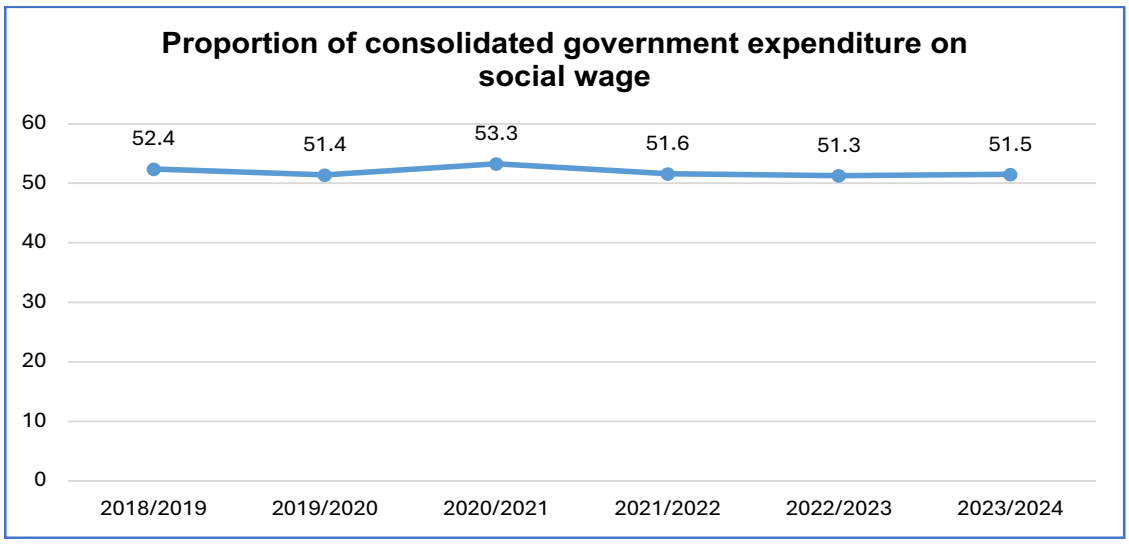
Youth Trained through NARYSEC: 2020 – 2024

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PROVINCE	2020/21		2021/22		2022/23		2023/24		2024/25		TOTAL MALE	TOTAL FEMALE	GRAND TOTAL P/PROVINCE
	M	F	M	F	M	F	M	F	M	F			
Eastern Cape	123	99	35	55	63	52	130	144	91	108	442	458	900
Free State	72	100	49	62	22	26	121	157	77	111	341	456	797
Gauteng	78	93	65	60	112	170	127	193	55	111	437	627	1064
KwaZulu-Natal	160	196	39	137	54	41	207	113	59	118	519	605	1124
Limpopo	197	235	150	224	57	128	155	255	72	123	631	965	1596
Mpumalanga	104	133	168	221	12	13	124	188	89	130	497	685	1182
North West	77	84	78	92	81	53	159	200	99	142	494	571	1065
Northern Cape	22	32	5	21	53	59	134	167	72	104	286	383	669
Western Cape	49	73	51	79	35	48	168	162	85	102	388	464	852
TOTAL	882	1045	640	951	489	590	1325	1579	699	1049	4035	5214	
GRAND TOTALS	1927		1591		1079		2904		1748		9249		

Social security.

216. Government of South Africa is implementing the social assistance programme known as social grants to promote social protection. Nearly two-thirds of the South African population (64.0%) are covered, directly or indirectly, by the social assistance system. Income-poor households are often unable to provide sufficient for members therefore, addressing income poverty and lack of basic needs remain critical as a pre-requisite for survival and development of communities.



Source: Budget Review 2023/24, National Treasury

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217. The graph above shows the proportion of government expenditure on social wage. The South African government has invested more than half of the national budget into pro-poor policies and programmes. In 2023/24, 51.5% of government funds were spent on the country's social wage.

218. South Africa provides the most extensive system of unconditional cash transfers in the world, including grants for children, persons with disabilities, older people and recently, adult with insufficient means. Social grants include the Older Persons Grant; War Veterans Grant; Disability Grant; Child Support Grant including the child support grant Top Up; Care Dependency Grant; Foster Child Grant; Grant-in-Aid and the recently implemented COVID-19 Social Relief of Distress grant.

Table showing Type of poverty alleviation grants by sex and number of recipients, as at end of February 2024

Grants Recipients by sex as at end of February 2024					
	Female (N)	%	Male (N)	%	Total
Care Dependency grant	158 859	96,3	6160	3,7	**165 019**
Child Support Grant	12 931 339	97,8	291 126	2,2	**13 222 465**
Disability Grant	518 494	49,4	531 305	50,6	**1 049 799**
Foster Care Grant	226 947	93,4	15 984	6,6	**242 931**
Grant in Aid	260 571	66,5	131 455	33,5	**392 026**
Old Age Grant	2 561 438	63,6	1 466 964	36,4	**4 028 402**
War veteran Grant	3	30,0	7	70,0	**10**
Total	**16 657 651**	**87,2**	**2 443 001**	**12,8**	**19 100 652**

SOURCE: Inputs from Department of Social Development

219. South Africa's social protection is based on a hybrid model of strategies that protects the vulnerable and those at risk, builds capabilities, and enhances economic inclusion throughout the various stages of life.

220. **In responding to recommendation 56(a)** on ensuring that legislation and policies on land reform and land use fully recognise and protect the rights of rural women to land ownership and use, the Upgrading of Land Tenure Rights Amendment Act,6 of 2021, came in force from 1 June 2024 along with regulations

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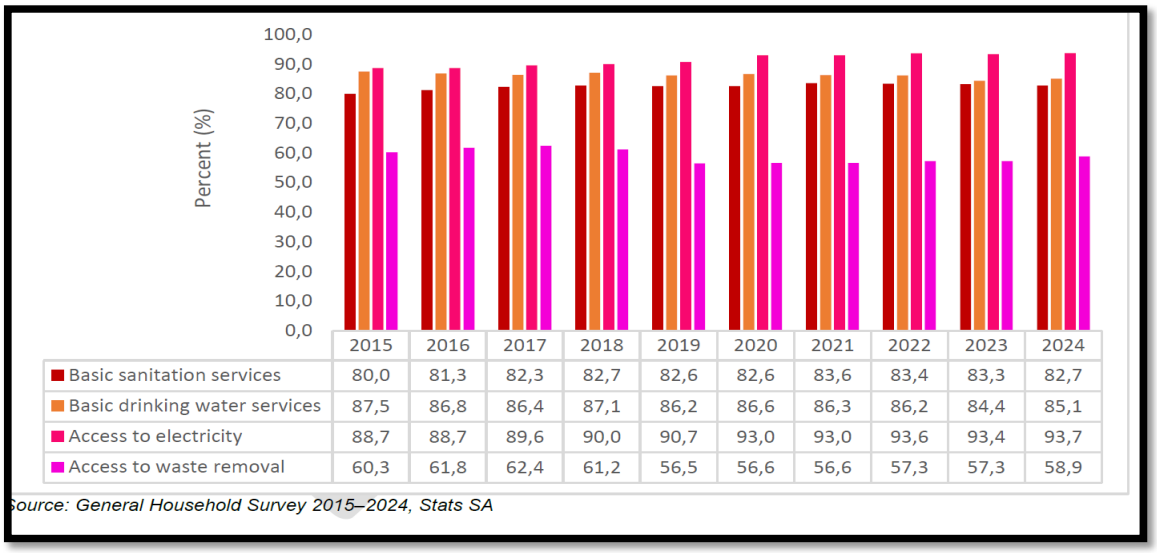
on converting a land tenure right into an ownership right. The amendment Act gives effect to a 2018 Constitutional Court ruling on sub-section 2(1) of the principal statute, which was found to be in violation of women's rights. This is noting that, when the principal statute came into force in 1991, it was assumed that a man headed any household affected by the new legislation and therefore held any deed of grant or right of leasehold to be converted into a right of ownership.

221. The Amendment Act strengthens women's land rights by allowing for applications to convert insecure or lesser forms of tenure into ownership; requiring notice to interested and affected persons before conversion; providing an opportunity for objections where rights may be adversely affected; allowing for inquiries to determine competing or overlapping tenure claims; and enabling an aggrieved person to approach the court for appropriate relief. This reform is particularly important for women in former homeland and customary tenure areas, where women have historically experienced exclusion from formal recognition of land rights, registration, and inheritance.

222. The Land Court Act 6 of 2023, which commenced on 5 April 2024, strengthens the institutional framework for enforcing land rights. It establishes a dedicated Land Court, provides for appeals, and expands adjudicative and mediation arrangements for land matters. For rural women, the Land Court Act is important because it improves the enforceability of land rights in disputes involving tenure insecurity, eviction, land allocation conflicts, inheritance-related occupation disputes; and access to remedies where administrative decisions or local power structures exclude women. The Act is especially significant in a context where many rural women face practical barriers to justice, including cost, distance, legal complexity, and male-dominated local dispute systems. A specialist court and mediation framework can, if effectively implemented, improve access to justice for women whose land rights are violated.

223. In **response to recommendation 56 (b)** on ensuring **rural women's access to basic services**, in 2024, 93.7% of people in South Africa had access to electricity, 85.1% had access to drinking water facilities and 82.7% to sanitation services, while only 58.9% of people had access to waste removal services.

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	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Basic sanitation services	80,0	81,3	82,3	82,7	82,6	82,6	83,6	83,4	83,3	82,7
Basic drinking water services	87,5	86,8	86,4	87,1	86,2	86,6	86,3	86,2	84,4	85,1
Access to electricity	88,7	88,7	89,6	90,0	90,7	93,0	93,0	93,6	93,4	93,7
Access to waste removal	60,3	61,8	62,4	61,2	56,5	56,6	56,6	57,3	57,3	58,9

Source: General Household Survey 2015–2024, Stats SA

Article 15: Equality before the law

224. South Africa has maintained compliance with Article 15 through its constitutional guarantees and ongoing reforms to enhance women's legal capacity and access to justice.

225. The constitutional framework, particularly the equality clause, continues to guarantee equal legal status and capacity for women in civil matters, including the right to conclude contracts, administer property and access courts on an equal basis with men. This framework is reinforced by ongoing alignment with international and regional commitments on gender equality, which emphasise equal legal capacity and access to justice.

226. Government has continued to expand access to courts and legal services, including gender-responsive justice reforms and collaboration with Chapter 9 institutions and civil society to improve women's ability to enforce their rights during the reporting period.

227. The issue of equality before the law has been addressed across several articles throughout the report.

228. Legal Aid South Africa Act 39 of 2014 provides state-funded legal representation to indigent persons, many of whom are women and enhances access to justice and equality before the law. The traditional Courts Act 9 of 2022 aligns traditional justice with South Africa's Constitution, legally mandating the full, voluntary, and equal participation of women in traditional court proceedings, both

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as parties and as leaders. It prohibits discrimination, promotes non-sexism, and requires the Minister of Justice to create measures protecting women's rights in these forums.

Article 16: Marriage and family life

229. The Constitution of South Africa considers gender as a fundamental principle. Section 25 addresses the property rights of South Africans, including equitable access to land, judicial redress for people dispossessed of property because of racially discriminatory laws or practices in the past and secure tenure or comparable redress for people living in tenure insecurity.

230. Marriage issues related to land ownership are regulated by the Marriage Act (Act No. 25 of 1961), the Matrimonial Property Act (Act No. 88 of 1984), the Recognition of Customary Marriages Act (Act No. 120 of 1998), and the Civil Union Act (Act No. 17 of 2006). The Promotion of Equality and Prevention of Discrimination (Act No. 4 of 2000), includes the promotion of equitable land ownership. Sections 6 and 8(e) prohibit "any policy or conduct that unfairly limits access of women to land rights." The Communal Property Associations, 1996 (Act. 28 of 1996) protects the interests of women through non-discriminatory provisions and inclusive decision-making processes in communal property ownership and use of communal land (section 9). The Communal Land Rights Act (No. 11 of 2004) legally entitles women to the same tenure and rights in or to land. It protects them from any laws, rules, or practices that may discriminate against anyone based on gender (Section 4). The Extension of Security of Tenure Act (No. 62 of 1997) provides measures to facilitate land tenure's long-term security and is gender neutral and non-discriminatory. The Prevention of Illegal Eviction from and Unlawful Occupation of Land Act (No. 19 of 1998) states that the rights of the elderly, children, persons with disabilities and particularly households headed by women should be considered and that "it should be recognised that the needs of those groups should be considered."

231. **In response to recommendation 62** The Recognition of Customary Marriages Amendment Act 1 of 2021 (the RCMAA) came into operation on the 1 June 2021. It amends s 7(1) of the Recognition of Customary Marriages Act 120 of 1998 (the RCMA) following the Constitutional Court (CC) judgments in Gumede v President of the Republic of South Africa and Others 2009 (3) BCLR 243 (CC) and

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Ramuhovhi and Others (Maphumulo as Intervening Party) v President of the Republic of South Africa and Others (Trustees of the Women's Legal Centre Trust as amicus curiae) 2018 (2) BCLR 217 (CC). Section 6 of the RCMA provides that 'a wife in a customary marriage has on the basis of equality with her husband and subject to the matrimonial property system governing the marriage, full status and capacity, including the capacity to acquire assets and to dispose of them, to enter into contracts and to litigate, in addition to any rights and powers that she might have at customary law'.

232. **On the recognition of Muslim and Hindu marriages,** Divorce Amendment Act 1 of 2024, which came into operation on 14 May 2024 signal a significant development in the country. This law amended the Divorce Act 70 of 1979 to expressly recognise Muslim marriages for purposes of divorce proceedings and related relief. This Act provides a definition for a Muslim marriage to ensure the protection and to safeguard the interests of dependent and minor children of a Muslim marriage and provide for the redistribution of assets on the dissolution of a Muslim marriage. Although this was not a direct amendment to the Marriage Act itself, it materially advanced the legal position of Muslim women in the family law system.

233. Regarding the issue of **raising the minimum age of marriage to 18** years for both boys and girls, one of the significant provisions of the new **Marriage Bill (B43-2023)** is the complete prohibition of child marriages. The bill sets the minimum legal age for marriage at 18 years, aligning with international standards and recognizing the importance of protecting the well-being and rights of children. This crucial amendment will ensure that no person under the age of 18 can enter a marriage, irrespective of parental consent. By outlawing child marriages, South Africa takes a vital step towards safeguarding the rights and futures of its young population.

Right to bank loans and mortgages and other forms of financial credit

234. The National Development Plan (NDP) 2030 envisions a South Africa where all citizens, particularly women and marginalised groups, are empowered to participate meaningfully in the economy. NDP 2030 emphasises an inclusive economy that benefits all South Africans with the emphasis on women's access to financial resources, entrepreneurship opportunities, and sustainable development initiatives, driving inclusive economic growth. With regards to Human Rights and

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Economic Justice, the NDP underscores human rights as a foundation for sustainable development with the message that financial inclusion and economic empowerment are fundamental rights essential for reducing poverty and achieving equity.

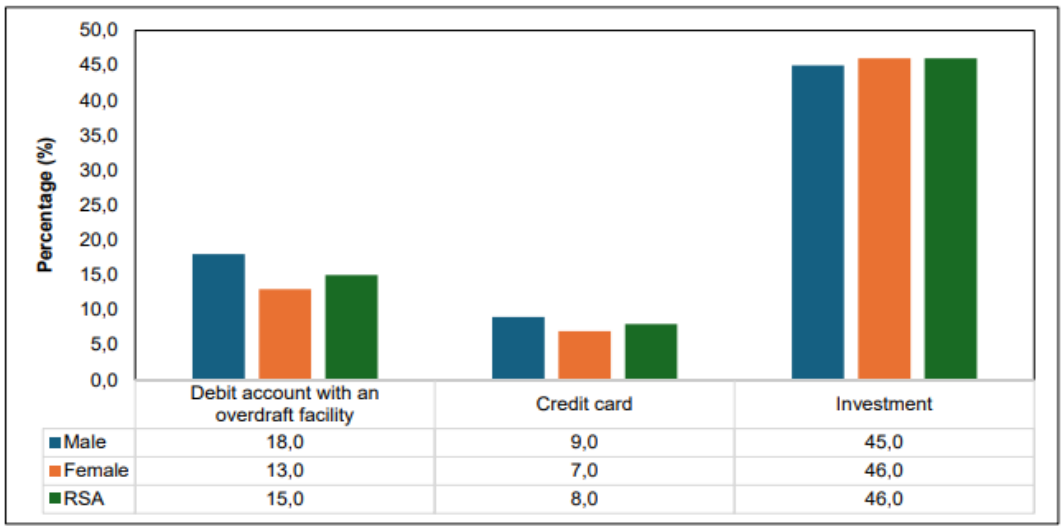
235. To improve financial inclusion, the government of South Africa introduced the Financial Inclusion Policy Framework (2023) "An Inclusive Financial Sector for All", a policy framework seeking to deepen inclusion for individuals especially women and low-income households, expand access for SMMEs (notably women-owned), and encourage diverse financial service providers and channels.

236. South Africa also developed the Women Financial Inclusion Framework (WFIF) (2023), which aims to address the gender gap in financial inclusion, ensuring that women are not only included in the financial system but also able to actively participate, contribute, and benefit equally from all sectors of the economy. WFIF addresses various barriers women face, such as limited access to credit, financial literacy, and digital financial services. The framework on Women's Financial Inclusion will improve guided efforts towards gender equality and women's economic empowerment from a government perspective to achieve gender equality and empower all women and girls by 2030.

Access to banking services

237. The graph below shows the percentage of persons with access to various accounts by sex in 2023. The South African Reserve Bank study highlighted slight gender differences in financial access. While a slightly larger percentage of males (9,0%) reported possessing a credit card in their own name compared to females (7,0%), a smaller percentage of males (45,0%) than females (46,0%) have ever made financial investments. Nationally, 15,0% of individuals reported holding a debit card with an overdraft facility (18,0% for males and 13,0% of females).

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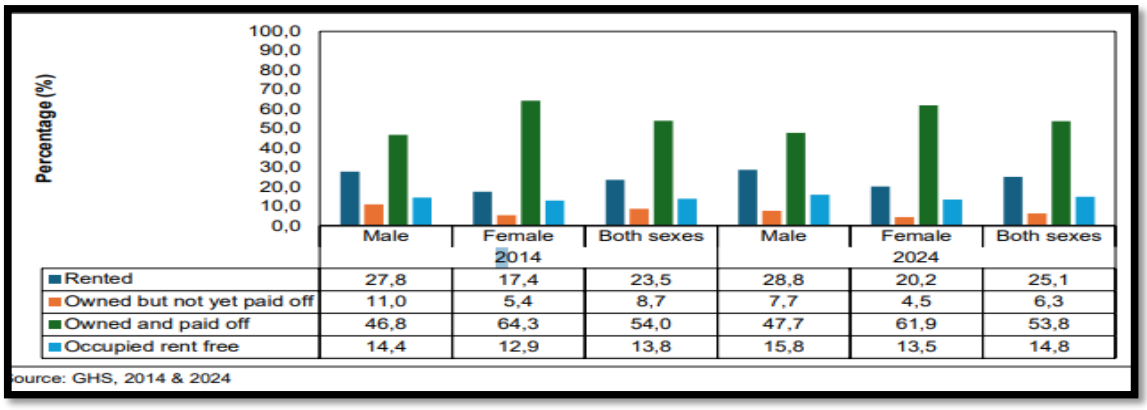


	Debit account with an overdraft facility	Credit card	Investment
Male	18,0	9,0	45,0
Female	13,0	7,0	46,0
RSA	15,0	8,0	46,0

Source: SARB, 2023

Property ownership and asset control

238. Ownership and access to land or property confer significant economic advantages, including increased agricultural productivity, the ability to use assets as collateral for credit, and opportunities for income generation through rental or commercial use. However, women often face legal, institutional and cultural barriers that prevent them from holding formal rights to land. Without recognised ownership or secure tenure, women are frequently excluded from these economic benefits, limiting their financial independence and resilience.



	Male	Female	Both sexes	Male	Female	Both sexes
	2014			2024		
Rented	27,8	17,4	23,5	28,8	20,2	25,1
Owned but not yet paid off	11,0	5,4	8,7	7,7	4,5	6,3
Owned and paid off	46,8	64,3	54,0	47,7	61,9	53,8
Occupied rent free	14,4	12,9	13,8	15,8	13,5	14,8

ource: GHS, 2014 & 2024

239. The graph above presents household dwelling ownership patterns, disaggregated by sex of the household head. The data shows that more than half of households were more likely to own the dwellings they occupied. Nationally, the percentage of households that occupied dwellings that were owned and fully paid off declined slightly from 54,0% in 2014 to 53,8% in 2024. In contrast, while the

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CONTINUES ON PAGE 770 OF BOOK 7

Printed by and obtainable from the Government Printer, Bosman Street, Private Bag X85, Pretoria, 0001
Contact Centre Tel: 012-748 6200. eMail: info.egazette@gpw.gov.za
Publications: Tel: (012) 748 6053, 748 6061, 748 6065

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Government Gazette
Staatskoerant

REPUBLIC OF SOUTH AFRICA
REPUBLIEK VAN SUID AFRIKA

Vol. 731 29 May Mei 2026 No. 54758

PART 7 OF 7

N.B. The Government Printing Works will not be held responsible for the quality of "Hard Copies" or "Electronic Files" submitted for publication purposes

ISSN 1682-5845

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percentage households that occupied dwellings rent-free increased from 13,8% in 2014 to 14,8% in 2024 over the same period indicating a modest shift in tenure arrangements.

240. Gender-based differences in housing tenure were also evident. Female-headed households were more likely to occupy dwellings that are owned and fully paid off, suggesting a greater degree of housing security among this group. Conversely, male-headed households were more frequently found in rented dwellings or in properties that were owned but not yet fully paid off, reflecting differing financial and housing dynamics between sexes.

CONCLUSION

241. South Africa's sixth CEDAW periodic report reflects meaningful progress in advancing gender equality, particularly through strengthened legal frameworks, expanded policy commitments, and improved institutional mechanisms aimed at protecting women's rights.

242. Notable gains include efforts to combat gender-based violence, enhance women's political representation, and promote socio-economic inclusion.

243. Despite these gains, persistent challenges continue to hinder full realization of these rights, including high levels of gender-based violence, economic inequality, limited access to resources for rural and marginalized women, and gaps in effective implementation and accountability.

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GENERAL NOTICES • ALGEMENE KENNISGEWINGS

NON-GOVERNMENTAL ORGANIZATION

NOTICE 3960 OF 2026

Aan die Staatspresident van die Republiek van Suid-Afrika en die RSA Administrasie as geheel, die Verenigde Nasies, Brics Nasies en die geheel van die Wêreldbevolking in hulle persoonlike en/of verteenwoordigende hoedanigheid en aan die Boervolk.

Die RSA regering en administrasie is in onregmatige besit en/of beheer van die Boervolk se grondgebied en ‘n manifestasie van kolonialisme soos uiteengesit in staatskoerantkennisgewings 3586/2025, 3651/2025 en 7053 op 30 Januarie 2026;

En aangesien die Boervolk van Transvaal en die Oranjevrijstaat internasionaal erkende soewereine volke is wat van hulle grondgebied ontneem is en onderdruk is deur kolonialisme en manifestasies van kolonialisme sedert 31 Mei 1902;

En aangesien dit duidelik blyk dat Brittanje of haar agent, die huidige administrasie van die RSA, nooit van plan was om te presteer soos per die terme van die Vredesverdrag van Vereeniging nie, tesame met die beginsels soos neergelê in voormelde goewermentskennisgewings en geskoei op die Richtersveld saak, -bygevolg is die geheel van die RSA administrasie ‘n valse fasade en derhalwe niks anders as ‘n versinsel en bygevolg ab initio nietig;

en omdat geen hof in die RSA by magte is om oor sodanige feitestel te beslis nie, -soos uitgewys deur die Hoëhof te Bloemfontein in die Hattingh saak in 2025;

En aangesien Resolusie 1514/60 van die Verenigde Nasies bepaal dat alle volke geregtig is op selfbeskikking en dat geen gebrek aan politiese-, ekonomiese-, sosiale- en geletterdheidsfaktore, -waar en indien van toepassing mag wees, ooit as voorwendsel gebruik mag word om onafhanklikheid te verhinder nie;

En aangesien die Internasionale hof in die Serwië Kosovo aangeleentheid bepaal het dat n onderdrukte volk nie die toestemming van sy onderdrukker nodig het om sy onafhanklikheid aan te kondig en eensydiglik uit te roep nie;

En aangesien die RSA administrasie, -legitiem of nie, se eie Grondwet onderhorigheid deur die RSA Administrasie aan Internasionale Reg vereis;

En aangesien daar geen legitieme besware ge-opper is en bestaan teen die voormelde staatskoerantkennisgewings en/of die inhoud daarvan nie, - derhalwe onbetwis;

En aangesien die Boervolk van die Oranjevrijstaat en die Boervolk van die Zuid-Afrikaanse Republiek een volk is wat in twee internasionale volke verdeel is deur kolonialisme;

En aangesien die twee Boervolke ook bondgenote was in die oorlog teen Brittanje en dit uitdruklik, alternatiewelik stilswyend, alternatiewelik by implikasie beteken dat die een in

die bresse sal tree en sal ageer vir die ander sou die ander nie in staat wees om dit te kan doen nie;

En aangesien daar nie tans n Waarnemende Volksraad vir die ZAR bestaan of ander derglike spreekbuis om namens die Boervolk van die ZAR te ageer nie;

Derhalwe verklaar en roep die Boervolk van die Oranjevrijstaat uit, via sy waarnemende Volksraad, namens die Boervolk van die Oranjevrijstaat wat insluit die oostelike gedeelte van Natalia, die Boervolk van die Zuid-Afrikaanse Republiek en die Boervolk as geheel, -

DAT:

1.vanaf 31 Mei 2026 -

i. Geen een van die wette, regulasies, reëls, jotas en/of titels van die RSA administrasie verder van toepassing is en geldig is op die geheel van die Boervolk in die gebiede Oranjevrijstaat, die eertydse Zuid-Afrikaanse Republiek grondgebied en die Republiek van Natalia nie;

ii. die gemelde Boervolk en Boere Republieke vry en onafhanklik van die RSA Administrasie sal wees.

iii. En dat die Boervolk in geheel vanaf 31 Mei 2026 nie verder val onder die jurisdiksie van die RSA Howe nie, maar dat die Boervolk sy eie Hooggeregshowe van Jurie van eweknieë sal hê, welke die hoogste hof van die Boervolk sal wees en welke howe ondergeskik aan geen ander hof sal wees nie.

iv. Identifikasie dokumentasie uitgereik deur die Waarnemende Volksraad en Administrasie van die Oranjevrijstaat aan Boere en Boerinne, prima facie bewys van Boervolk burgerskap sal wees.

v.

(a) die Waarnemende Volksraad en Administrasie van die Oranjevrijstaat die bestuur van die Boerrepublieke in die interim, sal hanteer en behartig tot en met die Republieke se onderskeie volksverkiesings.

(b)Beide Republieke, Oranjevrijstaat en Transvaal (Zuid-Afrikaanse Republiek) sal so spoedig doenlik volksverkiesings hou, elkeen volgens sy konstitusie en grondwet van toepassing in 1899, waarkragtens ‘n Volksraad en ‘n Staatspresident verkies sal word per Republiek.

(c)die interim administrasie sal behartig word met die Oranjevrijstaat Constitutie van 1879 as grondwet.

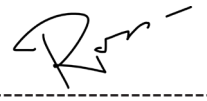
2.Die RSA administrasie met daadwerklike stappe die stelselmatige oorhandiging van die administrasie van die gebiede aan die Boervolk bewerkstellig, - die koste verbonde aan die daarstelling van die Boervolk administrasie vir die rekening van die huidige RSA administrasie te wees.

3. Alle ooreenkomste gesluit, Internasionaal en plaaslik, deur en met die RSA Administrasie van nul en gener waarde is nie, tensy hernu word met die onderskeie Boervolke se Administrasies.

4. Alle persone, instansies, instellings, regerings of wie ook al in besit is van Boervolk eiendom, of ooit in besit daarvan was, onmiddellike die Waarnemende Volksraad van die Republiek Oranjevrijstaat daarvan in kennis stel te die ondervermelde e-pos adres.

5. Oranjevrijstaat staatskoerantkennisgewings sal voortaan geplaas word by www.oranjevrijstaatboervolk.com en sodra geplaas geag gelees te gewees het.

Gedoen en geteken te Bloemfontein op hierdie 22 ste dag van Mei 2026.



Per: Willem A. Rossouw (Wim)

Lid Waarnemende Volksraad www.oranjevrijstaatboervolk.com

Republiek Oranjevrijstaat navrae@oranjevrijstaat.com

DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM

NOTICE 3961 OF 2026

land reform &
rural development
Department:
Land Reform and Rural Development
REPUBLIC OF SOUTH AFRICA

Private Bag X833, PRETORIA, 0001; 600 Lillian Ngoyi Street, PRETORIA, 0002
Tel: 012 – 312 8911; E-mail: terries.ndove@dlrrd.gov.za; Website: www.dlrrd.gov.za

Form 2

(Regulation 2(1))

DEPARTMENT OF LAND REFORM AND RURAL DEVELOPMENT

UPGRADING OF LAND TENURE RIGHTS ACT, 1991 (ACT NO. 112 OF 1991):
SECTION **2**

Notice of an application for conversion of a land tenure right by the Minister

I, Mzwanele Nyhontso Minister of Land Reform and Rural Development, has received an application for the conversion of a land tenure right described below.

Interested persons are hereby informed of the application for the conversion of the land tenure right.

Any person interested in the application may object to such application within a period of (30) thirty days from the publication of this notice. An objection to the application must be lodged at the address below.

1. The name, surname, identity number and residential address of the applicant:
   Mamello Annacleta Phatela ; 1951/07/31; Erf 948 Maluti Township.

2. The nature of the land tenure right:
   Deed of Grant

NO	Name & Surname	Erf Number	Title Number	Identity Number
1.	Mamello Annacleta Phatela	Erf 948, Maluti	G 948/1983	51/07/31
2.	Busisiwe Princesss Mqina	Erf 451 Maluti	G69/1996	620618****088
3.	Nompumelelo Alphina Mbokwana	Erf 841 Maluti	G168/1986	580910****424
4.	Arnold Joseph Molikeng Lebenya	Erf 684 Maluti	G43/1995A	540509****087
5.	Mary Nkutu Motsilili	Erf 378 Maluti	G218/1981	40/11/06
6.	Fiddian Moeketsane Sekoai	Erf 913 Maluti	G102/1982	50/05/29
7.	Mary Nkutu Motsilili	Erf 759 Maluti	G386/1982	40/11/06
8.	Nompumelelo Alphina Mbokwana	Erf 802 Maluti	G168/1986	580910****424
9.	Nozipho Primrose Moshesh	Erf 102 Maluti	G212/1992	53/06/20
10.	Belemi Isaac Cheka Ngomane Bayard Majikijela	Erf 723 Maluti	G271/1993A	37/01/01 700312****088
11.	Tense Thato Masakala	Erf 936 Maluti	G46/1985	57/03/14
12.	Lesenyeo Stephen Morai Phumza Patience Morai	Erf 1050 Maluti	G249/1992	660911****89 771203****081
13.	Christopher Sefali	Erf 1053 Maluti	G61/1996	59/09/09
14.	Matsiu Saferia Mofokeng	Erf 357 Maluti	G467/1982	57/04/15
15.	Salome Thembekile Sikhunyana	Erf 530 Maluti	G82/1974	Unknown

16.	Nomonde Nozuko Dontsa	Erf 63 Maluti	G20/1993	54/09/14
17.	Thantaswa Lucia mmoso	Erf 430 Maluti	G53/1981	57/04/27
18.	Vuyiswa Marjorie Mafunda	Erf 2 Maluti	G301/1991	51/07/29
19.	Ivy Mzekandaba	Erf 229 Maluti	G248/1990	231213****300
20.	Mokhele Motsoko	Erf 432 Maluti	G35/1981	57/10/26
21.	Thandiwe Nongqayi	Erf 387 Maluti	G219/1993	570727****204
22.	Mameja Emily Somdaka	Erf 588 Maluti	G49/1974	Unknown
23.	Kolitswe die-Gratia Bennie	Erf 403 Maluti	G105/1980	41/11/16
24.	Mookho Agnes Arosi	Erf 291 Maluti	G240/1992	49/08/25
25.	Bonginkosi Pratrick Dontsa	Erf 633 Maluti	G15/1993	590511****502
26.	Refiloe Petronella Ntlola Honour Malamlela Ntlola	Erf 398 Maluti	TG 616/2005	650316****083 621106****087
27.	Emily Ndabile Mpitsa	Erf 397 Maluti	G141/1991	47/05/02
28.	George Lesaoana Khoapa	Erf 288 Maluti	G119/1980	41/07/28
29.	Margaret Ketetso Kortjass	Erf 976 Maluti	G106/1983	43/12/16
30.	Samuel Nkoala Mabea	Erf 579 Maluti	G323/1983	29/07/01
31.	Bernad Holo Haas	Erf 854 Maluti	T4033/2003	710113****086
32.	Andreas Pule Matela Cynthia Noxolo Matela	Erf 1229 Maluti	T918/2006	710621****081 800713****085

33.	Maleboheng Veronica Kondile	Erf 974 Maluti	T1433/2007	611202****081
34.	Motselise Christina Monaheng	Erf 1161 Maluti	TG 602/2005	530620****086
35.	Lulama Upington Lurwengu Bulelani Lenford Mvundlela Molaoli Mangoali Khuthala Mangoali	Erf 177 Maluti	G19/1995A	62/06/20 660525****082 710701****081 730831****085
36.	Washington Mdolo	Erf 1037 Maluti	G144/1983	33/03/13
37.	Malehloa Stephania Koloko	Erf 1173 Maluti	TG1610/2000	590514****085
38.	Victor Joseph Malefane Pulela Zandile Maria Pulela	Erf 597 Maluti	TG2987/2000	651125****089 681220****088
39.	Jankula James Lebeko	Erf 1234 Maluti	G140/1990	520115****084
40.	Mohlalefi Ezekiel Maputle	Erf 390 Maluti	G179/1985	53/01/01
41.	Mohlowa Ernest Khotseng	Erf 646 Maluti	G162/1986	49/04/06
42.	Virginia Nompindelelo Silimela	Erf 1121 Maluti	G110/1985	35/04/15
43.	Moses Mokhele	Erf 513 Maluti	G23/1974	Unknown
44.	Simthembile Shadrack Ndlela	Erf 632 Maluti	G66/1980	54/06/20
45.	Merriete Nthofela Tenene	Erf 705 Maluti	G149/1988	610925****089
46.	Mampe Flora Meselane	Erf 868 Maluti	TG770/2001	580215****085

47.	Nonceba Constance Bekubu	Erf 1099 Maluti	G147/1992	64/04/27
48.	Michael Rantebo Lepheana	Erf 25 Maluti	G132/1988	590809****206
49.	Thotobole Mary Bernadet Zungu	Erf 807 Maluti	G495/1982	49/12/13
50.	Cecilia Moyakazi Matangana	Erf 247 Maluti	G72/1996A	620921****082
51.	Jackson Bongani Mcence	Erf 132 Maluti	T1118/2005	450505****082
52.	Jackson Bongani Mcence	Erf 1248 Maluti	T1118/2005	450505****082
53.	Mlungisi Phillip Dabula	Erf 121 Maluti	G63/1987	521204****605
54.	Thandiwe Ntombekaya Salukazana	Erf 817 Maluti	G123/1993	591130****003
55.	Thembinkosi Mshuqwana	Erf 1001 Maluti	G85/1982	55/03/25
56.	Mongezi Milward Kondlo	Erf 64 Maluti	G139/1979	51/05/20
57.	Sindiswa Ndamane	Erf 400 Maluti	G117/1980	53/05/28
58.	Theko David Moshoeshoe	Erf 521 Maluti	G8/1976	Unknown
59.	Dalindyebo Samson Mchunu	Erf 73 Maluti	G11/1974	Unknown
60.	Vincent Malunga Dabula	Erf 694 Maluti	G 329/1982	500501****906
61.	Mveleli Mbuyiselo Madikiza	Erf 1020 Maluti	G156/1992	61/12/28
62.	Mtandeki Cornwell Madubela	Erf 583 Maluti	G220/1993	37/07/01
63.	Onesimus Sejabakela Diaho	Erf 385 Maluti	G330/1983	54/07/18

64.	Vuyokazi Mercy Dabula	Erf 446 Maluti	G42/1995A	54/12/12
65.	Lesibo Remigius Setsubi	Erf 418 Maluti	G80/1980	51/09/27
66.	Nthofela Mary Sefoloko	Erf 1175 Maluti	G6/1997A	700818****087
67.	Agnencia Nkhothatseng Lepheana	Erf 920 Maluti	G129/1986	52/11/28
68.	Calvinator Azizia Somdaka	Erf 754 Maluti	G 38/1984	49/04/17
69.	Margaret Moleko	Erf 813 Maluti	G73/1995	660324****085
70.	Tamsanqa Tido Gumenke	Erf 1127 Maluti	G128/1994	400909****102
71.	Benjamin Mhlayifani Nonjiko	Erf 780 Maluti	G 302/1991	551014****085
72.	Peter Lulama Hene	Erf 123 Maluti	G376/1984	540709****080
73.	Benjamin Mhlayifani Nonjiko	Erf 747 Maluti	G 302/1991	551014****085
74.	Amelia Bongeka Vikilahle	Erf 313 Maluti	G117/1979	520911****084
75.	Mandlenkosi Enos Ndumndum	Erf 908 Maluti	G335/1983	290324****089

REQUEST THE DEPUTY DIRECTOR GENERAL: LAND REDISTRIBUTION AND TENURE REFORM TO APPROVE THE ISSUING OF PUBLICATION NOTICES IN THE GOVERNMENT GAZETTE, LOCAL NEWSPAPERS, MUNICIPAL NOTICE BOARDS AND SOCIAL MEDIA PLATFORMS, INFORMING ALL INTERESTED PERSONS OF THE APPLICATION FOR CONVERSION OF LAND RIGHTS IN TERMS OF SECTION 2(1A)(a) OF THE UPGRADING OF LAND TENURE RIGHTS ACT 112 OF 1991 AS AMENDED (ACT 6 OF 2021)

3. The location of the property by stand number, known name for the area; name of local municipality and the province:

   Erf 948 Maluti Township , Matatiele Local Municipality , Eastern Cape Province.

4. The description of the property:

   House

5. The capacity in which the land tenure right is being held or could have been held by the applicant:

   Owner

6. If the application is made on behalf of more than one-person, personal particulars of such other persons:

   N/A

7. Address at which objection can be lodged:

   (Physical address): Department of Agriculture, Land Reform and Rural Development

   600, Lilian Ngoyi, Berea Park

   Pretoria

   0002

   (Email address): queen.filani@dlrrd.gov.za

   thabani.motaung@dlrrd.gov.za

MR. TERRIES NDOVE
DEPUTY DIRECTOR GENERAL: LAND REDISTRIBUTION AND TENURE REFORM
DATE: 2026/05/11

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DEPARTMENT OF TRADE, INDUSTRY AND COMPETITION

NOTICE 3962 OF 2026

COMPETITION TRIBUNAL
NOTIFICATION OF DECISION TO APPROVE MERGER

The Competition Tribunal gives notice in terms of rules 34(b)(ii) and 35(5)(b)(ii) of the "Rules for the conduct of proceedings in the Competition Tribunal" as published in Government Gazette No. 22025 of 01 February 2001 that it approved the following mergers:

Case No.	Acquiring Firm	Target Firm	Date of Order	Decision
LM004Apr26	Norwegain Investment Fund for developing countries	Nafasi Water Technologies (Pty) Ltd	13/05/2026	Approved
LM202Mar26	Future Indefinite Investment 180 (Pty) Ltd	Permasolve Investments (Pty) Ltd	15/05/2026	Approved

The Chairperson Competition Tribunal

BOARD NOTICES • RAADSKENNISGEWINGS

BOARD NOTICE 923 OF 2026

LUBITO LWEKUKHETSA EMALUNGA EMMANGO LATAWUSEBENTA NJENGEBHODI YEBACONDZISI BEYUNITHI YESICHAZAMAGAMA SESISWATI VELONKHE

Umtsetfo Webhodi yeTilwimi taseNingizimu Afrika (No. 59 wa-1995, njengobe ubuyeketwe), esigabeni 8(8)(c), uvumela I-PanSALB kutsi icale nome yakhe emayunithi etichazamagama velonkhe (NLUs) kute tikhicite tichazamagama letiphelele letihwimilunye kulelo nalelo lwimi lolusemtsetfweni. Ema-NLU akhutsata kutfutfukiswa kwelulwimi ngekuhlanganisa tichazamagama naleminye imikhicito lehlobene ngelulwimi lwayo lolusemtsetfweni lwaseNingizimu Afrika Kufanele basebente njengetinkhampani letinemkhawulo ngesicintsekiso semtsetfo wetinkhampani (No. 71 wa-2008).

Lesi satiso lesimema onkhe emalunga emmango kanye netinhlangano nobe tikhungo temfundvo, temasiko kanye netinhlangano letibukene nesintfu kutsi tikhetse bantfu labatawusebenta kubhodi lebacondzisi be-Siswati NLUs. LeBhodi yeBacondzisi be-Siswati NLU itawusekela I-NLU ekukhiciteni tichazamagama telulwimi lunye kanye naleminye imikhicito yekubhalwa nekuchazwa kwemagama lehlose kutfutfukisa nekusebentisa lulwimi lwasekhaya, kutemfundvo, kanye nakuleminye imiculu yetemisebenti. Emkhatsini waleminye imisebenti, IBhodi leBacondzisi itawubuka kusebenta kwetimali, kanye naletinye tinhlobo temitfombolusito letingatfolakala kute kutfutfukiswe lulwimi lolutsintsekako, kanye nekwakha nekulungisa inchubomgomo netinhlelo letitawulandzelwa kute kufinyelelwe etinhlosweni letihlobene nekubhalwa, kushicilelwa nekumakethwa kwetichazamagama naleminye imikhicito yekubhalwa nekuchazwa kwemagama.

LOKUDZINGEKAKO/ EMAKHONO

Lophakanyiswe kumele abenenshisekalo etindzabeni tekutfutfukiswa kwelulwimi, nome lokungenani abe nelikhono linye kunawa lalandzelako..

1. Lwati emkhakheni we-lexicography (kuhlanganisa sichazamagama),lokubaluleke kakhulu.
2. Likhono lekuphatsa nebuholi.
3. Likhono lekuphatsa timali.
4. Lwati lwetindzaba temtsetfo, noma
5. Likhono kutekutsengisa,
6. Lwati lwetinhlelo tebucwepheshe
7. Bucwepheshe belulwimi lwesintfu.

FUTSI kufanele kube ngumuntfu lokhuluma lelolulwimi laphakanyiselwa lona.

Tiphakamiso kufanele titfunyelwe ngalokubhaliwe futsi kufanele tivete nome tilake imininingwane lelandzelako:

- Silhloko, emagama laphelele, emakheli (endzawo neliposi), kanye nemininingwane yekuchumana (imeyili netinombolo telucingo) taloyo lokhetsiwe kanye ne-curriculum vitae (CV) lenamakhasi lamabili aloyo lophakanyiswe.
- I-CV kumele ivete emagama laphelele aloyo lophakanyiswako, inombolo yamatisi, bulili, mininingwane yekuchumana (likheli le-meyili netinombolo telucingo), emakheli (endzawo kanye neleposi), ligama lesifundza lahlala kuso, netinchazelo letimfishane tesiphiliyoni sakhe, lwati, kanye nemakhono elulwimini lolufanele kanye/noma nemasiko.
- Emakhophi lacinisekisiwe amatisi alophakanyiswe kanye neticu temfundvo netebucwepheshe.
- Nome ngabe nguluphi lolunye lwati lolusekela ekuhlanganiseni emagama nemininingwane yekuchumana lokungenani bofakazi ababe babili (2). munye wabofakazi kumele aphume enhlanganweni noma esikhungweni selulwimi, emasiko, nemdzabu noma inhlangano yemmango/yemphakatsi.
- Incwadzi yelikhasi lelilodvwa letisayinirwe ngalokufanelekile levela kulokuphakamisile lekhombisa kutsi kungani lophakanyiswe afanelekile kubamba lichaza ekutfutfukisweni nasekusetjentisweni kwelulwimi lakhetselwe lona.
- Lilomu lesicelo leligcwaliswe ngalokufanelekile kufanele lisayinwe ngumphakamisi, umsekeli, kanye nelophakanyiswako.

Kute kuphakanyiswa lokutawucatjangelwa ngaphandle kwekutsi kufakwe konke lokungenhla nome lokudzingekako.

Kutfola lwati lolwengetiwe mayelana nenchubo kanye netidzingo, sicela uvakashele iwebhusayithi ye-PanSALB ku-www.pansalb.org noma ushayele:

Nkat. N Mkhize Lucingo lwasekhoveisi: (012) 341 9838 **I-imeyili:** *nonkululeko@pansalb.org*
Tiphakamiso kufanele tidluliselwe ku: Sikhulu Lesisetulu, Caphela: Sigaba Selulwimi, IBhodi Yetilwimi Tavelonkhe taseNingizimu Afrika
Nge-meyili: *nonkululeko@pansalb.org* **Ngeliposi leliya ku:** Private Bag X06, Arcadia, 0007
Kufaka wena matfupha: 5th Floor, Provisus Building, 523 Stanza Bopape Street, Arcadia, 0083

Lusuku lwekuvalwa: 10/04/2026

Sicela wati kutsi tiphakamiso letifakwa ngefeksi ngeke tamukelwe.

Sive sinye, tilwimi letinyenti

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BOARD NOTICE 924 OF 2026

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PanSALB

PAN SOUTH AFRICAN LANGUAGE BOARD ACT OF 1995 (ACT NO. 59 OF 1995)

CALL FOR COMMENT

NORTHERN CAPE PROVINCIAL LANGUAGE COMMITTEE (NCPLC)

The Pan South African Language Board (PanSALB) herewith declares that the following persons have been duly co-opted and recommended for appointment as members of the Northern Cape Provincial Language Committee (NCPLC) in terms of Section 8(8)(b) of the PanSALB Act (Act No. 59 of 1995) as amended, and in accordance with revised Norms and Rules for Provincial Language Committee published as Board Notice No. 622 of 2024 Government Gazette No. 50625 of 14 June 2024.

Co-opted candidates are hereby published for public comment. Members of the public are invited to submit written comments or objections to the recommendations of any of the persons whose names appear below. Comments are to be submitted within 14 days from the date of publication of this Board Notice in the Government gazette.

Should no comments or objections be received then the recommended person's name will be deemed to be confirmed for appointment by PanSALB.

Name	Language represented	Specialisation
Mr. Abraham William Katimba	Nama	Nama language development and preservation programmes, fluent Khoekhoegowab/Nama speaker, with reading and writing skills. Diopment Association (SANDEVA)
Ms. Nombuso Maka	IsiXhosa	IsiXhosa Educator and Examiner.
Mr. Muhammed Sheraz Obaray	SASL	Deaf culture activist, SASL communication and ABET basic level 1 Kha – Ri – Gude facilitator.
Ms. Rolene Opperman	Afrikaans	Afrikaans Educator, moderator and examiner.
Mr. Ulrich Leonardo Hendriks	Afrikaans	Specialised in Language and Media studies.
Ms. Kediemetse Charmaine Senwedi	Setswana	Official of the NC Dept. Education Curriculum unit and educator.
Ms. Doreen Mpho Mongale	English	English Teacher, Curriculum specialising in English additional language.
Ms. Sebaetse Margaret Chivatsi	Setswana	CoGHSTA

Comments and/or objections should be sent to:
The Acting Chief Executive Officer – Mr JJ Dantile
Attention: Mr. Raseabi Mosha Mosieleng

37 Chapel Street, Nedbank Building,
3rd Floor, Kimberley 8301
E-pos: raseabi@pansalb.org
Contacts: (053) 832 0037

LEKGOTLA LA DIPOLELO KA MOKA TŠA AFRIKA BORWA

LEKGOTLA LA DIPUO TSOHLE TSA AFRIKA BORWA

SOTO YA DIPUOTSOTLHE YA AFORIKABORWA

IBHODI YETILWANE TONKHE TASEMNGEZIMU AFRIKA

BODONYANGAREDZI YA NYAMBO YA AFRIKA TSHIPEMBE

HUVO YO ANGERHELA YA TINDZIMI TA AFRIKA-DZONGA

PAN BUID-AFRIKAANSE TAALRAAD

PAN SOUTH AFRICAN LANGUAGE BOARD

IBHODI YAMALIMI WOKE WEMVELO AFRIKA

IBHODI YEELIMI ZONKE ZASEMZANTSI AFRIKA

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RAADSKENNISGEWING 924 VAN 2026

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Proclamation Building | Arcadia | 0083

PanSALB

WET OP DIE SUID-AFRIKAANSE TAALRAAD, WET VAN 1995 (WET NR. 59 VAN 1995)

OPROEP OM KOMMENTAAR

NOORD-KAAPSE PROVINSIALE TAALKOMITEE (NPT)

Die Pan Suid-Afrikaanse Taalraad (PanSAT) verklaar hiermee dat die volgende persone behoorlik gekoöpteer en aanbeveel is vir aanstelling as lede van die Noord-Kaapse Provinsiale Taalkomitee (VPT) volgens Artikel 8(8)(b) van die PanSAT-Wet (Wet Nr. 59 van 1995) soos gewysig, en in ooreenstemming met die hersiene Norme en Reëls vir Provinsiale Taalkomitees gepubliseer as Raadskennisgewing Nr. 622 van 2024, Staatskoerant Nr. 50825 van 14 Junie 2024.

Gekoöpteerde kandidate word hiermee gepubliseer vir publieke kommentaar. Lede van die publiek word genooi om geskrewe kommentaar oor, of besware teen die aanbevelings van enige van die persone wie se name hieronder verskyn in te dien. Kommentaar moet binne 14 dae ingedien word vanaf die datum van publikasie van hierdie Raadskennisgewing in die Staatskoerant.

Indien geen kommentaar of besware ontvang word nie sal die aanbevole persoon se naam beskou word as bevestig vir aanstelling deur PanSAT.

Naam	Taal wat verteenwoordig word	Spesialisering
Mnr. Abraham William Katimba	Nama	Nama taalontwikkeling en bewaringsprogramme, Khoekhoegowab-/Nama sprekende met lees- en skryfvaardighede in die Nama taal.
Me. Nombuso Maka	isiXhosa	Onderwyser en eksamineerder vir isiXhosa
Me. Muhammed Sheraz Obaray	SASL	Aktivis vir die kultuur van Dowes, beskik oor SAGT kommunikasie vaardighede en fasiliteerder vir basiese vlak 1 in VBOO Kha-Ri-Gude
Me. Rolene Opperman	Afrikaans	Afrikaanse onderwyser, moderator en eksamineerder van ingrypingstrategieë in Afrikaans
Mnr. Ulrich Leonardo Hendriks	Afrikaans	Taal en Media
Me. Kedisemetse Charmaine Senwedi	Setswana	Amptenaar en onderwyser betrokke by die NK departement van onderwys se kurrikulum eenheid.
Me. Doreen Mpho Mongale	English	Onderwyser vir Engels, spesialisering in Engels
Me. Sebaetse Margaret Chivatsi	Setswana	CoGHSTA

Kommentaar en/of besware moet gestuur word aan:
Die Waarnemende Hoof-Uitvoerende Beampte – Mnr Julius Dantile
Aandag: Mnr. Raseabi Mosha Mosieleng

37 Chapel Straat, Nedbank Gebou, 3de Vloer, Kimberley 8301
E-pos: raseabi@pansalb.org
Kontak nr: (053) 832 0037

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Setšhaba se bee
se dipolelo tše dinši

LEKGOTLA LA DIPUO TSOHLE TSA AFRIKA BORWA
Setjhaba se le seng se
dipuo tse ngata

BOTO YA DIPUOTSOTLHE YA AFORIKABORWA
Setšhaba se le sengwe
se dipuo tse dintsi

IBHODI YETILIMI YONKHE TASEMNGCINI MU AFRIKA
Sive sinye,
tilimi lelinyenti

BODONYANGAREDZI YA NYAMBO YA AFRIKA TSHIPEMBE
Lushaka lutshi,
nyambo nnzhi

HUVO YO ANGERHELA YA TINDZIMI TA AFRIKA-DZONGA
Rixaka rin'we
tindzimi tinyingi

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amalimi amaningi

IBHODI YEELIMI ZONKE ZASEMZANTSI AFRIKA
Isizwe esinye,
iilwimi ezininzi

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Isizwe sinye
izilimi ezininji

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PanSALB

MOLAO WA 1995 WA BOTO YA DIPUOTSOTLHE YA AFORIKABORWA (MOLAO NO. 59 WA 1995)

BOIKUELO JWA DITSHWAELO

KOMITI YA DIPUO YA POROFENSE YA KAPABOKONE (NCPLC)

Boto ya Dipuotsotlhe ya Aforikaborwa (PanSALB) e dira kitsiso ya gore batho ba ba latelang ba tlhophilwe e bile ba atlanegisitswe go ka thapiwa jaaka ditokololo tsa Komiti ya Dipuo ya Porofense ya Kapabokone go latela Kgaolo 8(8)(b) ya Molao wa PanSALB (Molao No.59 wa 1995) jaaka o tlhabolotswe, mme o inaakanya le Melawana ya Komiti ya Dipuo ya Porofense ya Kapabokone e e phasaladitsweng jaaka Kitsiso ya Boto No.622 ya 2024 mo kaseteng ya Puso No.50825.

Batlhophiwa ba ba atlanegisitsweng ba phasaladiwa jaana gore setšhaba se tshwaele. Setšhaba se laledilwa go romela ditshwaelo kgotsa dikganetso tse di kwadilweng ka ga katlanegiso ya motho mongwe le mongwe yo leina la gagwe le tlhageletang ka fa tlase. Ditshwaelo di ka romelwa mo matsatsing a le lesomenne (14) go tloga ka letsatsi la phasalatso ya Kitsiso ya Boto mo kaseteng ya porofense.

Fa go ka se amogelwe ditshwaelo kgotsa dikganetso dipe, go tlaa tsewa gore PanSALB e tlaa tlhomamisa thapo ya batho ba ba atlanegisitsweng, ba ba umakilweng ka fa tlase.

Leina	Puo e e emetsweng	Boitseanape
Rre Abraham William Katimba	Se-Nama	Mananeo a Tshomarelo le Tlhabololo ya Puo ya Se-Nama, Sebui sa Se-Khoekhoegowab le Se-Nama le bokgoni jwa go buisa le go kwala.
Mme Nombuso Maka	Sexhosa	Morutabana/Monutisi le Motlhatlhobi wa Sexhosa
Rre Muhammed Sheraz Obaray	Puo ya Matshwao ya Aforikaborwa (SASL)	Modibelapuo le Setso sa basusu, Tlhaeletsano ya Puo ya Matshwao ya Aforikaborwa, le Mothusi wa Logato lwa ntlha lwa motheo wa Kha-Ri-Gude, ABET.
Mme Rolene Opperman	Seaforikanse	Morutabana/Monutisi wa Seaforikanse, Molekanyetsi, le Motlhatlhobi wa tsereganyo ya togamaano ya Seaforikanese
Rre Ulrich Leonardo Hendriks	Seaforikanse	Dithutego tsa Puo le Metswedi ya Tshedimosetso
Mme Kediemetse Charmaine Senwedi	Setswana	Morutabana/Monutisi Motlhankedi wa Lefapha la Thuto la Kapabokone: Yuniti ya Kharikhulamo
Mme Doreen Mpho Mongale	Seesemane	Morutabana/Monutisi wa Seesemane, Moitseanape wa puotlalelotso ya Seesemane.
Mme. Sebaetse Margaret Chivatsi	Setswana	CoGHSTA

Ditshwaelo le/kgotsa dikganetso di tshwanetse go romelelwa go:
Motlhankedipheithisi-mogolo wa Namaotshwere: Rre JJ Dantile
Tlhokomediso: Rre Raseabi Mosha Mosielelang

37 Chapel Street, Nedbank Building,
3rd Floor, Kimberley 8301
Imeile: raseabi@pansalb.org
Mogala: (053) 832 0037

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BODONYANGAREDZI YA NYAMBO YA AFRIKA TSHIPEMBE
Lushaka lutshi, nyambo nnzhi

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Rixaka rin'we tindzimi tinyingi

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Isizwe sinye, amalimi amaningi

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Isizwe esinye, iilwimi ezininzi

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Isizwe sinye izilimi ezininji

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PanSALB

LEKGOTLA LA DIPUO TSOHLE TSA AFRIKA BORWA (MOLAO 59 WA 1995)

PITSO YA DITSHWAELO

KOMITI YA PUO YA PROVENSE YA NORTHERN CAPE (NCPLC)

Lekgotla la Dipuo Tsotlhe Tsa Afrika Borwa (PanSALB) le phatlalatsa hore batho bana ba latelang ba kgethuwe ka tshwanelo ebile ho kgothaletswa hore ba tle ba kgethwe ho ba ditho tsa Komiti ya Puo ya Provense ya Northern Cape (NCPLC) ho latela Karolo ya 8(8) ya Molao wa PanSALB (Molao wa 59 wa 1995) o fetotsweng, le ho latela Ditlwaelo le Melawana ya Komiti ya Puo ya Provense e lekotsweng boljha, jwalo ka ha e phatlaladitswe e le Tsebiso ya Boto Nomoro ya 622 ya 2024 Gazete ya Mmuso Nomoro ya 50825 ya 14 Phupjane 2024.

Mabitso a kgothaleditsweng a phatlalatswa mona hore setjhaba se tshwaele. Setjhaba se mengwa ho romela ditshwaelo kapa dikganyetso tse ngotsweng ka mabitso a batho ba kgothaleditsweng a hlahellang tlase mona. Ditshwaelo di ka romelwa matsatsi a 14 ho tloha letsatsi la phatlalatso la tsebiso ya Boto gazeteng.

Ebang ho se na ditswaelo kapa dikganyetso tse amohelwang, ho tla bolela hore motho eo lebitso la hae le kgothaleditsweng le tla nkuwa e le la motho ya kgethuweng ke PanSALB.

Lebitso	Puo e emetsweng	Bolpabolo
Ntate Abraham William Katimba	Nama	Mananeo a poloko le ntshetsopele ya puo ya Nama, sebui sa Khoekhoegowab/Nama se nang le bokgoni ba ho e bua le ho e ngola.
Mme Nombuso Maka	IsiXhosa	Titjhere ya IsiXhosa, mohlahlobi.
Ntate Muhammed Sheraz Obaray	SASL	Molseki wa botjhaba ba Dithoko, dipuisano tsa SASL le motataisi wa boemo ba motheo ba 1 ba ABET ba – Kha – Ri – Gude.
Mme Rolene Opperman	Afrikaans	Titjhere ya Afrikaans, molekodi le mohlahlobi wa maano a ho kena dipakeng puong ya Afrikaans.
Ntate Ulrich Leonardo Hendriks	Afrikaans	O ipabola ka dithuto tsa Puo le Media.
Mme Kedlemetse Charmaine Senwedi	Setswana	Moofisiri wa Lefapha la Thuto la Northern Cape yuniting ya kharlkhulamo eo hape e leng titjhere.
Mme Doreen Mpho Mongale	English	Titjhere ya English, Kharlkhulamo e ipabolang ka English.
Mme Sebaetse Margaret Chivatsi	Setswana	CoGHSTA

Ditshwaelo le/kapa dikganyetso di romelwe mona:
ka Sehloohong wa Phethahatso ya Tshwereng
Mokobobo: Ntate JJ Dantile
Tlhokomediso: Mong. Raseabi Mosha Mosiieleng

37 Chapel Street, Nedbank Building,
3rd Floor, Kimberley 8301
E-mail: raseabi@pansalb.org
Tel: (053) 832 0037

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Lushaka luthihi, nyambo nnzhi

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Isizwe sinye izilimi ezininqi

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BOARD NOTICE 925 OF 2026

PITŠO YA DITSHWAYASWAYO TŠA SETŠHABA TŠA BAO BA KGETHILWEGO GO TLALELETŠA GO BOTO YA YUNITI YA TLHAMOPUKUNTŠU

Molao wa (Nr. 59 wa 1995, bjalo ka ge o fetošitšwe) wa Boto ya Maleme ka moka a Afrika Borwa (PanSALB), ka karolong ya 8(8)(c) o dumelela PanSALB go ka hloma Yuniti ya Tlhamopukuntšu ya Bosetšhaba (diNLU) go ka hlama pukuntšu yeo e feletšego ya polelo e tee sebakeng sa polelo ye ngwe le ye ngwe ya semmušo. DINLU di šomela pele tlhabollo ya polelo ka go kgoboketša dipukuntšu le ditšweletšwa tše dingwe tšeo di amanago le tšona ka polelo ya semmušo ya Afrika Borwa yeo e kgethilwego. Diyuniti di swanetše go šoma bjalo ka dikhamphani tšeo di nago le magomo go ya le ka tlhaetšo ya Molao wa Dikhamphani (Nr. 71 wa 2008).

Se se šoma bjalo ka boipiletšo bja gore maloko a setšhaba a fe ditshwayatshwayo tša bao ba kgethilwego go ba go Boto ya Yuniti ya Tlhamopukuntšu ya Sesotho sa Leboa. Balaodi ba Boto ya NLU ba tla laola NLU ya bona ka go šweletša pukuntšutlhaloši ya go tsenelela le ditšweletšwa tša go sepelelana le tlhamo ya pukuntšu tšeo maikemišetšo e lego tšwetšopele le tšhomišo ya polelo ka baboledi ba yona ba setlogo, ditlhutong, le diretšišetareng tše dingwe tša sephorofešenale. Magareng ga maikarabelo a mangwe, Balaodi ba Boto ba tla hlokomela tshepetšo ya tša ditšhelete, batho, le tše dingwe tša methopo yeo e lego gona sebakeng sa tlhabollo ya mantšu a polelo yeo e amegago le go hlama le go lokiša pholisi le maano ao a swanetšego go lateiwa gore go fihlelelwe maikemišetšo ao a amanago le go phatlalatša, go gatiša, le go bapatša dipukuntšu le ditšweletšwa tše dingwe tša tlhamopukuntšu.

Maina a bašišinywa bao ba latelago a phatlalatšwa gore setšhaba se fe ditshwayotshwayo. Maloko a setšhaba a laletšwa go romela ditshwayatshwayo goba dikganetšo ka mokgwa wa go ngwala mabapi le motho ofe goba ofe yeo a šišintšwego ka tlase. Ditshwayatshwayo di swanetše go romelwa matšatšing a 14 go tloga ka letšatšikgwedi la phatlalatšo ya Tsebišo ye ya Boto Kaseteng ya Bosetšhaba. Ge go ka se be le ditshwayaswayo goba dikganetšo tšeo di amogetšwego, gona go tla tšewa gore motho yo leina la gagwe le šišintšwego ke yena thwalago ke PanSALB.

MAINA A BATHO BAO BA KGETHILWEGO GO TLALELETŠA GO BOTO YA YUNITI YA TLHAMOPUKUNTŠU

Leina	Mabokgoni le botsibi
1. Ms Reshoketswe Sethume Sefoka	Tša Thuto
2. Mna Isaac Maslo Mashila	Boraditaba le dikgokaganyo
3. Mna. Maropeng Zacharia Maponya	Sošiološi le Mokgwatshepetšo wa tsebo ya tša setlogo
4. Ms Maphale Juliah Maphutha	Tša Molao

Ka kgopelo etela weposeete ya PanSALB go www.pansalb.org goba o ka ikgokaganya le:

Ms. Nonkululeko Mkhize Nr: (012) 341 9838 **Emelle:** nonkululeko@pansalb.org
Ditshwayatshwayo di swanetše go romelwa go: Mohlankedimogolophethiši, Go Tšwetšopele ya Polelo le Tšhomišo ya Polelo

Ka emelle: nonkululeko@pansalb.org **Ka poso:** Private Bag X08, Arcadia, 0007
O ka tliša ka letsogo: 5th Floor, Provisus Building, 523 Stanza Bopape Street, Arcadia, 0083

Letšatšikgwedi la go tswalela: Matšatši a lesomenne (14) ka morago ga phatlalatšo

Setšhaba se tee, dipolelo tše dintši
www.pansalb.org

Printed by and obtainable from the Government Printer, Bosman Street, Private Bag X85, Pretoria, 0001
Contact Centre Tel: 012-748 6200. eMail: info.egazette@gpw.gov.za
Publications: Tel: (012) 748 6053, 748 6061, 748 6065

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