Federated States of Micronesia National Greenhouse Gases (GHG) Inventory Report (NIR): 2018

AUGUST 13-2022

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Executive Summary

[to be included in final version]

Abbreviations

AFOLU	Agriculture, Forestry and Other Land Use
CCD	Climate Change Division
CH_4	Methane
CO	Carbon Monoxide
CO	Carbon Monoxide
CO_2e	Carbon Dioxide equivalent (also for CO_2-eq)
DECEM	Department of Environment, Climate Change, and Emergency Management
FSM	Federated States of Micronesia
FSMPC	Federated States of Micronesia Petroleum Corporation
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Giga Gram
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GWP	Global Warming Potential
HFCs	Hydro Fluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product use
LDC	Least Developed Countries
LPG	Liquefied Petroleum Gas
N_2O	Nitrous Oxide
NGOs	Non-Governmental Organizations
SIDS	Small Island Developing States
TNC	Third National Communication
TWG	Thematic Working Group
UNFCCC	United Nations Framework Convention on Climate Change

Contents

Federated States of Micronesia's (FSM) National Greenhouse Gas (GHG) Inventory (NIR): Introduction

Brief Background and Process

The National Greenhouse Gas (GHG) Inventory of the Federated states of Micronesia (FSM) has been developed as a part of the Third National Communication (TNC) to the United Nations Framework Convention on Climate Change (UNFCCC), for period 2001-2018. The FSM's national inventory includes greenhouse gas emissions and removals from Energy; Industrial Processes and Product Use (IPPU); Agriculture, Forestry and Other Land Use (AFOLU), and the Waste sector (along with each sector's individual categories and sub-categories) within the national territory and offshore areas over which the country has jurisdiction. This NIR is successive to the first National GHG inventory submitted by FSMs as a part of the initial National Communication (INC)[1] submitted in 1997 (based on 1994 data) and its second GHG inventory under the Second National Communication (SNC)[2] submitted in 2015 (based on 2000 data).

The third national communication (TNC), presents a comprehensive description of anthropogenic Greenhouse Gas (GHGs) emissions and removals from FSM for the year 2018 (also include for the period 2001 to 2017) in accordance with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[3], 2006 IPCC Guidelines for Greenhouse Gas Inventories[4] and IPCC Good Practice Guidance (GPG)[5]. A summary information table of previous inventory submissions (i.e., for the years 1994 and 2000), as reproduced from previous submissions have also been presented in this report.

Table 1: Summary Second National Greenhouse Gas (GHG) Inventory year 2000

Inventory Year: 2000	Sectoral Total GHG emissions in Gg			
Categories	**CO_2-equiv**	**CO_2**	**CH_4**	**N_2O**
1 - Energy	**158.18936**	**151.915**	**0.18935**	**0.00367**
2- Industrial Processes and Product Use	**0.07125**	**0.07125**	**0.00000**	**0.00000**
3 - Agriculture, Forestry, and Other Land Use	**0.77265**	**0.0000**	**0.02750**	**0.00001**
4 - Waste	**14.50491**	**0.0000**	**0.06157**	**0.04823**
Total GHG Emissions, excl. Removals	**171.53817**	**151.98625**	**0.27842**	**0.05191**

[1] First National Communication of FSM Submitted to UNFCCC https://unfccc.int/sites/default/files/resource/Micronesia%20INC.pdf
[2] Second National Communication of FSM Submitted to UNFCCC https://unfccc.int/sites/default/files/resource/fsmnc2.pdf
[3] https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html
[4] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
[5] Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, https://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html

Table 2: Summary Total National Greenhouse Gas (GHG) Inventory years 1994 & 2000

Greenhouse gas sources and sink categories	CO_2e Emissions (Gg)	CO_2 Emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)
Total National Emissions and Removals (1994)	184.6341	164.535	-474.11537	0.23374	0.05115
Total National Emissions and Removals (2000)	173.5443	151.986	-568.40867	0.27864	0.05191

The FSM's national GHG inventories for the year 2018 and time series for the year 2001-2017 have been prepared using the Tier1 approach for the applicable Greenhouse Gas (GHGs) as per the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories i.e., sectoral, sub-sectors, and gas type categorization. The sectors and gases analyzed for this NIR include the emissions by sources (excluding removals by sinks) of all anthropogenic GHGs (excluding the precursor gases and gases covered under the Montreal protocol). The NIR estimates the GHG emissions from the following sectors which are relevant to FSM:

1. Energy
2. Industrial Processes and Product Use (IPPU) – Not Occurring in FSM
3. Agriculture, Forestry and Other Land Use (AFOLU) and
4. Waste

Please note, in the country, industrial activities are negligible and GHG emissions occurring from Industrial Processes are zero (and not estimated under this NIR) further fossil fuel is mainly used in the energy sectors hence the use of GHGs in products, and from non-energy uses of fossil fuel carbon is non-existence; hence emissions from IPPU sector are considered as zero.

The reference (top-down) approach has been used to estimate GHG emissions from the energy sector (for the years 2009 to 2018, emissions for the years 2001 to 2008 have not been estimated due to a lack of data availability). The reference approach is based on FSM's energy supply data to calculate the GHG emissions from the combustion of fossil fuels; however, since the reference approach does not distinguish between different source categories within the energy sector i.e. sub-sectoral level (e.g., Electricity generation, Transportation, Residential and Commercial, Others, etc.) hence estimates available for total GHG emissions from Source category 1A, Fuel Combustion.

In this inventory report, emissions from some categories and sub-categories are not estimated ("NE") due to insufficient data, and some not occurring ("NO") or are relevant to FSM. A summary of the sectors, sub-sectors, and categories and sub-categories 'Estimated' and 'Not Estimated (NE)' and 'Not Occurring (NO)' for the period 2001-2018 is annexed to the report.

The GHG emissions estimated are:

1. Carbon dioxide (CO_2)
2. Methane (CH_4)
3. Nitrous Oxide (N_2O)

Following indirect GHGs are not estimated and reported. Further, these indirect GHG emissions are not accounted for in the aggregated national GHG emissions.

1. Oxides of Nitrogen (NOx),
2. Carbon Monoxide (CO),
3. Non-Methane Volatile Organic Compounds (NMVOC) and
4. Sulphur dioxide (SO_2)

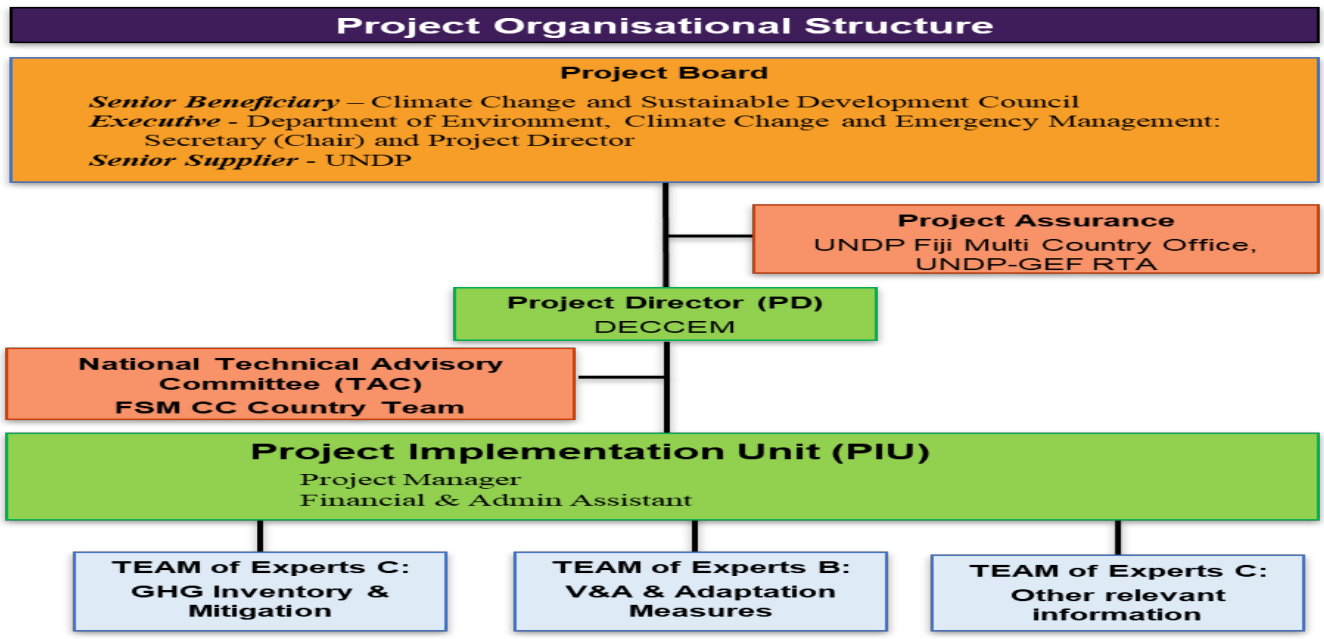
The GHG emissions are reported in Giga-grams (Gg) and the aggregated GHG emissions and removals are expressed in CO_2 equivalents (Gg CO_2e or CO_2eq) using the Global Warming Potential (GWP) defined by IPCC Fifth Assessment Report (AR5)[6].

This report also provides a description of the methodologies used, the quality assurance/quality control (QA/QC) measures applied, the results of the key category analysis, and approach-I quantification of the uncertainties associated with the estimates. As a best practice, FSM has carried out a key category analysis[7] which helped to identify the most relevant GHG inventory categories for FSM. Furthermore, an uncertainty assessment[8] has been conducted on the estimates of emissions and removals, which identifies the potential for improvement in future inventory.

Institutional Arrangements and Organization Structure for Inventory Preparation

The FSM has established an institutional arrangement to monitor, report, verify, and respond to the review of GHG estimates, further the process for data compilation and continuous improvement in NIR is an important aspect of institutional arrangement. The Department of Environment, Climate Change, and Emergency Management (DECCEM) is the national entity responsible for NIR and TNC reporting in FSM. The interactions between organizations that are involved in the TNC and NIR including the GHG inventory inputs, compilation processes, and outputs depicted in the figure below.

Figure 1: Institutional Arrangement and Organization Structure for TNC



[6] IPCC Fifth Assessment report, Global Warming Potential (GWP) Values, https://www.ipcc.ch/pdf/assessmentreport/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (p. 73-79)
[7] IPCC 2006 Guidelines, http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_4_Ch4_MethodChoice.pdf
[8] The IPCC 2006 Guidelines, http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf.

The TNC is being managed by the Project Board i.e. mainly responsible for decision making by consensus and providing guidance to the Project Manager, including recommendations from UNDP (Implementing Partner), approval of project plans, revisions, etc. The Project Board is comprised of: the Secretary of the DECEM (who also chairs and senior beneficiary to the Climate Change and Sustainable Development Council); the Project Director- DECEM (as an executive) and the UNDP (as the Senior Supplier). The project assurance role shall be provided by the UNDP Fiji Multi-Country Office, UNDP GEF RTA.

The National Technical Advisory Committee (TAC) provides technical advice and inputs relating to project implementation and is chaired by the Project Director with support from the Project Manager. The members of the TAC consist of the representatives from Government Ministry, CC country team, UNDP, other relevant government agencies, research and educational organizations, NGOs (including WCS), technical experts and other relevant stakeholders agreed by the Project Board.

The project implementation unit (PIU) has been formed with the TNC Project Manager, and Financial & Admin Assistant together. PIU is being supported by the teams of experts on GHG inventory & Mitigation, V&A & Adaptation, and other relevant information.

Training and Capacity Building

The training and Capacity Building program was designed and delivered to the PIU team and other key stakeholders. The overall objective was to develop the capacity, share experiences, and learnings from the previous NIRs, data, and information communication protocols (data collection, archiving, reporting, and quality management in the context of existing national statistical data collection systems) and best practices with the stakeholders; to achieve the necessary level of expertise to develop national GHG inventory through data collection, analysis, monitoring and reporting guidelines, and procedures as required by UNFCCC. The stakeholders were also updated on IPCC 2006 Guidelines, updates, and best practices. The training exercise was focused on the following key areas: (i) GHG estimation methods in the latest IPCC Guidelines (2006 and 2019 enhancement, GPGs); (ii) Application of the IPCC Guidelines to the national circumstances; and (iii) QA/QC and Review processes.

Stakeholder Consultation

Stakeholder consultation was carried out among the stakeholders from government and government departments, public and private sectors, local and international development partners, NGOs, and public groups. The first phase of the stakeholder consultation focused on the key objective of the TNC and NIR project, inception, approach & methodology, and processes. The stakeholders were updated on the key steps of TNC and consulted on various aspects of GHG inventory sectors e.g., data collection process, climate change mitigation, adaptation, and V&A management. The stakeholders were also updated on IPCC 2006 Guidelines and Best Practices to develop the national GHG Inventory.

The second phase of stakeholder consultation involved the presentation of the results i.e., National GHG Inventory for the period 2001 to 2018, data, standards, and assumptions applied for estimation and compilation of FSM's National GHG inventory, key sector, and categories, data gaps, assumptions, and uncertainties, etc. The objective of this phase was also to validate the assumptions and standards used for GHG inventory and seeks inputs from a wider stakeholder group. An important aspect of the stakeholder consultation was to update on the data gaps, uncertainties, etc. and issues and activities to be considered to improve the quality, completeness, and transparency of GHG inventory and updates on the national GHG inventory improvement plan (NIIP).

Quality Assurance/Quality Control and Review Mechanism

A quality assurance/quality control (QA/QC) and review mechanism was an integral part of the process and was devised in order to improve transparency, consistency, comparability, completeness, and accuracy of third national communication and national greenhouse gas inventory. An internal QA/QC plan was developed and roles and responsibilities were defined for the GHG Inventory Team Members. The QA/QC process and review mechanism have been implemented at all levels of data collection, inventory preparation, and reporting.

The inventory team routinely conducted checks on the consistency of the data and information provided by the different stakeholders (line ministries, government departments, Organizations, Public and private sector, etc.), to ensure data integrity, correctness, and completeness. In case of discrepancy or incompleteness, the inventory team consulted the relevant stakeholders and experts to reduce the data uncertainty, appropriate corrections, and address errors and omissions. The sub-sectoral and sectoral calculations of GHGs were shared with the experts for technical review of categories and sub-category activity data, emission factors, estimation parameters, and calculation methods. The inputs provided by the experts were addressed and the GHG emission reduction calculation was revised. On finalization of the GHG Inventory calculations, the draft report was prepared and shared with the key Stakeholders.

Further, the draft report and GHG inventory calculations were presented during the stakeholder consultation to seek input and finalize the report. The main outcomes of QA/QC and review process were overall improvement in the quality of data collection, calculations, reporting and inclusion of the key criteria analysis, uncertainty estimates, and subsequent improvements in the future GHG Inventory i.e., National Inventory Improvement Plan (NIIP).

National GHG Inventory: 2001 – 2018

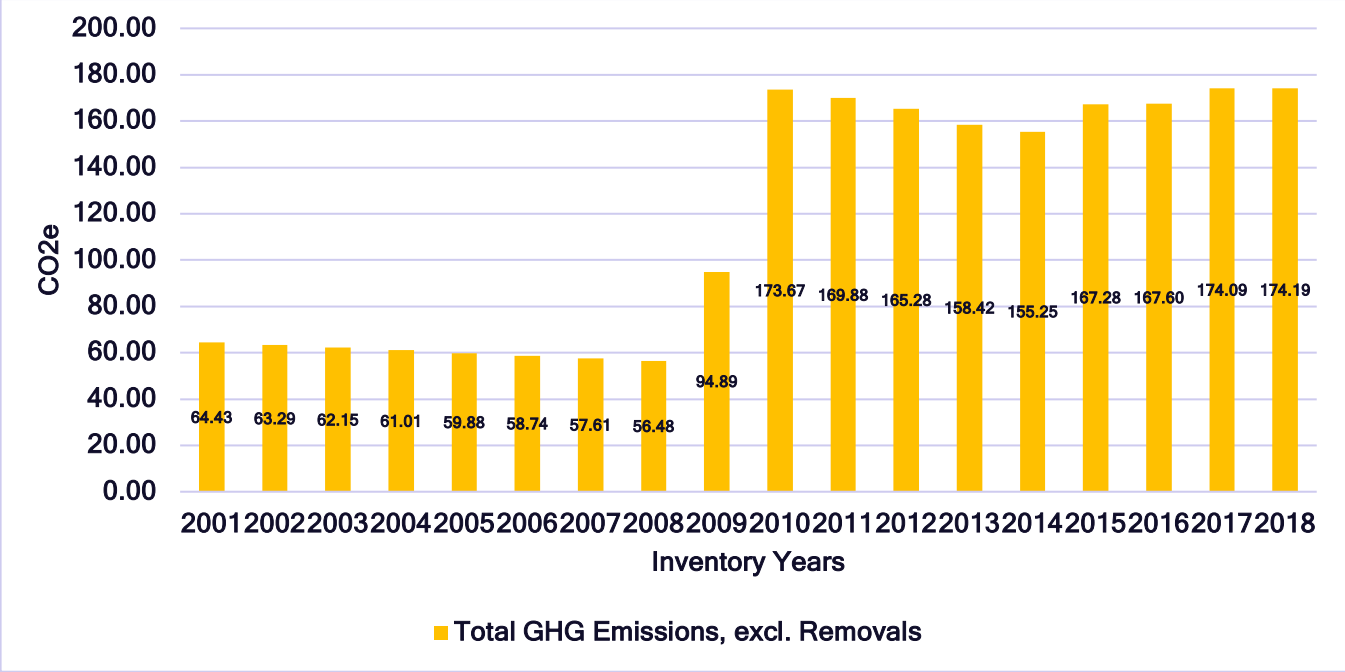
Overview

FSM's total GHG emissions for years 2001-2018 has been estimated based on the methodologies discussed in the previous section of the report and are presented hereunder in the following section. In 2018, the FSM's total GHG emissions (excluding removals) was 174.19 Gg CO_2e (in comparison to 184.63 Gg CO_2e estimated for year 1994 under the first national communication and 173.52 Gg CO_2e estimated for year 2000 under the second national communication). This comprises direct CO_2 emission 118.52 Gg, CH_4 emission 1.72 Gg and N_2O emissions 0.028 Gg during 2018. The emissions of other indirect GHG like perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and Sulphur hexafluoride (SF_6) are not estimated due to limited application and no manufacturing of the products containing these gases. In absolute terms, FSM's total GHG (CO_2e) emissions was around 0.0000031% of the total Global GHG emissions for year 2018. The global per capita GHG emissions (in terms of tonnes of CO_2e per person) for the year 2018 were about 7.274 tonnes of CO_2e per person per year (Considering Global population for 2018 was 7.602 billion persons[9]); whereas FSM's per capita GHG emissions was around 1.67 tonnes of CO_2e per person per year for the same period.

Total GHG Emissions

The FSM's total GHG emissions in Gg CO_2e (excluding removals) for the inventory years 2001-2018 are presented as following:

Figure 2: FSM's GHG Emission (excluding removals), Gg CO_2e: 2001 -2018



Note: The GHG emissions from Energy Sector was not estimated for the inventory years 2001-2008, due lack of energy data availability.

[9] World Bank Open Data, Population (Total) Indicator 2018, https://data.worldbank.org/indicator/SP.POP.TOTL

Table 3: FSM's GHG Emission (excluding removals), Gg CO_2e: 2001 -2018

Inventory Year	1 - Energy	2 - IPPU	3 - AFOLU	4 - Waste	Total GHG Emissions(excl. Removals)
	Gg $CO_2eq.$				
2001	NE	NE	35.12	29.31	**64.43**
2002	NE	NE	34.08	29.20	**63.29**
2003	NE	NE	33.04	29.10	**62.15**
2004	NE	NE	32.01	29.01	**61.01**
2005	NE	NE	30.97	28.91	**59.88**
2006	NE	NE	29.93	28.81	**58.74**
2007	NE	NE	28.89	28.72	**57.61**
2008	NE	NE	27.85	28.63	**56.48**
2009	39.73	NE	26.82	28.34	**94.89**
2010	119.64	NE	25.78	28.26	**173.67**
2011	116.83	NE	24.74	28.30	**169.88**
2012	113.23	NE	23.70	28.35	**165.28**
2013	108.34	NE	22.66	27.41	**158.42**
2014	105.69	NE	22.11	27.46	**155.25**
2015	115.98	NE	24.20	27.10	**167.28**
2016	114.17	NE	26.29	27.15	**167.60**
2017	119.79	NE	27.10	27.19	**174.09**
2018	118.52	NE	28.35	27.24	**174.11**

Figure 3: FSM's GHG Emission (excluding removals) by Gas (Gg): 2001 -2018

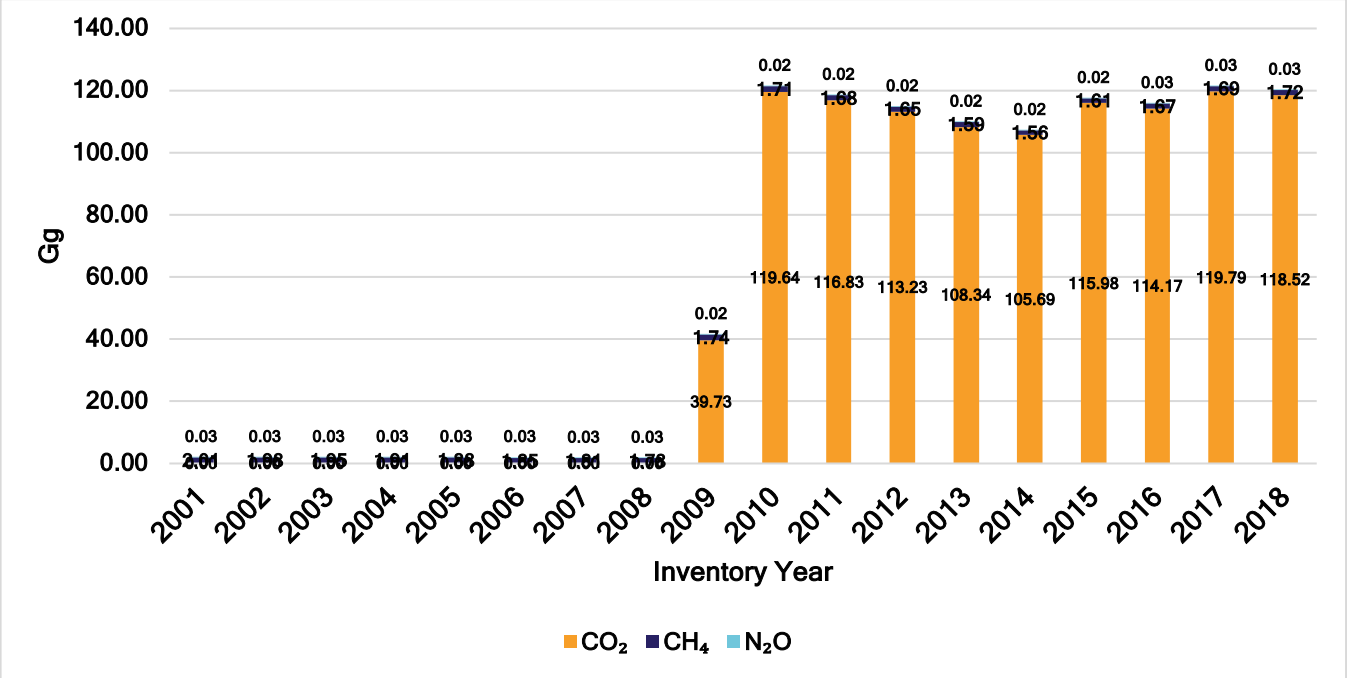
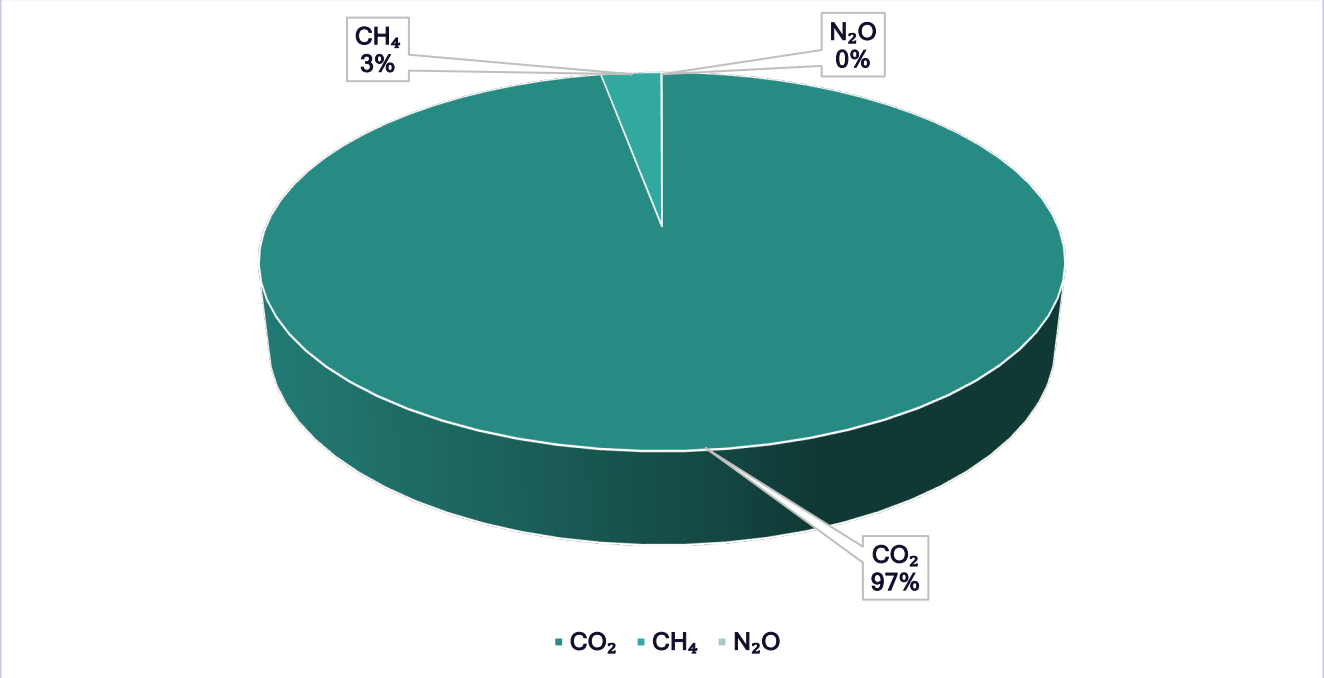


Table 4: FSM's GHG Emission (excluding removals) by Gas (Gg): 2001 -2018

Year	CO_2eq.	CO_2	CH_4	N_2O
2001	64.43	0.00	2.01	0.030
2002	63.29	0.00	1.98	0.030
2003	62.15	0.00	1.95	0.029
2004	61.01	0.00	1.91	0.028
2005	59.88	0.00	1.88	0.027
2006	58.74	0.00	1.85	0.027
2007	57.61	0.00	1.81	0.026
2008	56.48	0.00	1.78	0.025
2009	94.89	39.73	1.74	0.024
2010	173.67	119.64	1.71	0.024
2011	169.88	116.83	1.68	0.023
2012	165.28	113.23	1.65	0.022
2013	158.42	108.34	1.59	0.021
2014	155.25	105.69	1.56	0.022
2015	167.28	115.98	1.61	0.024
2016	167.60	114.17	1.67	0.025
2017	174.09	119.79	1.69	0.027
2018	174.11	118.52	1.72	0.028
Average	115.78	59.55	1.77	0.026

Figure 4: FSM's GHG Emission (excluding removals) by Gas (Gg): Average 2001-2018



The total GHG emissions from FSM is increasing during the inventory years 2001-2018, an indicative increase in the CO_2 emission followed by CH_4 and N_2O emissions. CO_2 emissions are mainly attributed to the fossil fuel combustion activities, while CH_4 and N_2O emissions are from agriculture-livestock (Enteric fermentation, Manure management and Aggregate sources and non-CO_2 emissions sources on land) and Waste Sector (Solid waste and waste water) respectively.

GHG Emissions by Sector

The main GHG emission sectors and sub-sectors in FSM are:

- Energy Sector
  - Fuel Combustion Activities (1.A)
- Agriculture, Forestry, and Other Land Use
  - Livestock (3.A)
  - Aggregate sources and non-CO2 emissions sources on land (3.C)
- Waste
  - Solid Waste
    - Solid Waste Disposal (4.A)
  - Wastewater Treatment and Discharge (4.D)
    - Domestic Waste Water

The listed sector and sub-sectors are sources of direct CO_2 emission, CH_4 emission and N_2O emissions and emissions of precursor gases (NOx, SOx and NMVOC); further the other indirect GHGs like perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and Sulphur hexafluoride (SF_6) are not estimated due to limited application and no manufacturing of the products containing these gases in FSM.

The total GHG emissions for the year 2001-2018 (excluding removals is summarized in the table below:

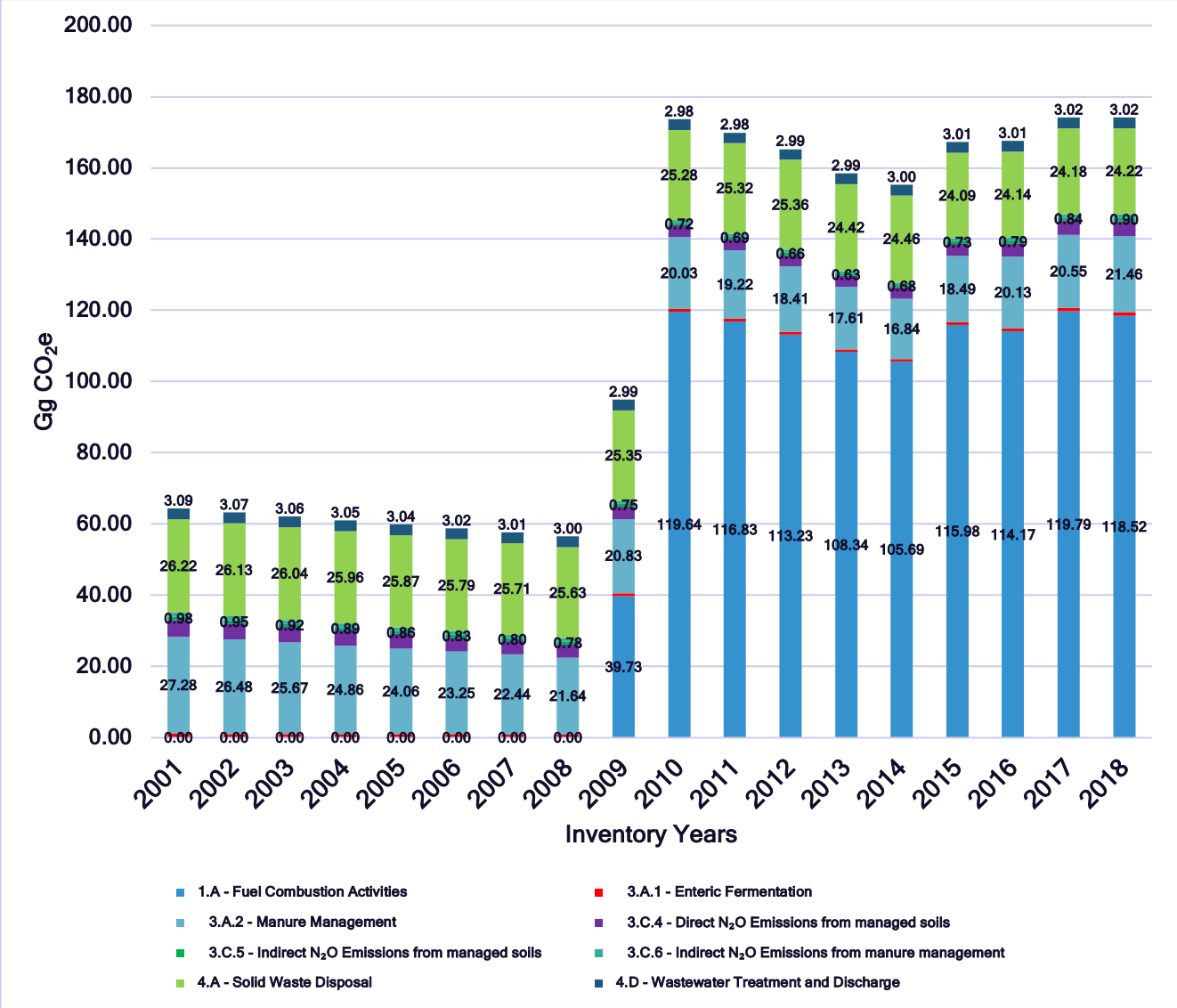
Table 5: FSM's Total GHG Emission (Gg CO_2e) : 2001 -2018

Inventory Year: 2001-2018	Net CO_2 Emissions, (CO_2 Equivalents Gg)																	
Categories	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1 - Energy	NE	NE	NE	NE	NE	NE	NE	NE	39.73	119.64	116.83	113.23	108.34	105.69	115.98	114.17	119.79	118.52
1.A - Fuel Combustion Activities	NE	NE	NE	NE	NE	NE	NE	NE	39.73	119.64	116.83	113.23	108.34	105.69	115.98	114.17	119.79	118.52
2 - Industrial Processes and Product Use	NE																	
3 - Agriculture, Forestry, and Other Land Use	35.12	34.08	33.04	32.01	30.97	29.93	28.89	27.85	26.82	25.78	24.74	23.70	22.66	22.11	24.20	26.29	27.10	28.43
3.A - Livestock	28.42	27.58	26.74	25.90	25.06	24.22	23.38	22.54	21.70	20.86	20.02	19.18	18.34	17.54	19.26	20.97	21.40	22.35
3.C - Aggregate sources and non-CO2 emissions sources on land	6.70	6.50	6.30	6.11	5.91	5.71	5.51	5.31	5.12	4.92	4.72	4.52	4.32	4.56	4.94	5.32	5.70	6.08
4 - Waste	29.31	29.20	29.10	29.01	28.91	28.81	28.72	28.63	28.34	28.26	28.30	28.35	27.41	27.46	27.10	27.15	27.19	27.24
4.A - Solid Waste Disposal	26.22	26.13	26.04	25.96	25.87	25.79	25.71	25.63	25.35	25.28	25.32	25.36	24.42	24.46	24.09	24.14	24.18	24.22
4.D - Wastewater Treatment and Discharge	3.09	3.07	3.06	3.05	3.04	3.02	3.01	3.00	2.99	2.98	2.98	2.99	2.99	3.00	3.01	3.01	3.02	3.02
Total GHG Emissions, excl. Removals	64.43	63.29	62.15	61.01	59.88	58.74	57.61	56.48	94.89	173.67	169.88	165.28	158.42	155.25	167.28	167.60	174.09	174.19

GHG Emissions by Sub-sector and Categories

The FSM's Sub-sectoral GHG emissions during the inventory years 2001-2018, presented here:

Figure 5: FSM's Sub-Sector-wise GHG Emissions- excluding removals (Gg CO_2e): 2001-2018



The FSM's sub-sector wise GHG emissions indicates that, the key GHG emissions contributions are from 1.A - Fuel Combustion Activities (electricity generation, transport and others), 3.A – Livestock (3.A.1 - Enteric Fermentation and 3.A.2 - Manure Management), 3.C.4 - Direct N2O Emissions from managed soils, 3.C.5 - Indirect N2O Emissions from managed soils, 3.C.6 - Indirect N2O Emissions from manure management, 4.A - Solid Waste Disposal, and 4.D - Wastewater Treatment and Discharge.

The sub-sector wise GHG emissions shows that, the GHG emissions from solid waste disposal and manure management activities are reducing year on year basis. This is mainly attributed due to the decline in livestock population and rehabilitation and upgrading of the some of the waste disposal sites from unmanaged to semi-aerobic process. The average emissions from these two subsectors are 21.8% and 18.7% respectively. Followed by Direct N_2O Emissions from managed soils 3.2%,

Wastewater Treatment and Discharge 2.6%, Enteric Fermentation 0.8%, Indirect N_2O Emissions from manure management 0.8% and Indirect N_2O Emissions from managed soils 0.7%. A detailed analysis of each of the sub-sectors is provided in the later sections of the report. The following graph present the average emissions from the each of subsector.

Figure 6: FSM's Sub-Sector-wise Average GHG Emissions (excluding removals): 2001-2018

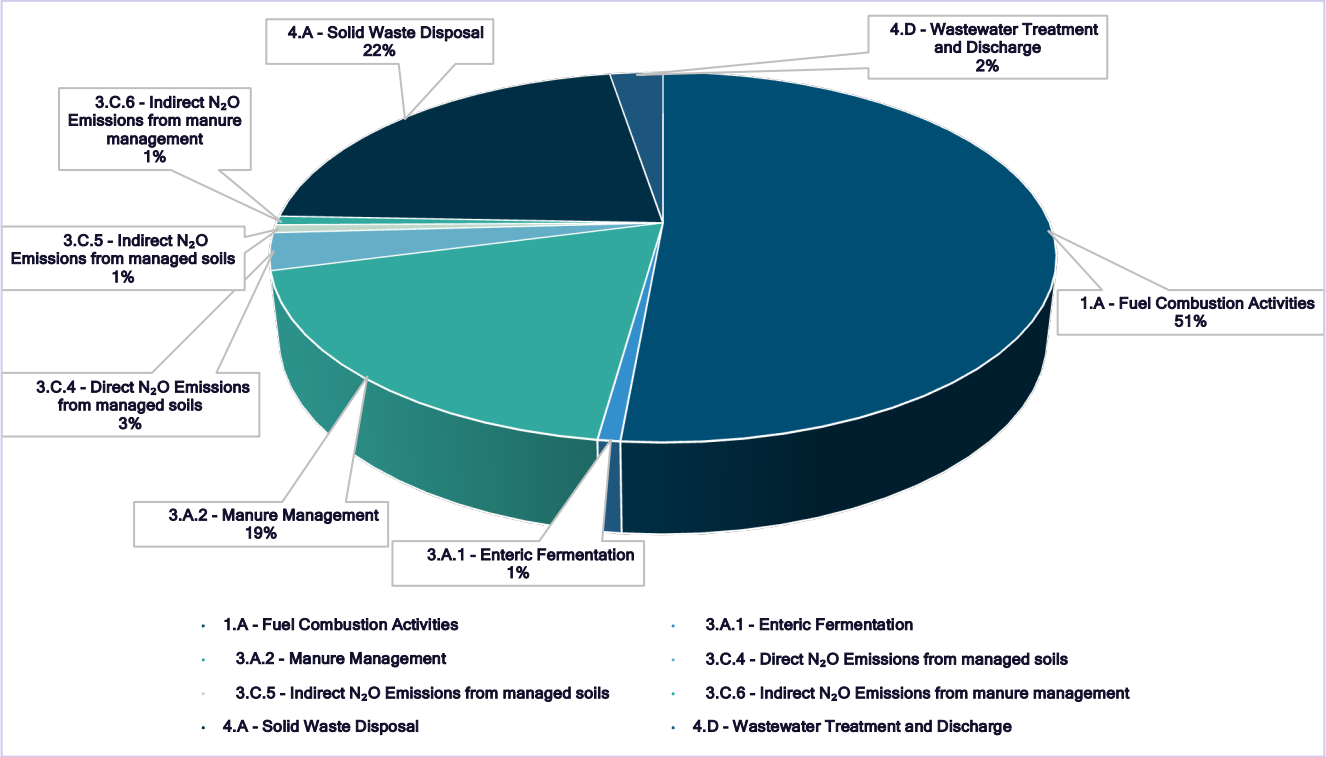


Table 6: FSM's Sub-Sectoral GHG Emission (excluding removals), Gg CO2e: 2001 -2018

Inventory Year: 2001-2018	Net CO_2 Emissions, (CO_2 Equivalents Gg)																	
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
1.A - Fuel Combustion Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.73	119.64	116.83	113.23	108.34	105.69	115.98	114.17	119.79	118.52
3.A.1 - Enteric Fermentation	1.14	1.10	1.07	1.04	1.00	0.97	0.94	0.90	0.87	0.83	0.80	0.77	0.73	0.70	0.77	0.84	0.85	0.89
3.A.2 - Manure Management	27.28	26.48	25.67	24.86	24.06	23.25	22.44	21.64	20.83	20.03	19.22	18.41	17.61	16.84	18.49	20.13	20.55	21.46
3.C.4 - Direct N_2O Emissions from managed soils	4.60	4.46	4.33	4.19	4.05	3.92	3.78	3.65	3.51	3.38	3.24	3.10	2.97	3.19	3.45	3.70	3.96	4.22
3.C.5 - Indirect N_2O Emissions from managed soils	0.98	0.95	0.92	0.89	0.86	0.83	0.80	0.78	0.75	0.72	0.69	0.66	0.63	0.68	0.73	0.79	0.84	0.90
3.C.6 - Indirect N_2O Emissions from manure management	1.12	1.09	1.06	1.02	0.99	0.96	0.92	0.89	0.86	0.83	0.79	0.76	0.73	0.69	0.76	0.83	0.90	0.96
4.A - Solid Waste Disposal	26.22	26.13	26.04	25.96	25.87	25.79	25.71	25.63	25.35	25.28	25.32	25.36	24.42	24.46	24.09	24.14	24.18	24.22
4.D - Wastewater Treatment and Discharge	3.09	3.07	3.06	3.05	3.04	3.02	3.01	3.00	2.99	2.98	2.98	2.99	2.99	3.00	3.01	3.01	3.02	3.02
Total GHG Emissions, excl. Removals	64.43	63.29	62.15	61.01	59.88	58.74	57.61	56.48	94.89	173.67	169.88	165.28	158.42	155.25	167.28	169.60	174.09	174.19

GHG Emissions by Gases

The gas by gas emissions for FSM inventory years 2001-2018 include three main Greenhouse gases viz Carbon dioxide (CO_2), Methane (CH_4) and Nitrous-oxide (N_2O). The emissions of other GHGs like hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) have not been estimated as due to the reasons and limitation discussed in the previous section. Further, the emissions from precursor gases like Carbon Monoxide (CO), Nitrogen Oxides (NOx) and non-Methane Volatile Organic Compounds (NMVOC) and other gases not controlled by the Montreal Protocol, such as Sulphur Oxides (SOx) have also not been estimated and analyzed due to the lack of detailed activity data and associated uncertainty in the estimation. However, the TNC team envisages to improve the quality of data collected and estimate the emissions form these precursor gases in the future inventories and included this in the national inventory improvement plan (NIIP).

The dominant GHG emission in FSM is carbon dioxide (CO_2) which emits mainly from fossil fuel combustion activities for power generation, transportation. Next main GHG is Methane (CH_4) and it mainly occurs from Livestock, Aggregate sources and non-CO2 emissions sources on land and Solid Waste and Waste water disposal and treatment activities. This is followed by N_2O emissions mainly from livestock, Aggregate sources and non-CO_2 emissions sources on land and waste water sub-sector.

Gas wise GHG emissions in FSM during the inventory years 2001-2018 are presented in the table below and discussed in detail in the following section:

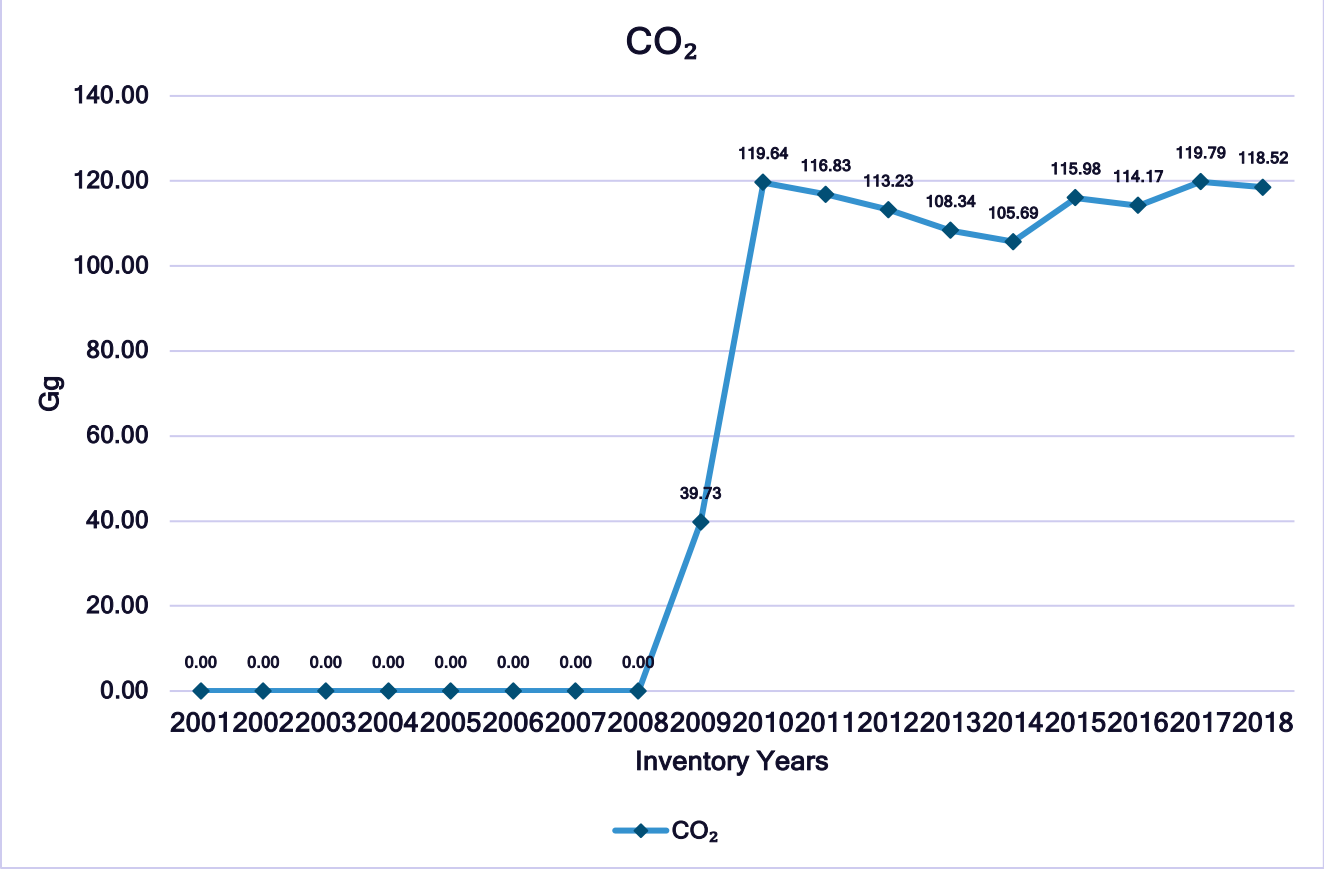
Table 7: FSM's Gas-wise GHG Emission (excluding removals), Gg: 2001-2018

Year	CO_2	CH_4	N_2O
2001	NE	2.01	0.030
2002	NE	1.98	0.030
2003	NE	1.95	0.029
2004	NE	1.91	0.028
2005	NE	1.88	0.027
2006	NE	1.85	0.027
2007	NE	1.81	0.026
2008	NE	1.78	0.025
2009	39.73	1.74	0.024

2010	119.64	1.71	0.024
2011	116.83	1.68	0.023
2012	113.23	1.65	0.022
2013	108.34	1.59	0.021
2014	105.69	1.56	0.022
2015	115.98	1.61	0.024
2016	114.17	1.67	0.025
2017	119.79	1.69	0.027
2018	118.52	1.72	0.028
Average	59.55	1.77	0.026
% Share	97%	3%	0.042%

Carbon dioxide (CO_2)

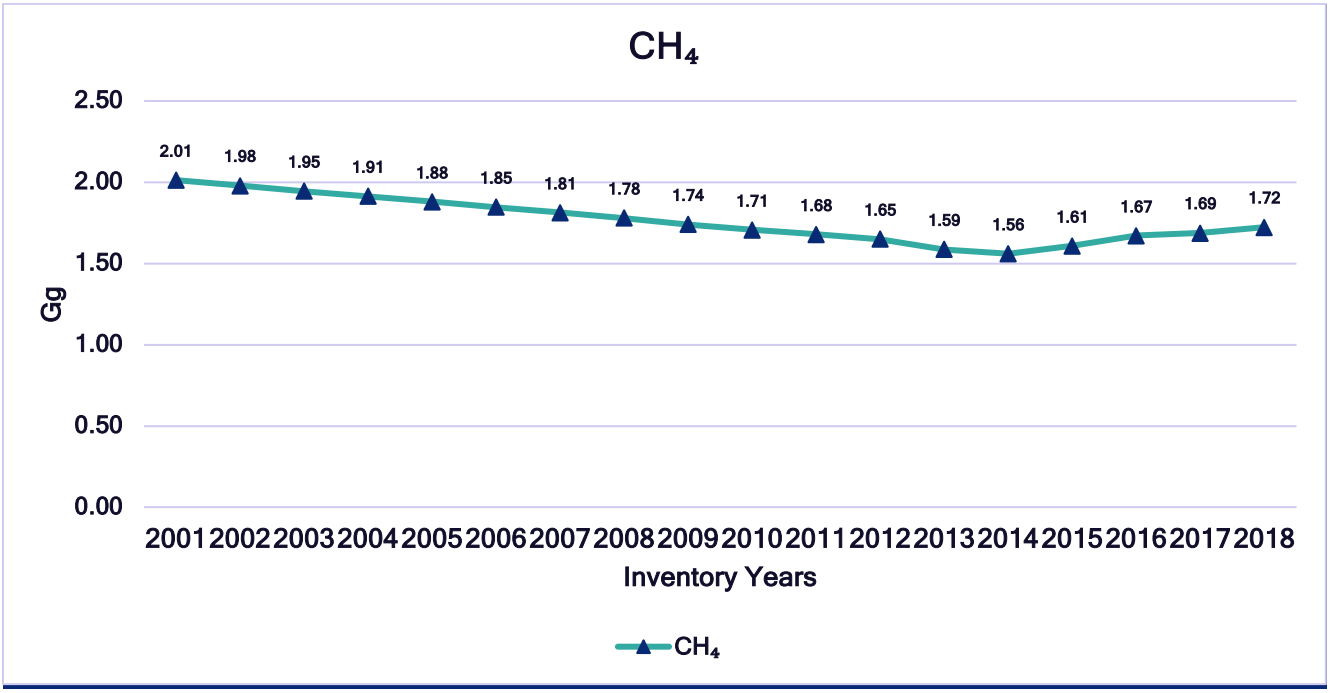
Figure 7: FSM's Total CO_2 emissions in Gg: 2001-2018



The net CO_2 emissions in FSM is estimated for the period 2007-2015, the energy sector is the main source of CO_2 emissions in accounts for entire CO_2 emissions in FSM. The net CO_2 emissions shows an increasing trend and has increased from 39.73 Gg CO_2e in 2009 to 119.79 Gg CO_2e in 2018. During the years 2001-2018, the net CO_2 emissions could not be estimated due to lack of formal data on fuel imported into the country.

Methane (CH_4)

Figure 8:FSM's Total Methane (CH4) emissions in Gg – 2001-2018



The CH_4 emission trend shown a declining trend over until the year 2014 and thereafter it again starts increasing till 2018. The CH_4 emissions in FSM reached to 1.75 Gg in 2018 declining from 2.01 Gg in 2011, representing 14.42% decrease during the inventory period. Majority of the CH_4 emissions (about 54%) in FSM comes from Waste sector (Solid waste- MSW and Domestic waste water). Whereas, the remaining 46% of CH_4 emissions is due to agriculture sector, mainly Livestock- enteric fermentation and manure management. The decrease in CH_4 emissions is mainly attributed due to a decrease in the population of Livestock's and due to rehabilitation and upgrading of the some of the waste dumpsites from unmanaged to semi-aerobic site.

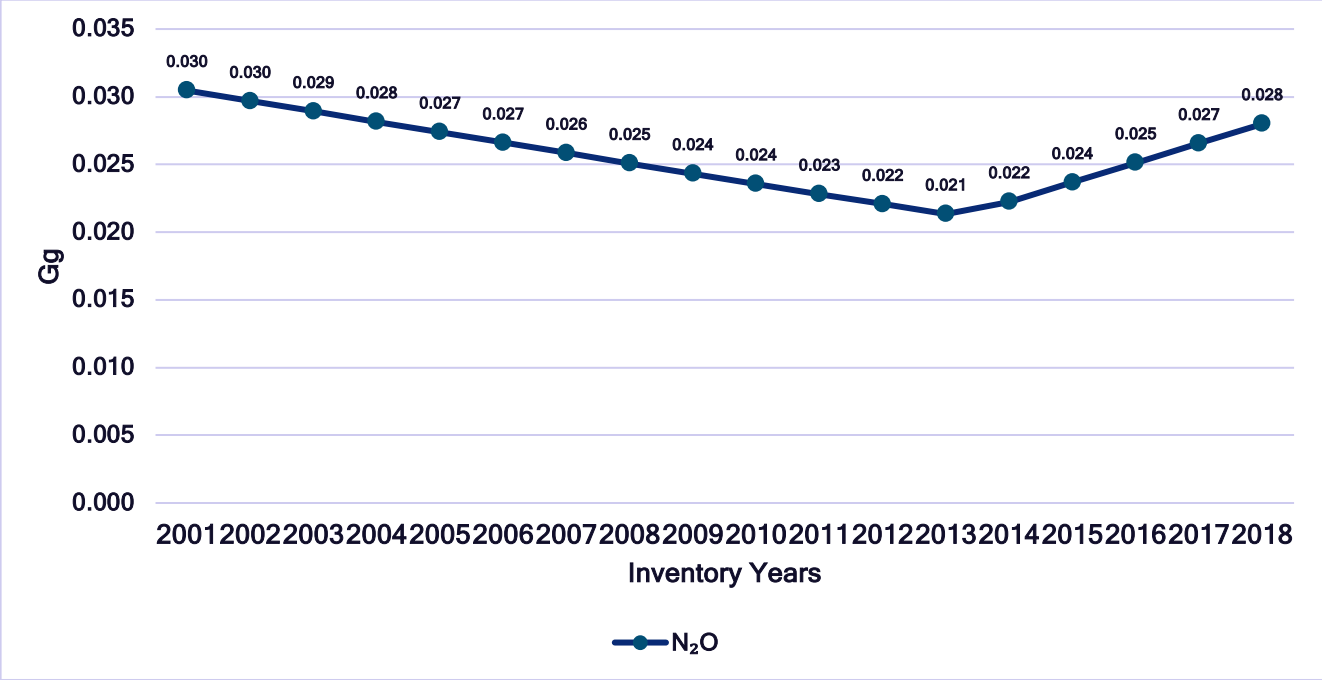
Table 8: FSM's Sub-sector wise CH_4 Emission Gg: 2001 -2018

Year	3.A.1 - Enteric Fermentation	3.A.2 - Manure Management	4.A - Solid Waste Disposal	4.D - Wastewater Treatment and Discharge	Total CH_4 Emissions
2001	0.041	0.974	0.936	0.061	2.013
2002	0.039	0.946	0.933	0.061	1.979
2003	0.038	0.917	0.93	0.061	1.946
2004	0.037	0.888	0.927	0.061	1.913
2005	0.036	0.859	0.924	0.06	1.879
2006	0.035	0.83	0.921	0.06	1.846
2007	0.033	0.802	0.918	0.06	1.813
2008	0.032	0.773	0.915	0.06	1.78
2009	0.031	0.744	0.905	0.059	1.74
2010	0.03	0.715	0.903	0.059	1.707
2011	0.029	0.686	0.904	0.059	1.679
2012	0.027	0.658	0.906	0.059	1.65
2013	0.026	0.629	0.872	0.059	1.587

2014	0.025	0.602	0.874	0.06	1.56
2015	0.027	0.66	0.861	0.06	1.608
2016	0.03	0.719	0.862	0.06	1.671
2017	0.031	0.734	0.864	0.06	1.688
2018	0.032	0.766	0.865	0.06	1.723
Average	0.032	0.772	0.901	0.06	1.766

Nitrous Oxide (N_2O)

Figure 9: FSM's Total Nitrous Oxide (N_2O) emissions in Gg – 2001-2018



The net N_2O emissions in FSM follows the same trend as that of CH_4 emissions. N_2O emissions reached to 0.028 Gg in 2018 declining from 0.030 Gg in 2011, representing a decrease of about 6.67% during the inventory period. The average contribution of N_2O emissions on total GHG emissions of FSM is negligible of about 0.042%. Approximately 80% of the FSM's total N_2O emissions comes from contributed agriculture sector (Aggregate sources and non-CO2 emissions sources on land). Whilst, the remaining 20% of N_2O emission is comes from waste sector (Domestic wastewater Treatment and Discharge). The rationale behind the decreasing N_2O emission trend is same as of the CH_4 emissions.

Table 9: FSM's Subsector wise N2O Emission Gg: 2001 -2018

Year	3.C.4 - Direct N2O Emissions from managed soils	3.C.5 - Indirect N2O Emissions from managed soils	3.C.6 - Indirect N2O Emissions from manure management	4.D - Wastewater Treatment and Discharge	Total N2O Emissions
2001	0.0174	0.0037	0.0042	0.0052	0.0305
2002	0.0168	0.0036	0.0041	0.0052	0.0297
2003	0.0163	0.0035	0.004	0.0051	0.0289
2004	0.0158	0.0034	0.0039	0.0051	0.0282

2005	0.0153	0.0033	0.0037	0.0051	0.0274
2006	0.0148	0.0031	0.0036	0.0051	0.0266
2007	0.0143	0.003	0.0035	0.0051	0.0259
2008	0.0138	0.0029	0.0034	0.005	0.0251
2009	0.0133	0.0028	0.0032	0.005	0.0243
2010	0.0127	0.0027	0.0031	0.005	0.0236
2011	0.0122	0.0026	0.003	0.005	0.0228
2012	0.0117	0.0025	0.0029	0.005	0.0221
2013	0.0112	0.0024	0.0027	0.005	0.0213
2014	0.012	0.0026	0.0026	0.005	0.0222
2015	0.013	0.0028	0.0029	0.005	0.0237
2016	0.014	0.003	0.0031	0.005	0.0251
2017	0.0149	0.0032	0.0034	0.0051	0.0266
2018	0.0159	0.0034	0.0036	0.0051	0.028
Average	0.0142	0.003	0.0034	0.0051	0.0257

Other GHGs (PFCs, HFCs and SF_6)

Emissions from Other indirect GHGs like Perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and Sulphur hexafluoride (SF_6) are not estimated and reported under this inventory. This is due to limited applications and no manufacturing of the products containing other GHGs in FSM.

Precursor and Indirect Emission (NOx, CO, NMVOC and SO_2)

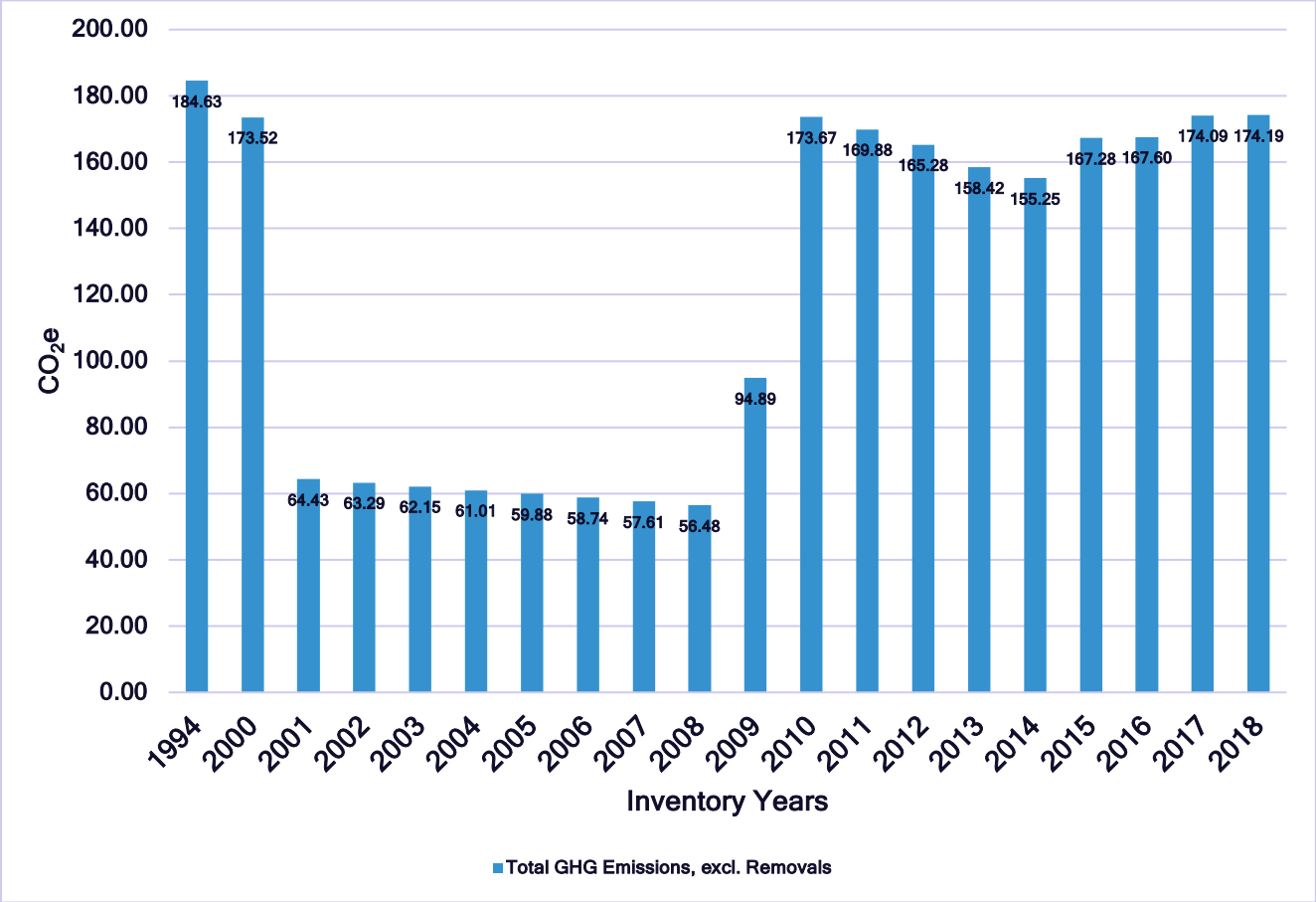
The other indirect emissions of NOx, CO, NMVOC and SO_2 occurs in FSM. However, they are not main source of the GHGs and have very negligible quantum. Further due to lack of data and high uncertainty involved in estimation of emissions of these gases, they are not estimated under this inventory for the years 2001- 2018.

GHG Emission Trend Analysis: 1994 – 2018

GHG Emission Trend: 1994-2018

This section presents the trend analysis for key emission-intensive sectors in FSM (namely Energy, AFOLU, and Waste) for the inventory period 1994 to 2018.

Figure 10: FSM's Total GHG emissions (excluding removals) in Gg CO2e: 1994-2018



FSM's total GHG emissions reached to 174.19 Gg CO_2e in 2018 from 184.63 Gg CO_2e in 1994, representing decline in emission levels by about 5.65% over 24 years. The rationale behind the sudden dip in the emission levels during the years 2001 to 2008 is mainly due to unavailability of formal data on fuel imported into the country. Further, the dip in emission level during the years 2010 to 2014 is attributed due to slower economy growth during these years. The 1994 and 2000 GHG inventory covered all the key IPCC sectors i.e., Energy, IPPU, AFOLU, IPPU and Waste sector. However, the current inventory for the period 2001-2018 does not include emissions from the IPPU sector due to lack of information.

Sectoral GHG Emission Trend: 1994-2018

This section presents the GHG emission trends in FSM's key GHG emission sector of i.e., Energy, Agriculture (Livestock and Aggregate sources and non-CO_2 emissions sources on land) and Waste (Solid waste- MSW and Domestic waste water) for more categoric review and analysis of GHG emission trends in FSM.

Figure 11: FSM's total GHG emissions by sectors (excluding removals) in Gg CO_2e: 1994-2018

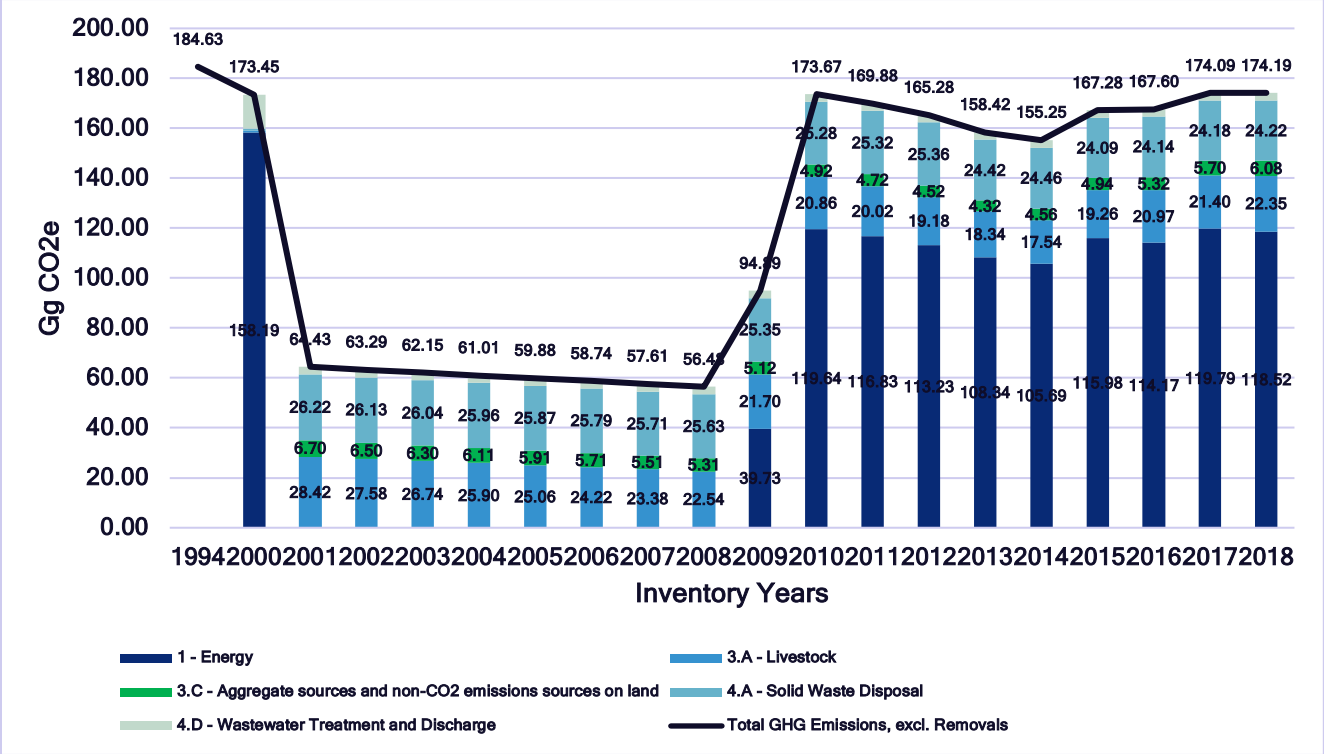
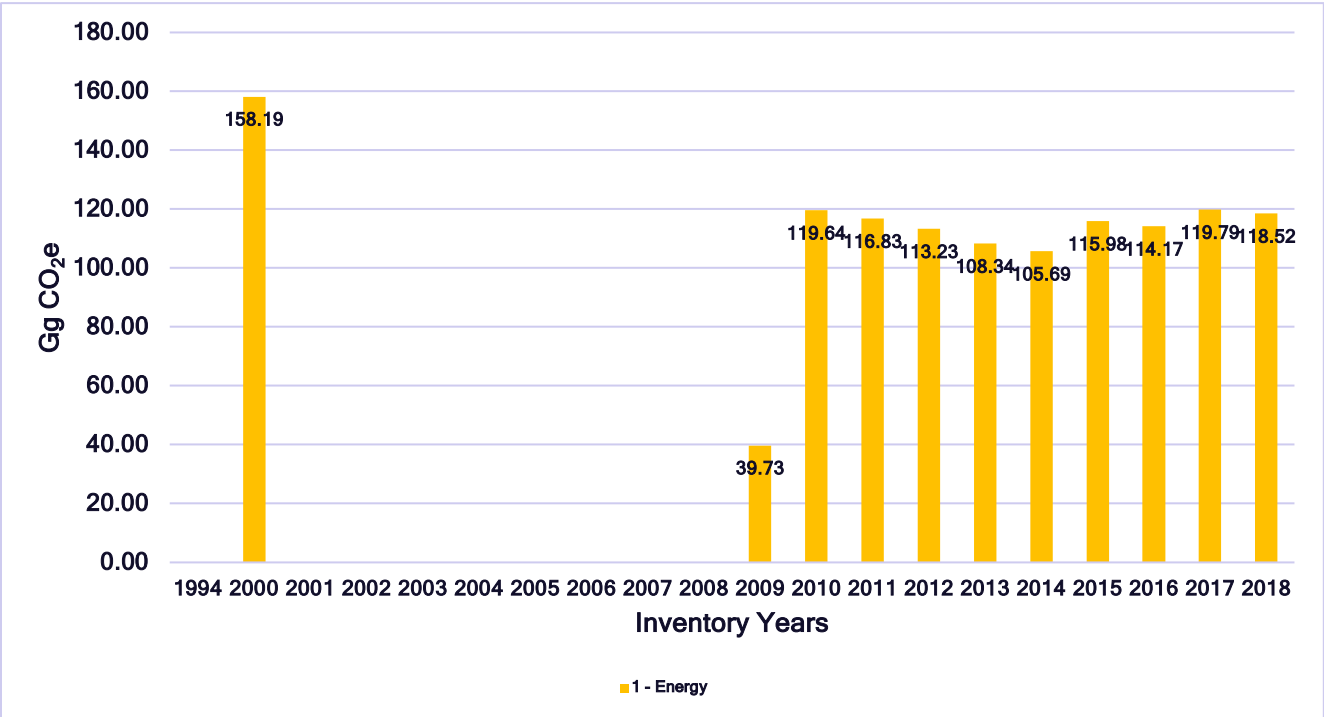
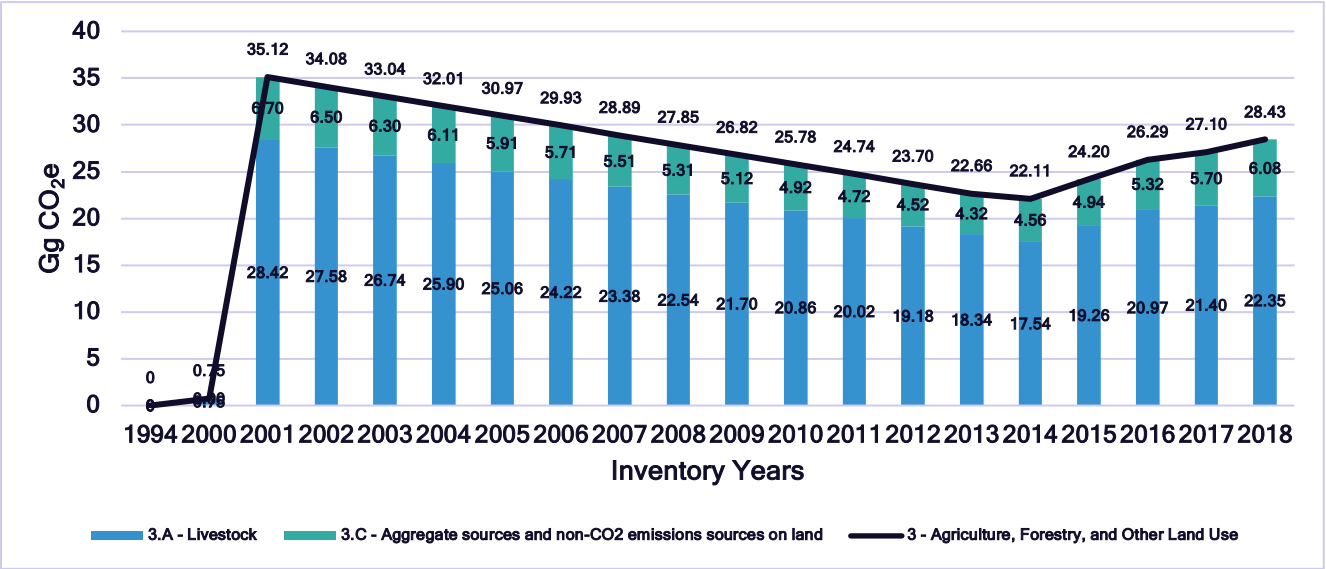


Figure 12: FSM's Energy sector total GHG emissions in Gg CO_2e: 1994-2018



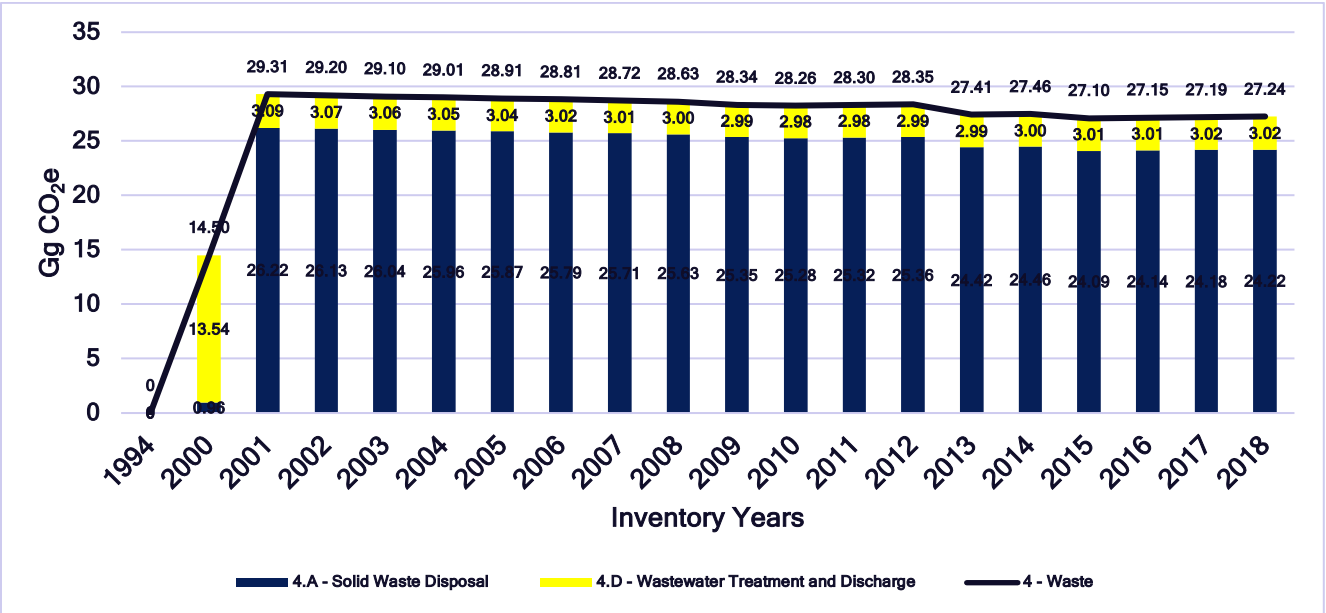
The estimated total energy sector GHG emission reached to 118.52 Gg CO_2e in 2018 from 158.19 Gg CO_2e in 1994, representing a decline in emissions by about 25%. Energy sector emissions is analogous to the quantity of fuel imported in to the country.

Figure 13: FSM's AFOLU sector total GHG emissions (excl. removals) in Gg CO_2e: 1994-2018



FSM's total GHG emissions from Agriculture sector totaled 28.43 Gg CO_2e in 2018. The emissions from 'Livestock' and 'Aggregate sources and non-CO_2 emissions sources on land' sub-sector in FSM shows a decreasing trend until the year 2014 and thereafter increases slightly during the end years i.e., during 2015 to 2018. Livestock sector emissions reached to 22.35 Gg CO_2e in 2018 from 0.75 Gg CO_2e in 2000. Livestock production (pigs and poultry) is important throughout FSM, particularly for subsistence and cultural use. Most of the livestock in FSM are raised for home consumption, however a significant proportion is used for ceremonial and cultural purposes, such as weddings, funerals and feasts of celebration. However, there is a lack of modern scientific manure management systems and most of the livestock are free ranging due to which the emissions form the both 'livestock' and 'Aggregate sources and non-CO_2 emissions sources on land' sub-sector has the significant share in the total GHG emissions from FSM.

Figure 14: FSM's Waste sector total GHG emissions (excl. removals) in Gg CO_2e: 1994-2018

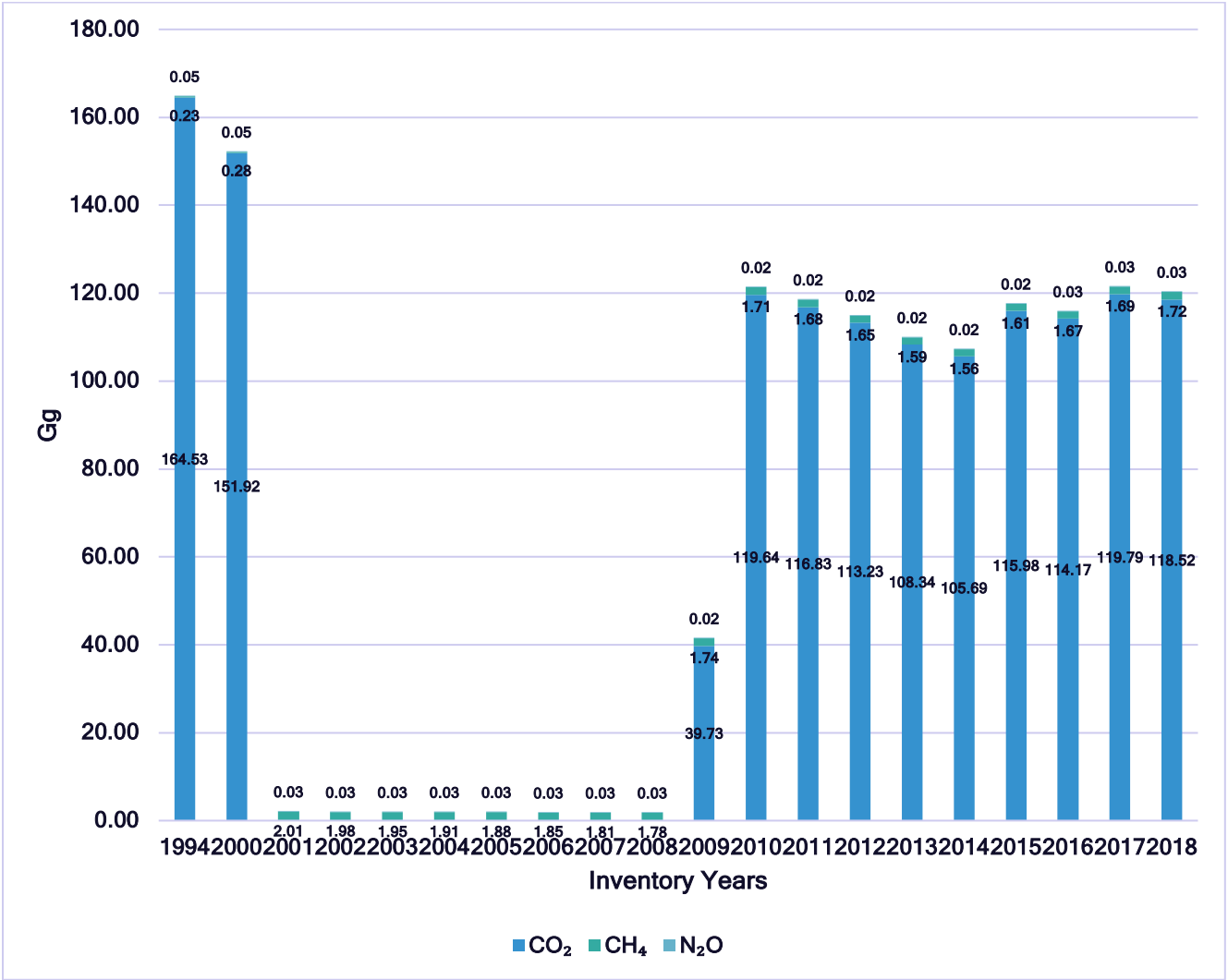


The Waste sector emissions in FSM reached to 27.24 Gg CO_2e from 14.50 Gg CO_2e in 1994. Waste sector emissions. The waste sector emissions show a decreasing trend during the inventory years 2001 to 2018. This is mainly due to decrease in the reported population of the country between years 2000 to 2010 and some of the waste disposal sites were rehabilitated and upgraded to semi-aerobic type from anaerobic.

Gas-wise Emission Trend: 1994-2018

This section presents the Gas wise emission trend in FSM during 1994 to 2018. The CO_2 emissions is mainly due to fuel combustion activities. Whilst, CH_4 and N_2O emissions are contributed from Agriculture sector (Livestock and Aggregate sources and non-CO_2 emissions sources on land) and Waste sector (Solid waste- MSW and Waste water treatment- Domestic).

Figure 15: FSM's Gas-wise emissions in Gg: 1994-2018



The CO_2 emissions trend analysis indicates that's the emission levels of CO_2 in FSM have decreased to 118.52 Gg to 164.53 Gg during the period 1994 to 2018, representing a decline of about 28% approximately. CH_4 emissions shows a significant increase of over 637% during the period 1994- 2018, increasing to 1.72 Gg in 2018 from 0.23 Gg in 1994. Whereas, the N_2O emission trend shows a decreasing trend, indicating a decrease of about 45%, reaching to 0.028 Gg in 2018 from 0.051 Gg in 1994.

GHG Emission Sector Analysis: 2001– 2018

The following section present the analysis of FSM's key GHG emission sectors i.e., Energy, AFOLU and Waste Sector for years 2001 to 2018.

Energy Sector

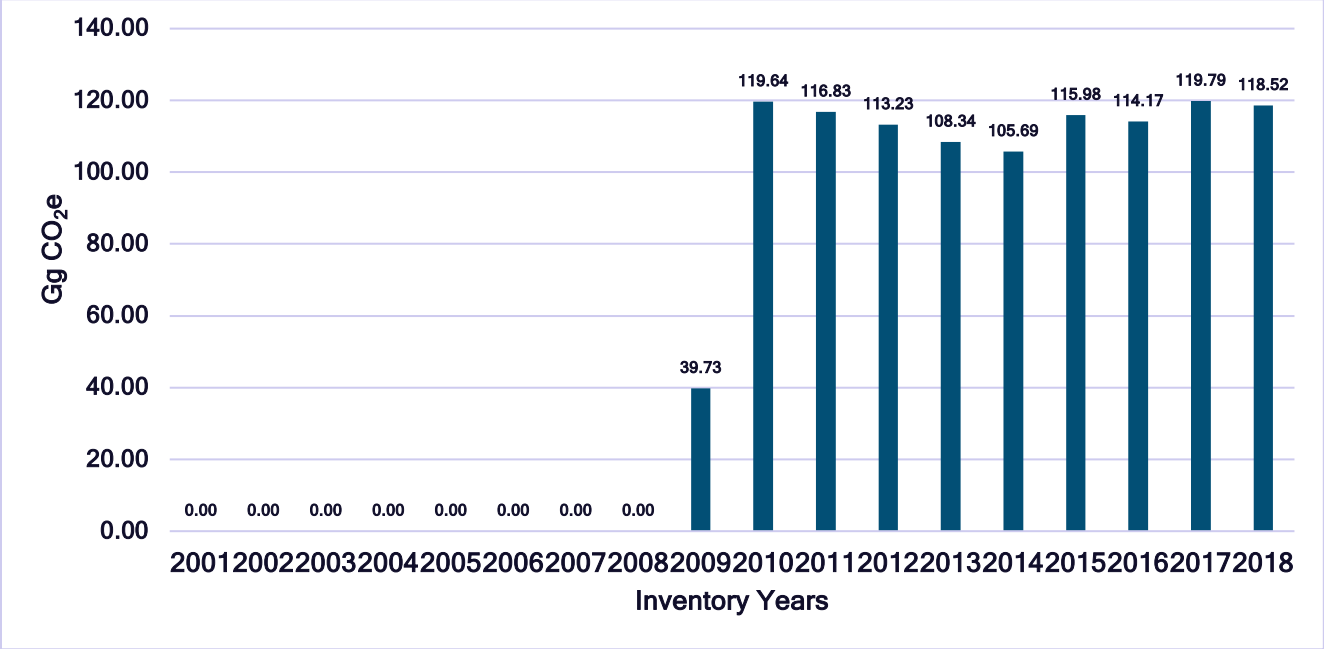
The Energy sector in FSM is the major emission contributing sector to the FSM's total GHG emissions. The energy sector in FSM is heavily dependent on imported of fossil fuel to sustain its economy and meeting its energy requirements. In 2008, Federated States of Micronesia (FSM) Petroleum Corporation (FSMPC), a government-owned enterprise, was established and took over from Mobil, the responsibility for fuel supply in all the States i.e., Pohnpei, Kosrae, Yap and Chuuk. Bulk fuel supplies come directly from Guam and Singapore and are shipped directly into the 4 main sea ports by tanker and then is distributed through tankers in all the FSM states., there is limited information available on the category and sub-category wise (end) use of the imported fuels; further no reliable data was available on imported quantity the years 2001-2008. Hence, it was not feasible to estimate energy sector emissions using the sectoral approach. To this end, the energy sector emissions have been estimated using the IPCC reference approach for the years 2009 to 2018.

The estimated energy sector emissions for the inventory period using Reference approach have been presented in the following table and figure.

Table 10: FSM's Energy Sector GHG emissions Gg CO_2e: 2001-2018

Inventory Year: 2001-2018	Net CO2 Emissions, (CO2 Equivalents Gg)																	
Categories	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1 - Energy	NE								39.73	119.64	116.83	113.23	108.34	105.69	115.98	114.17	119.79	118.52
% Share in total GHG emissions	-	-	-	-	-	-	-	-	42 %	69 %	69 %	69 %	68 %	68 %	69 %	68 %	69 %	68 %

Figure 16: FSM's Energy Sector GHG emissions Gg: 2001-2018



The energy sector accounted for 118.52 Gg CO_2e in 2018, contributing about 68% of the total GHG emissions in the country. The emission level increases from 39.73 Gg CO_2e in 2009 to 119.64 Gg CO_2e in 2010 and decreases thereafter until 2014. The decrease in emission level during the period 2010 to 2014 is mainly attributed to slower economic growth during these years. Emission level increases year from 2015 onwards followed by a marginal dip in 2016. The quantity of diesel fuel imported in to the country has increased marginally over the years. This is attributed due to the increase in renewable energy for electricity generation. Gasoline and Jet kerosene imports has increase significantly during the inventory period. Following table and figure presents a summary of total fuel imported in to the country during the inventory year 2001-2018.

Figure 17: FSM's Fuel Import ('000 US Gallons): 2009-2018

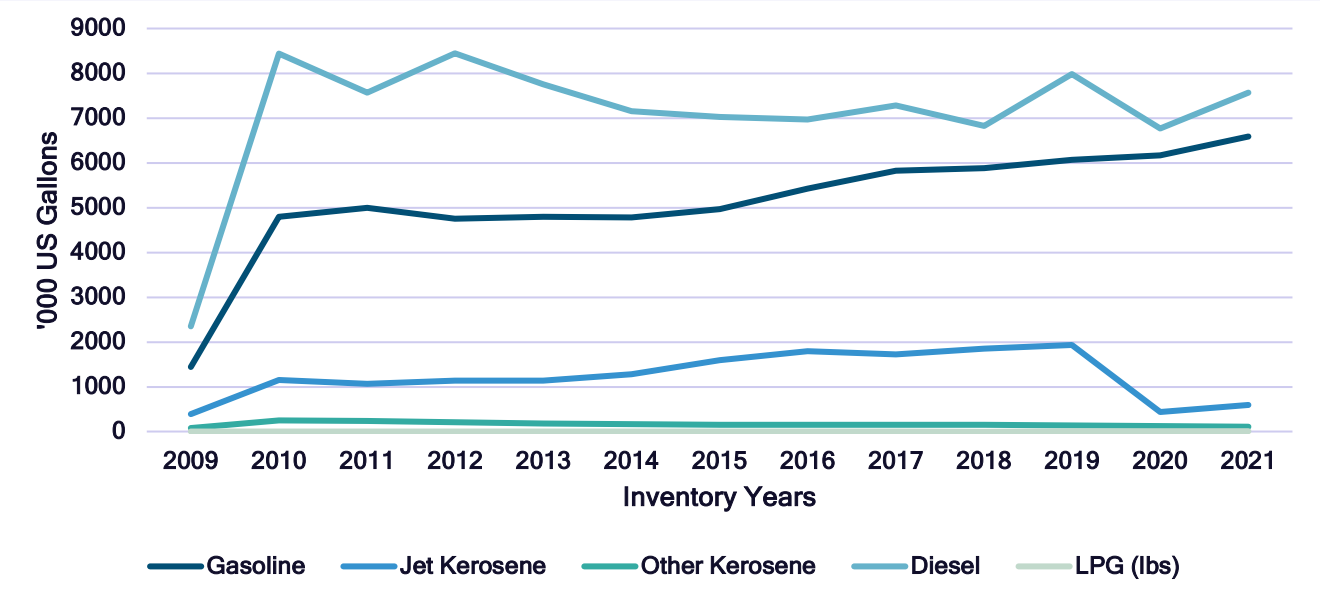


Table 11: FSM's total fuel import quantity: 2009-2018

Year	Gasoline	Jet Kerosene	Other Kerosene	Diesel	LPG
	US Gallons	US Gallons	US Gallons	US Gallons	lbs
2009	1441755	389088	77963	2348861	0
2010	4802498	1152900	248305	8436518	0
2011	4991095	1064988	242687	7570898	0
2012	4757476	1140690	205745	8445833	0
2013	4793000	1134100	176808	7760033	0
2014	4775736	1278479	161968	7150328	0
2015	4967209	1593628	151208	7023881	0
2016	5428907	1792873	150467	6966299	0
2017	5831519	1726207	155290	7285021	0
2018	5886967	1853876	150482	6824830	93
2019	6073106	1932976	129320	7989110	2969
2020	6162546	431384	118561	6762201	5977
2021	6588128	594702	108518	7561368	7209

Industrial Processes and Product Use (IPPU)

The GHG emissions occurring from industrial processes, from the use of greenhouse gases in products, and from non-energy uses of fossil fuel carbon are estimated under this sector. In FSM, there were no heavy industry and neither the country exported any products in large quantities during the inventory period 2001-2018. However, emissions from industrial processes mainly 'Lime production' takes place in FSM but due to lack of data the emissions levels from this source category are not estimated. Further, this sector also comprises emissions from solvent and other product use containing volatile compounds, primarily Non-Methane Volatile Organic Compounds (NMVOC). In FSM, there were some food Industries like breadmaking and other food production process (e.g., meat, fish and non-alcoholic beverages) at the time of inventory period. Food Industries are source of NMVOC emissions, but lack of data on quantity of production of these food item and beverages it was not possible to estimate NMVOC emissions from this source category for this inventory period. FSM also imports small quantities of products like solvents, fire extinguishers, refrigerants and ODS but due lack of data on quantity of products imported in to the country the GHG emissions from this source are also not estimated for this inventory period.

Agriculture, Forestry, and Other Land Use (AFOLU)

Agriculture in FSM is carried out at subsistence level and it is a major source of methane emissions, after Waste sector in FSM. Emissions the Forestry and Other Land Use have not been estimated in this inventory. The emissions from the following sub-sectors and categories are estimated under this inventory.

- Livestock
  - Enteric Fermentation
  - Manure Management
- Aggregate sources and non-CO_2 emissions sources on land

Methane emissions due to livestock farming have significance in FSM. While, N_2O emissions from manure management systems are not occurring in FSM since most of the livestock are free ranging and no commercial livestock operations utilize the manure in such manner. The Livestock population data used for estimating GHG emissions for the inventory period 2001-2018 is estimated based on the Federated Statess of Micronesia 2013-14 HIES report[10] and FSM Integrated Agriculture Census 2016[11]. The data for the missing years have been estimated using Extrapolation and interpolation techniques in accordance with the IPCC good practice guidance (GPG). Rice cultivation and liming is not practiced in the country which disregards it as a source of emissions. The emissions from field burning of agricultural residues, use of urea and other synthetic fertilizers have not been estimated for the inventory period 2001-2018 due to lack of data. Direct and Indirect N_2O emissions have been estimated and are mainly attributed due to deposit of urine and manure on pasture, range and paddock by grazing animals.

[10] : Federated Statess of Micronesia 2013-14 HIES report, https://sdd.spc.int/digital_library/federated-statess-micronesia-2013-14-hies-report

[11] FSM Integrated Agriculture Census 2016, https://www.spc.int/DigitalLibrary/Doc/SDD/Census/FM/FSM_2016_IAC_200120.pdf

The emissions from agriculture sector in FSM is the third largest contributor and account for average about 24% of FSM's total GHG emissions for the year 2001-2018. As can be seen from the following table and figure, the GHG emissions from agriculture sector have declined during the inventory period. This decrease is mainly attributed due to the decline in livestock population. Agriculture sector emissions (excluding removals) reached to 28.43 Gg in 2018 from 35.12 Gg CO2e in 2001, representing a decrease in emissions of about 19% approximately.

Table 12: FSM's AFOLU Sector GHG Emission in Gg CO_2e (excluding Removal): 2001-2018

Inventory Year: 2001-2018	Net CO_2 Emissions, (CO_2 Equivalents Gg)																	
Categories	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
3 - Agriculture, Forestry, and Other Land Use	35.12	34.08	33.04	32.01	30.97	29.93	28.89	27.85	26.82	25.78	24.74	23.70	22.66	22.11	24.20	26.29	27.10	28.43
3.A - Livestock	28.42	27.58	26.74	25.90	25.06	24.22	23.38	22.54	21.70	20.86	20.02	19.18	18.34	17.54	19.26	20.97	21.40	22.35
3.A.1 - Enteric Fermentation	1.14	1.10	1.07	1.04	1.00	0.97	0.94	0.90	0.87	0.83	0.80	0.77	0.73	0.70	0.77	0.84	0.85	0.89
3.A.2 - Manure Management	27.28	26.48	25.67	24.86	24.06	23.25	22.44	21.64	20.83	20.03	19.22	18.41	17.61	16.84	18.49	20.13	20.55	21.46
3.C - Aggregate sources and non-CO_2 emissions sources on land	6.70	6.50	6.30	6.11	5.91	5.71	5.51	5.31	5.12	4.92	4.72	4.52	4.32	4.56	4.94	5.32	5.70	6.08
3.C.4 - Direct N_2O Emissions from managed soils	4.60	4.46	4.33	4.19	4.05	3.92	3.78	3.65	3.51	3.38	3.24	3.10	2.97	3.19	3.45	3.70	3.96	4.22
3.C.5 - Indirect N_2O Emissions from managed soils	0.98	0.95	0.92	0.89	0.86	0.83	0.80	0.78	0.75	0.72	0.69	0.66	0.63	0.68	0.73	0.79	0.84	0.90
3.C.6 - Indirect N_2O Emissions from manure management	1.12	1.09	1.06	1.02	0.99	0.96	0.92	0.89	0.86	0.83	0.79	0.76	0.73	0.69	0.76	0.83	0.90	0.96
AFOLU Sector Total (excluding removals)	35.12	34.08	33.04	32.01	30.97	29.93	28.89	27.85	26.82	25.78	24.74	23.70	22.66	22.11	24.20	26.29	27.10	28.43

Figure 18: FSM's AFOLU Sector GHG Emission in Gg CO_2e (excluding Removal): 2001-2018

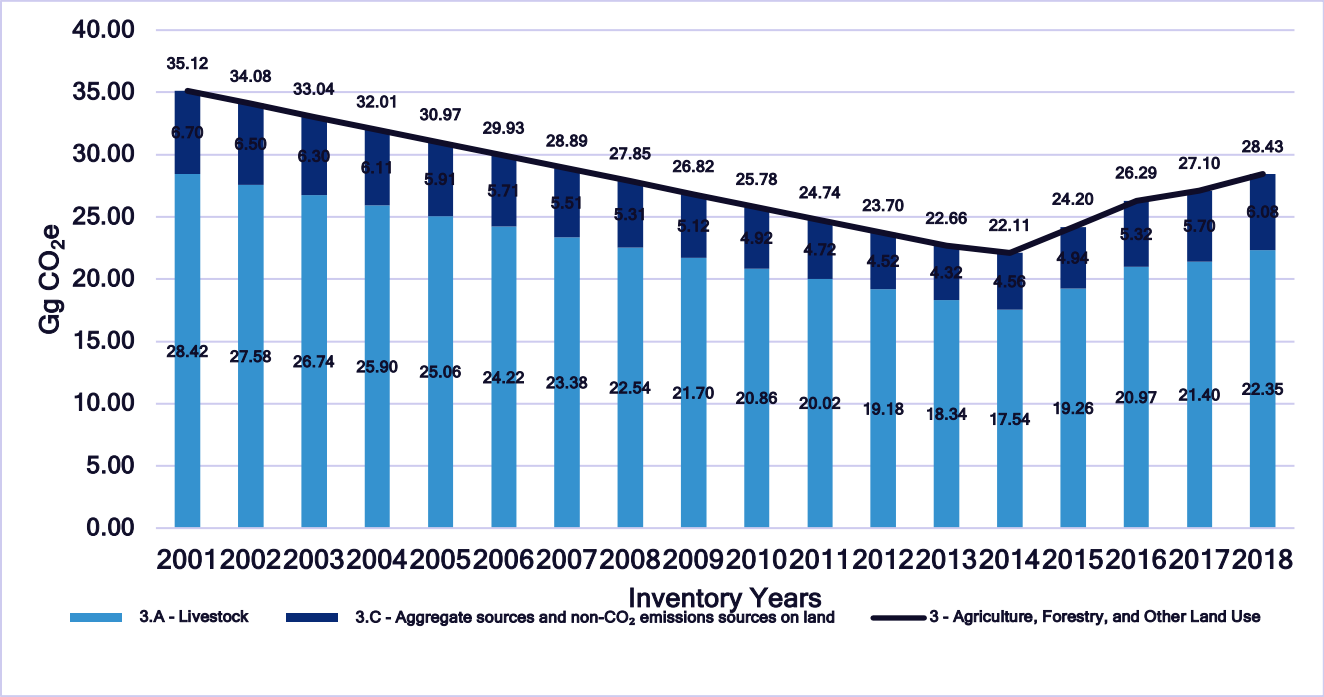
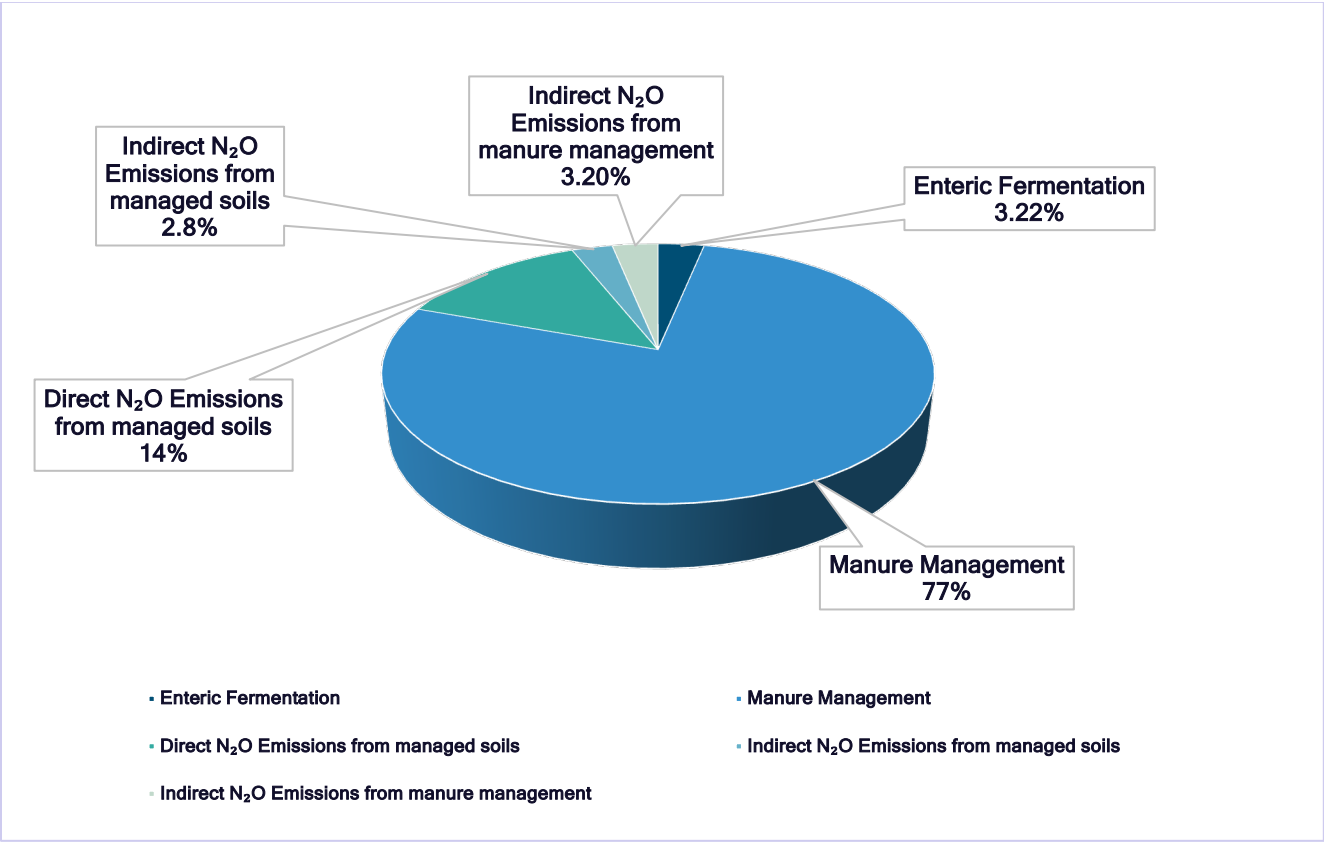


Figure 19: FSM's AFOLU Sector GHG Emission Share (excluding Removal): 2001-2018



Major share of GHG emissions in FSM's agriculture sector comes from Livestock farming, mainly manure management (77%) and Enteric fermentation (3%). While, the rest comes from Direct N_2O emissions from managed soil (14%) and Indirect N_2O emissions from managed soils and manure

management (2.8% and 3.2% respectively). The sub-sector analysis in the subsequent sections entails detailed discussion on these GHG emission contributing sub-sectors and categories.

Livestock

Livestock farming is an important throughout FSM, particularly for subsistence and cultural use[12]. About 61% of the household possessed some form of livestock in 2016 (mainly poultry or pigs). Poultry and Pigs are generally raised in FSM. Pigs are nearly raised by every family for ceremonial and cultural purposes, such as weddings, funerals and feasts for celebration. However, FSM's livestock population has been declining year on year. There is very limited data available on total livestock population and livestock farming practices in FSM. The data used for the inventory period 2001-2018 have been estimated based on the Integrated Agriculture census 2016 and Household Income and Expenditure Survey Report 2013-2014[13]. The following table presents the livestock population data used for estimating GHG emissions from Livestock sub-sector.

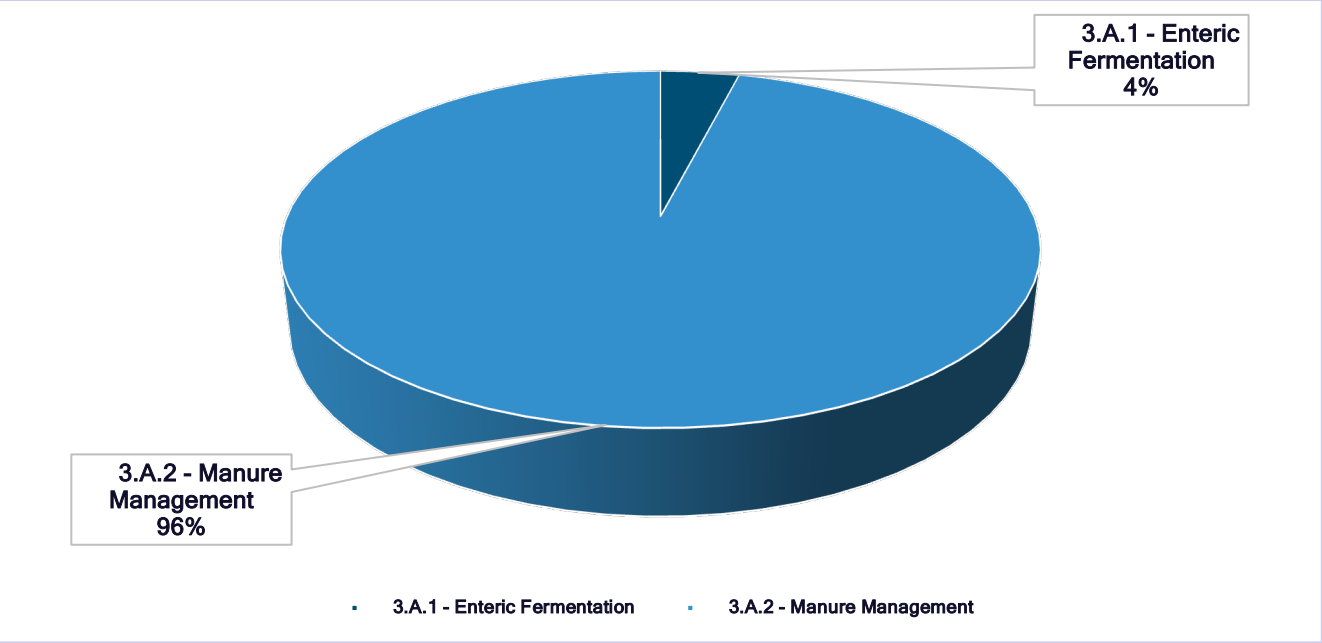
Table 13: Livestock Population in FSM: 2001-2018

Year	Pigs	Chicken
2001	40600	-
2002	39400	-
2003	38200	-
2004	37000	-
2005	35800	-
2006	34600	-
2007	33400	-
2008	32200	-
2009	31000	-
2010	29800	-
2011	28600	-
2012	27400	-
2013	26200	-
2014	25000	79900
2015	27450	75350
2016	29900	70800
2017	30525	66250

[12] Federated States of Micronesia Integrated Agriculture Census 2016, https://fsm-data.sprep.org/dataset/federated-statess-micronesia-integrated-agriculture-census
[13] Federated Statess of Micronesia 2013-14 HIES report, https://sdd.spc.int/digital_library/federated-statess-micronesia-2013-14-hies-report

2018	31880	61700

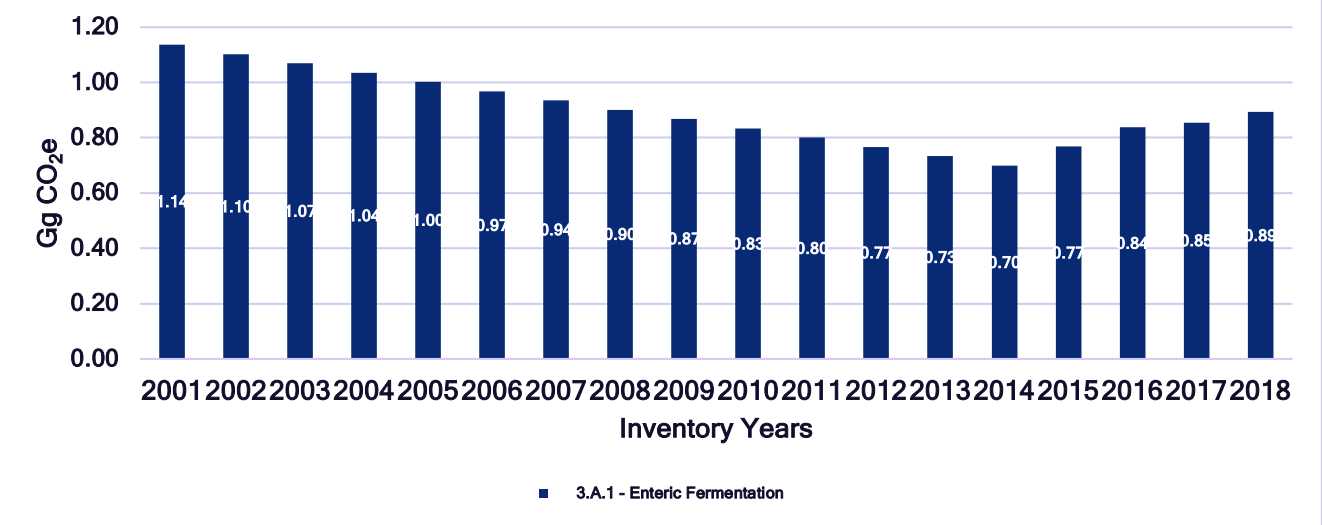
Figure 20: FSM's Livestock sub-sector GHG Emission Share (excluding Removal): 2001-2018



Enteric Fermentation

Methane is produced in herbivorous animals as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. Ruminant livestock (e.g., cattle, goat, sheep) are major sources of methane and moderate amounts produced from non-ruminant livestock (e.g., pigs, horses). This methane when released adds to GHG emission in the atmosphere. Enteric fermentation contributes to about 4% of the GHG emissions from Livestock sub-sector. The GHG emissions contributions from Enteric Fermentation declined from 1.14 Gg CO_2e in 2001 to 0.89 Gg CO_2e in 2018.

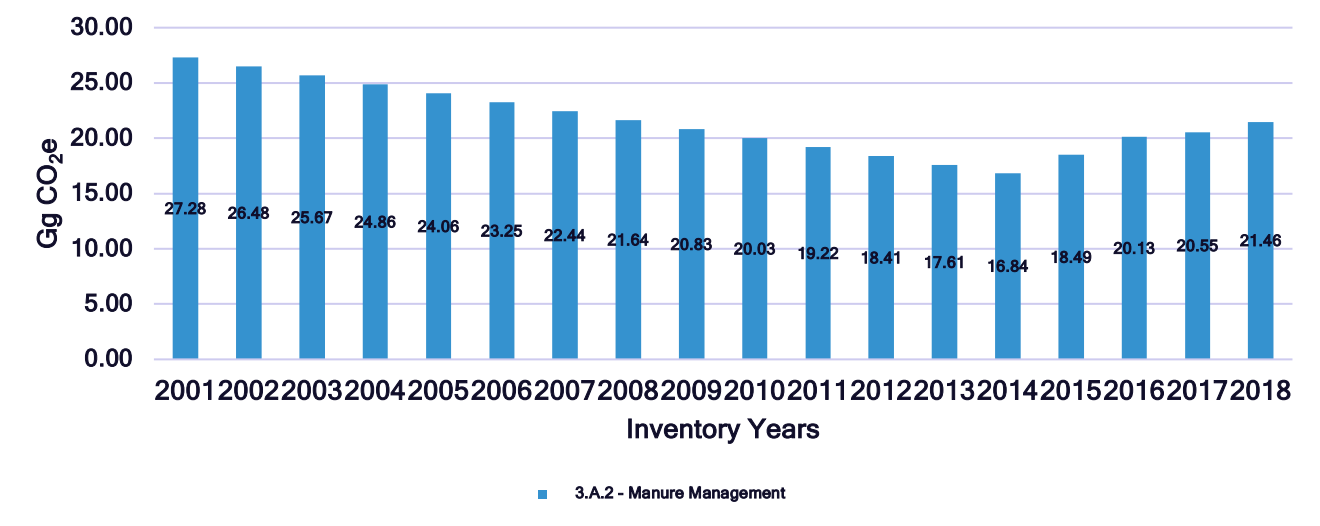
Figure 21: GHG emissions from Enteric Fermentation in Gg CO_2e: 2001-2018



Manure Management

Manure management contributes to about 96% of the GHG emissions from Livestock sub-sector in FSM. GHG emissions contributions from Manure management has reduced from 27.28 Gg CO_2e in 2001 to 21.46 Gg CO_2e in 2018. This represents a decrease in emission contributions of about 21% during the inventory years 2001-2018. This can be further reduced if modern/ scientific manure management systems are introduced in to the country.

Figure 22: GHG emissions from Manure Management in Gg CO_2e: 2001-2018



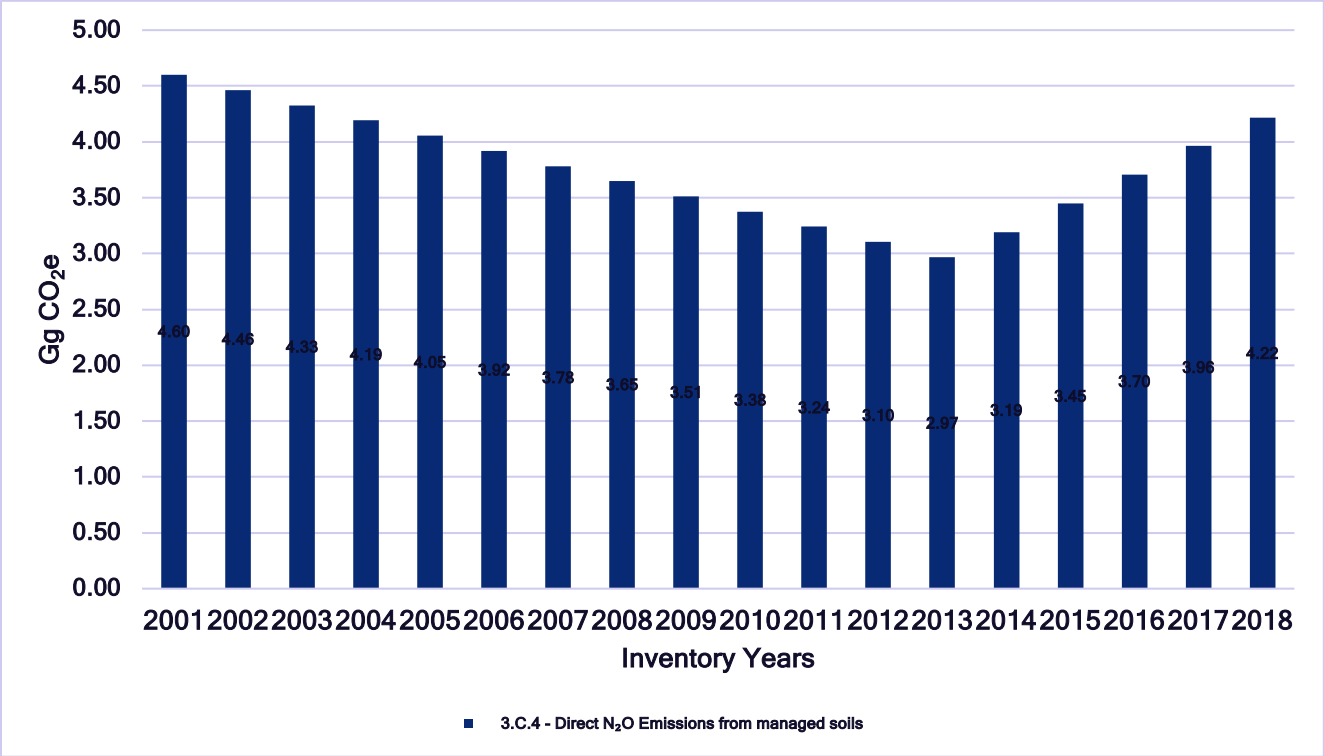
Aggregate sources and non-CO_2 emissions sources on land

The N_2O emissions from soils mainly occurs from two pathways- direct and indirect. Direct N_2O emissions to estimated using net N additions to soils (synthetic or organic fertilizers, deposited manure, crop residues etc) and mineralization of N in soil due to cultivation/land-use change on mineral soils. Indirect N_2O emissions occurs from two pathways. The first of these pathways is through the volatilization of N as NH_3 and oxides of N (NOx), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes and other waters. The second pathway is the leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residues, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals. Due to limited data availability on usage of fertilizers in FSM, only emissions from animal manure are taken into account. This sub-sector contributes about 20% of the total GHG emissions from AFOLU sector.

Direct N_2O Emissions from managed soils

The Direct N_2O emissions from managed soils occurring due to urine and dung N deposited on pasture, range and paddock by grazing animals (F_{PRP}) have been estimated for the inventory years 2001-2018. The emissions from this category reached to 4.22 Gg CO_2e in 2018 decreasing from 4.60 Gg CO_2e in 2001.

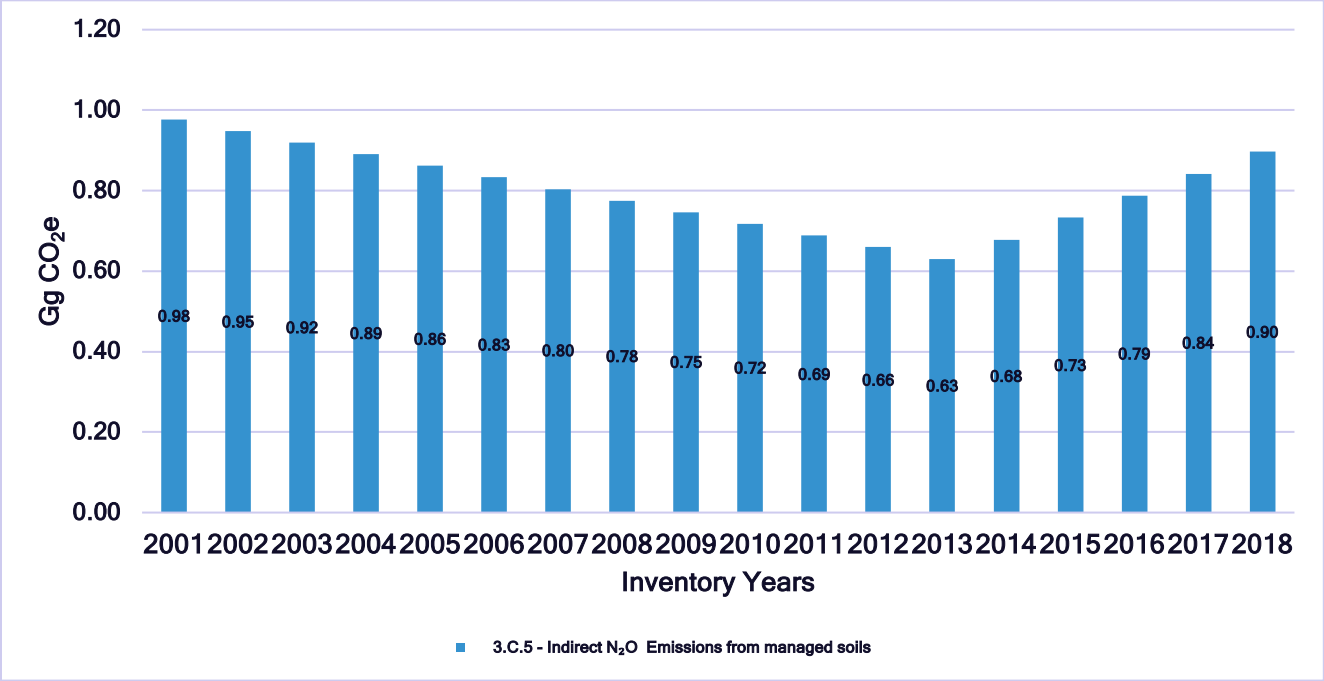
Figure 23: GHG emissions from Direct N_2O Emissions from managed soils in Gg CO_2e: 2001-2018



Indirect N_2O Emissions from Managed Soils

Under this category emissions due to the volatilization of N as NH_3 and oxides of N (NOx), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes and other waters are estimated. The GHG emissions from this category decreased to 0.90 Gg CO2e in 2018 from 0.98 Gg CO_2e in 2001.

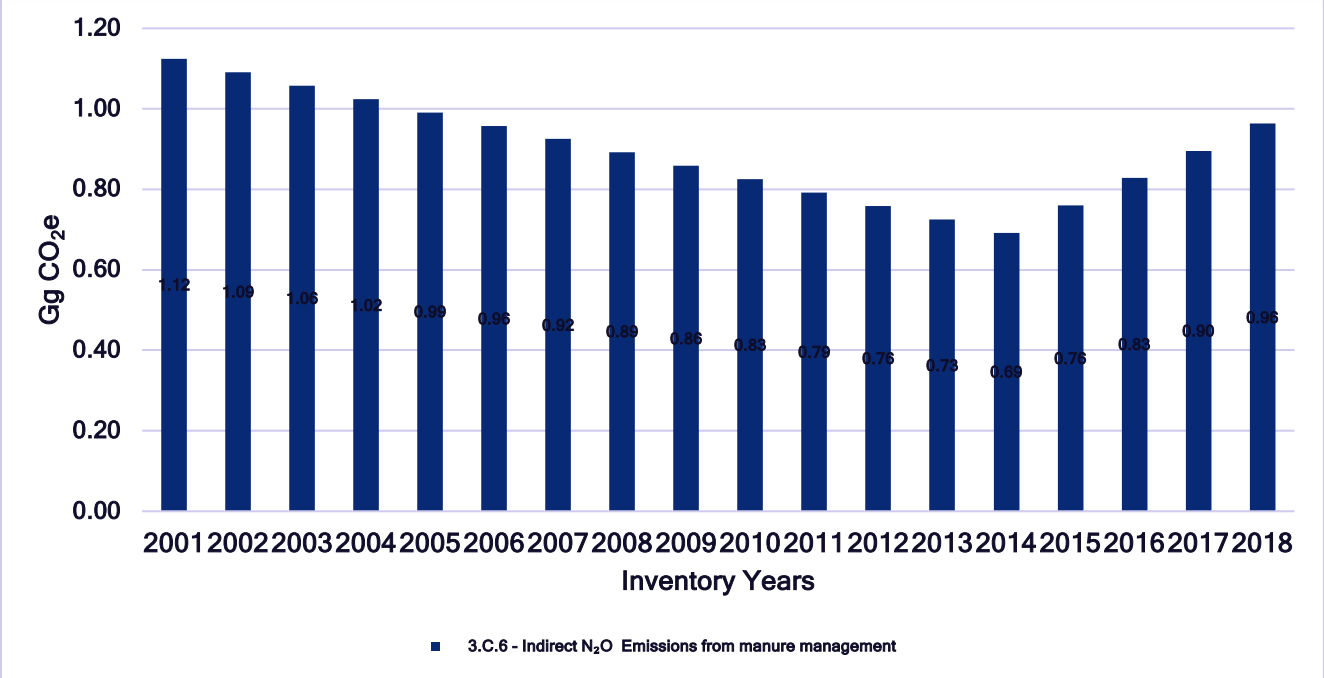
Figure 24: GHG emissions from Indirect N_2O Emissions from managed soils in Gg CO_2e: 2001-2018



Indirect N_2O Emissions from Manure Management

Under this category indirect N_2O emissions from manure management occurring through NH_3 volatilization and leaching of N during storage and handling of animal manure are estimated. The GHG emissions from this category decreased from 0.96 Gg CO_2e in 2018 from 1.12 Gg CO_2e in 2001.

Figure 25: GHG emissions from Indirect N_2O Emissions from Manure Management in Gg CO_2e: 2001-2018



Waste sector

The waste sector include mainly Solid waste and Wastewater and mainly responsible for emission of Methane and Nitrous oxide from the following two categories:

- Solid Waste Management and Disposal
- Domestic and Commercial Wastewater Discharge

Figure 26: FSM's Waste sector Emissions in Gg CO_2e: 2001-2018

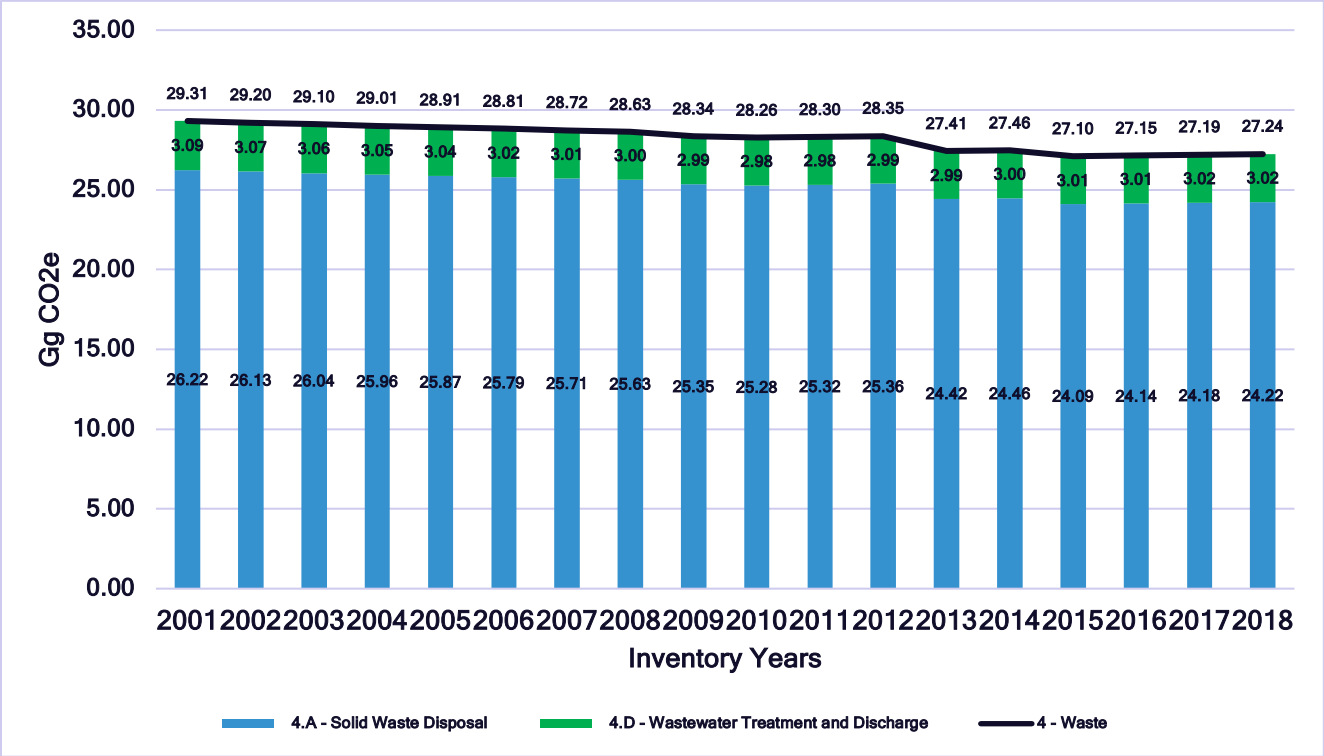


Table 14: FSM's Waste sector Emissions in Gg CO_2e: 2001-2018

Inventory Year: 2001-2018	Net CO2 Emissions, (CO2 Equivalents Gg)																	
Categories	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4 - Waste	29.31	29.20	29.10	29.01	28.91	28.81	28.72	28.63	28.34	28.26	28.30	28.35	27.41	27.46	27.10	27.15	27.19	27.24
4.A - Solid Waste Disposal	26.22	26.13	26.04	25.96	25.87	25.79	25.71	25.63	25.35	25.28	25.32	25.36	24.42	24.46	24.09	24.14	24.18	24.22
4.D - Wastewater Treatment and Discharge	3.09	3.07	3.06	3.05	3.04	3.02	3.01	3.00	2.99	2.98	2.98	2.99	2.99	3.00	3.01	3.01	3.02	3.02

Table 15: Waste Sector GHG Emissions (Gg): 2001-2018

	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total CH_4 emission	(Gg)	0.936	0.933	0.930	0.927	0.924	0.921	0.918	0.915	0.905	0.903	0.904	0.906	0.872	0.874	0.861	0.862	0.864	0.865

ns (MSW)																		
Total CH_4 emissions (WW)	(Gg)	0.061	0.061	0.061	0.061	0.060	0.060	0.060	0.060	0.059	0.059	0.059	0.059	0.059	0.060	0.060	0.060	0.060	0.060
Total CH_4 emissions (Waste Sector)	(Gg)	0.998	0.994	0.991	0.988	0.984	0.981	0.978	0.975	0.965	0.962	0.964	0.965	0.932	0.933	0.920	0.922	0.923	0.925
Total N_2O emissions	(Gg)	0.005175	0.005154	0.005132	0.005112	0.005091	0.005071	0.005052	0.005032	0.005013	0.004995	0.005003	0.005012	0.005021	0.005029	0.005038	0.005047	0.005056	0.005065
CO_2e	(Gg)	29.31	29.20	29.10	29.01	28.91	28.81	28.72	28.63	28.34	28.26	28.30	28.35	27.41	27.46	27.10	27.15	27.19	27.24

Figure 27: Waste Sector Emissions Gg CH_4 and N_2O: 2001-2018

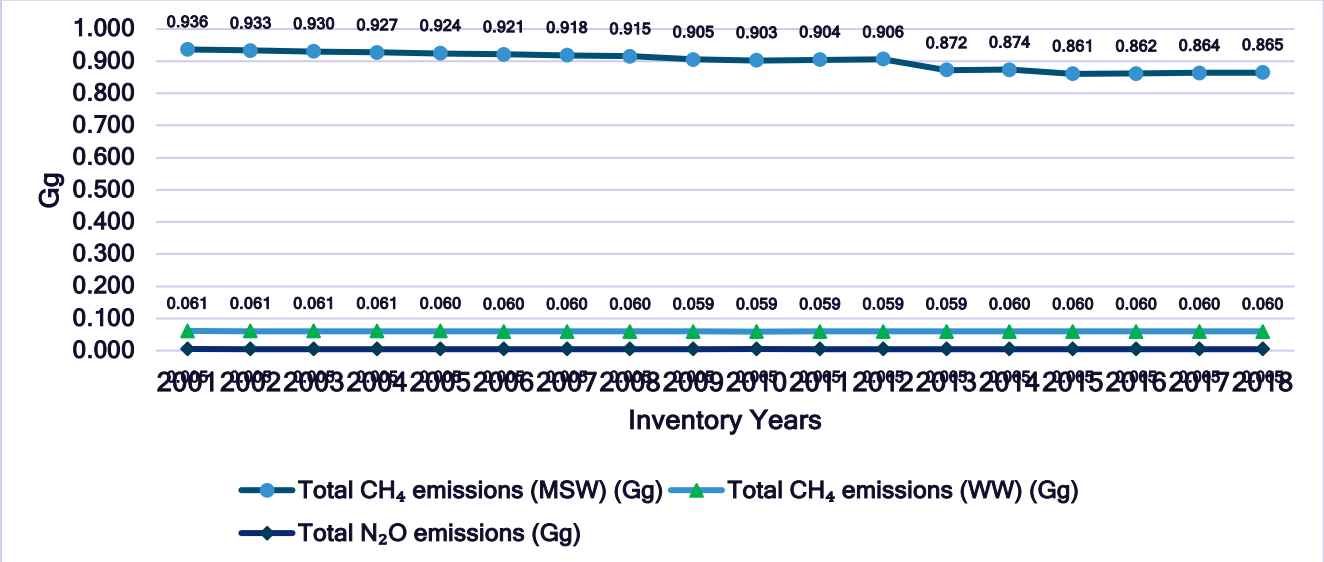


Figure 28: Waste Sector Emissions Gg CH_4: 2001-2018

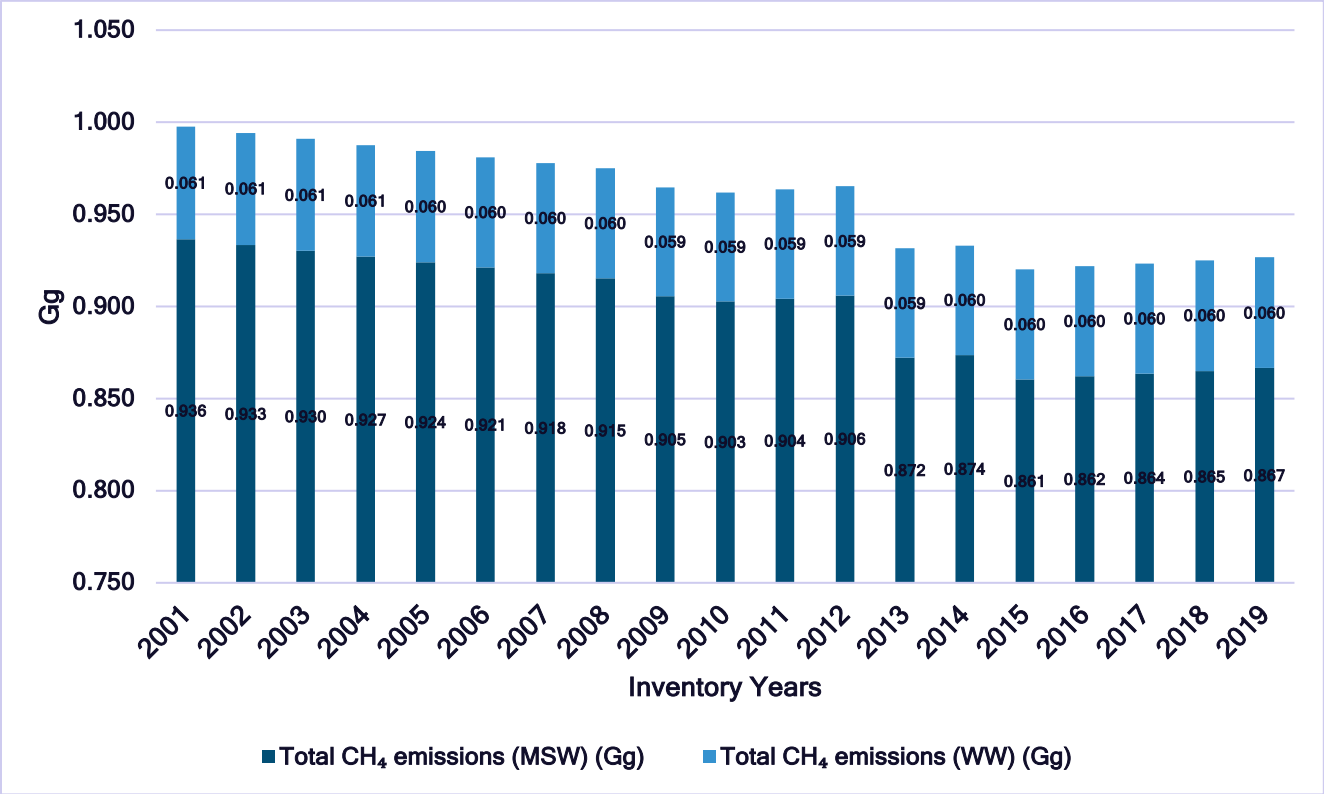


Figure 29: Waste Sector Emissions Gg N_2O: 2001-2018

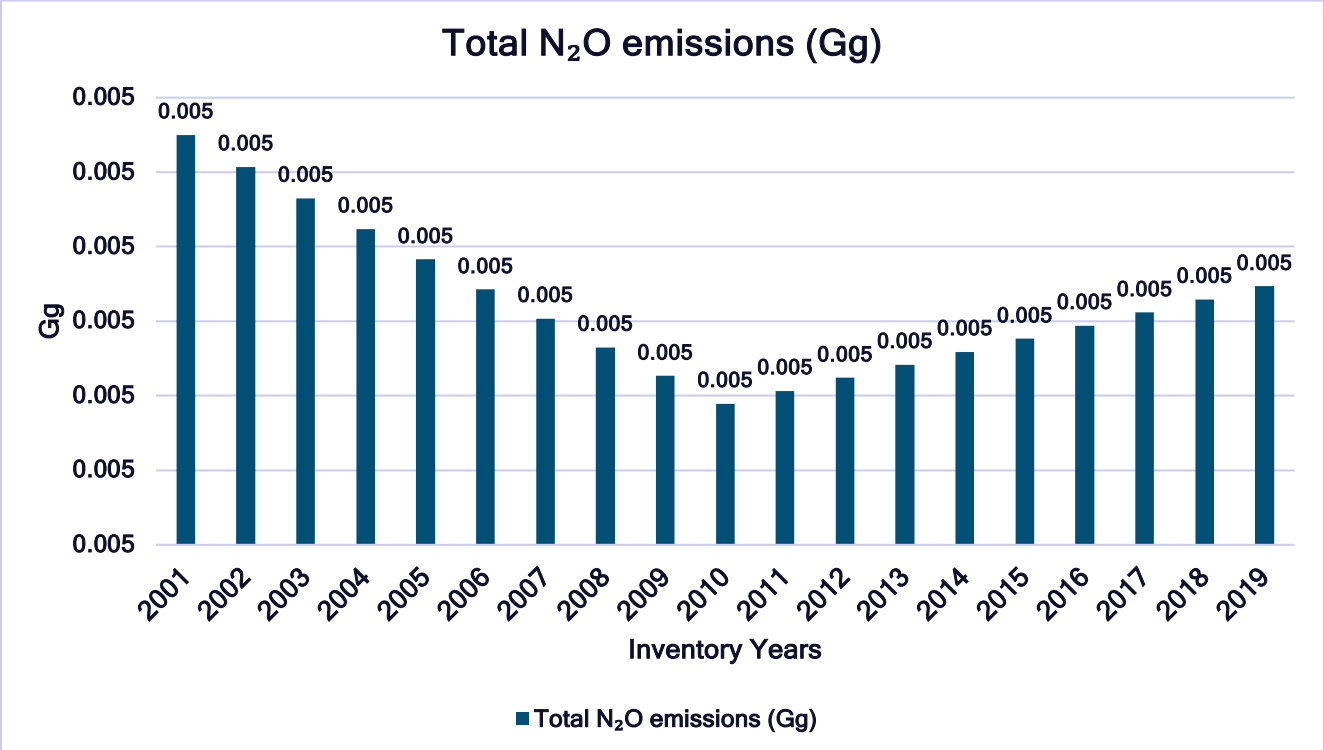


Table 16: Waste Sector Emissions Gg N_2O: 2001-2018

Years	Total N_2O emissions (Gg)
2001	0.005175
2002	0.005154
2003	0.005132
2004	0.005112
2005	0.005091
2006	0.005071
2007	0.005052
2008	0.005032
2009	0.005013
2010	0.004995
2011	0.005003
2012	0.005012
2013	0.005021
2014	0.005029
2015	0.005038
2016	0.005047
2017	0.005056
2018	0.005065

GHG emissions from Solid waste disposal and Wastewater treatment and discharge are discussed in more detail in the subsequent sections for the inventory years 2001-2018. It is to be noted that the biological waste treatment and incineration of solid waste are not considered under this inventory.

Solid Waste Disposal - Municipal Solid Waste (MSW)

The key source of methane emissions from solid waste management and disposal includes emissions from anaerobic decomposition of waste disposed at the various landfills and open dump sites in all the statess i.e., Yap, Chuuk, Pohnpei, and Kosrae. Solid waste disposal is one of the major concerns for FSM and constitutes about 21.8% of total GHG emissions from the country and 89% of total GHG emission from waste sector. In FSM the methods of waste disposal vary from states to states and ranges from open dumps to semi-aerobic Fukuoka Landfill. The main waste disposal facilities in each states are shown in the following table.

Table 17: Information on Landfill sites and open dumps in all states: 2001-2018

Information on Landfill sites and open dumps	
Yap States	Yap main public landfill, Colonia area: converted to Semi-aerobic and Operational since 2015 Major community dump sites: (i) Fanif municipality Rumuu village (ii) Tomil municipality Dechmur village (iii) Gagil municipality Makiy village (iv) Gagil municipality Gachpar village (v) Gagil municipality Wanyan village.
Chuuk States	No dedicated landfill site until 2016. Marina Interim Dump site (MID) started operation from 2016 January
Pohnpei States	Dekehtik landfill site started operation in 1997 and converted to Semi-aerobic in 2013.
Kosrae States	Tofol Landfill site (Semi-aerobic type): Landfilling commenced in 2009. Open dumpsites exist in other municipalities with states. However, their names and location are not available.

Land acquisition and cost-effective waste collection and transportation services has been and continues to remain a major challenge. The government of FSM with support and assistance from Japan International Cooperation Agency (JICA) is continuously making efforts to improve the solid waste management situation in the country.

The GHG emissions have been calculated as per the Tier 1 method: Based on the IPCC First Order Decomposition (FOD) method, using mainly default activity data and default parameters. In the absence of actual monitored data, the MSW generation in FSM is estimated from the total population in each states i.e., Yap, Chuuk, Pohnpei, Kosrae and using average waste generation rate of 0.5-0.9 kg/person/day. The waste composition was taken from the States Solid Waste Management Strategy reports of each states. The MSW generation and waste composition considered for the inventory calculation is provided in following table and figure.

Table 18: Solid Waste (MSW) Generation in FSM (Ton): 2001-2018

Years	Population				Total Population	Total Solid Waste (MSW) generated-Ton	Total Waste disposed at managed sites (landfill) -Ton	Total Waste disposed at un-managed sites (landfill, open dumping) -Ton	Total No. of landfill	Total No. Uncontrolled waste dumps
	Yap	Chuuk	Pohnpei	Kosrae						
2001	11255	53079	34653	7572	106559	26236	0	26236	1	7
2002	11269	52568	34821	7459	106117	26145	0	26145	1	7
2003	11283	52062	34990	7348	105683	26057	0	26057	1	7
2004	11297	51561	35160	7239	105257	25970	0	25970	1	7
2005	11311	51065	35331	7131	104838	25884	0	25884	1	7
2006	11325	50573	35502	7025	104425	25801	0	25801	1	7
2007	11339	50086	35674	6920	104019	25719	0	25719	1	7
2008	11353	49604	35847	6817	103621	25638	0	25638	1	7
2009	11367	49127	36021	6716	103231	25560	0	25560	2	7
2010	11377	48654	36196	6616	102843	25482	0	25482	2	7
2011	11397	48739	36259	6628	103023	25526	0	25526	2	7
2012	11417	48824	36322	6639	103202	25571	0	25571	2	7
2013	11437	48909	36386	6651	103383	25616	0	25616	3	7
2014	11457	48994	36449	6662	103562	25660	0	25660	3	7
2015	11477	49080	36513	6674	103744	25705	0	25705	3	7
2016	11497	49165	36576	6686	103924	25750	0	25750	4	6
2017	11517	49251	36640	6697	104105	25794	0	25794	4	6
2018	11537	49337	36704	6709	104287	25839	0	25839	4	6
MSW Generation rate (Kg/capita/day)	0.834	0.582	0.743	0.773						

Figure 30: MSW Characterization (wt%) – Yap States

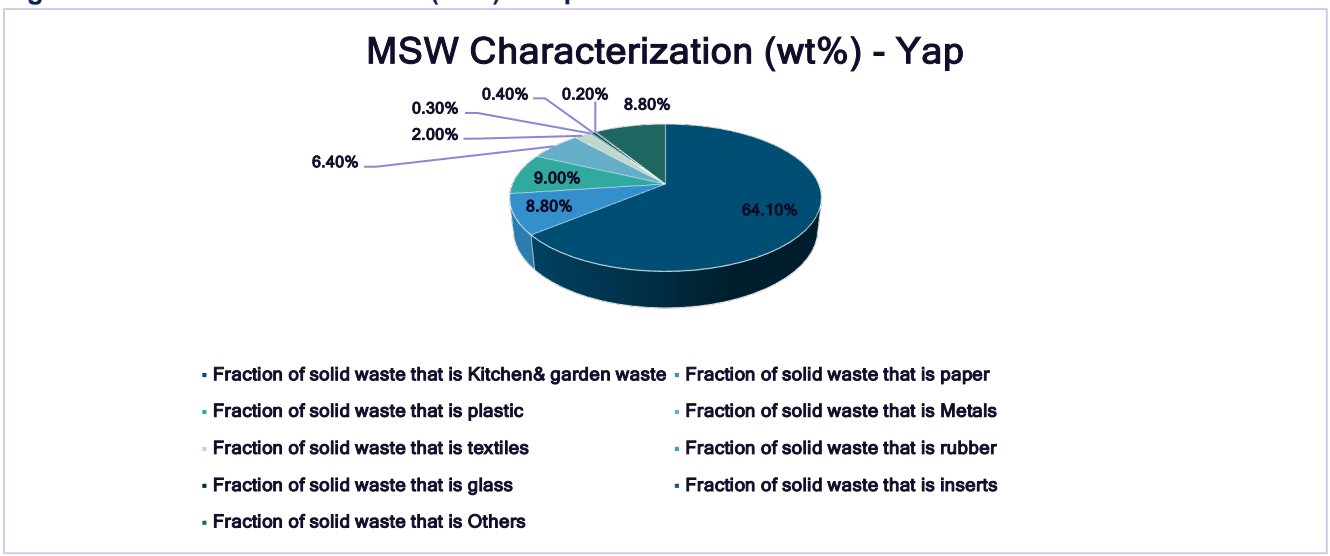


Figure 31: MSW Characterization (wt%) – Chuuk States

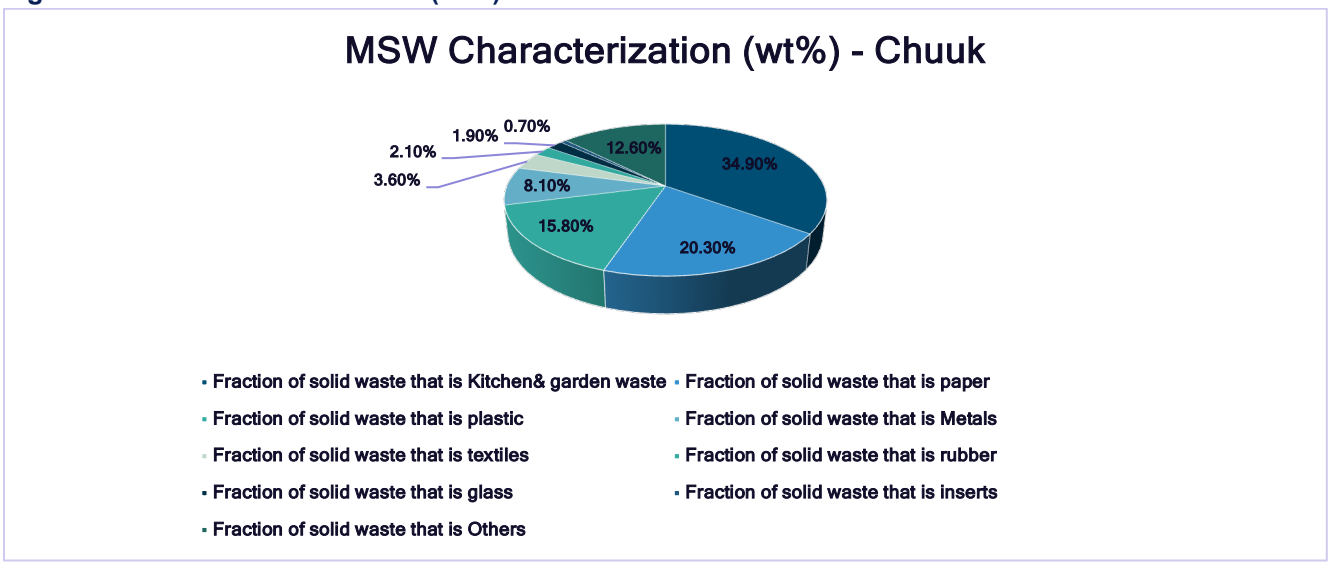


Figure 32: MSW Characterization (wt%) – Pohnpei States

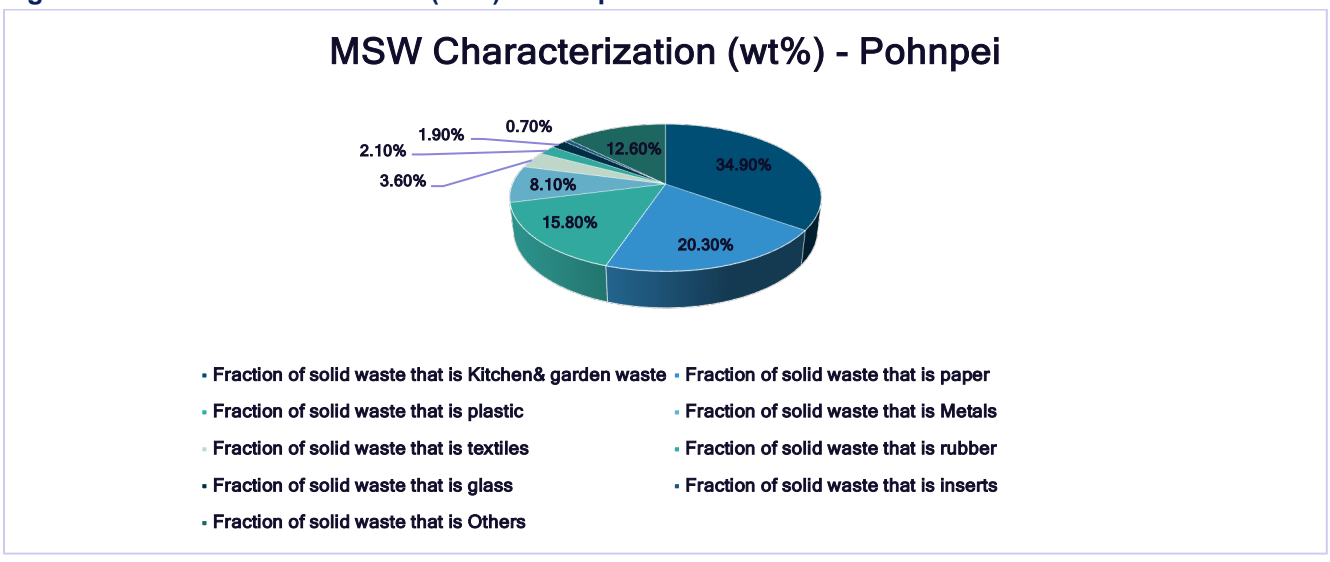


Figure 33: MSW Characterization (wt%) – Kosrae States

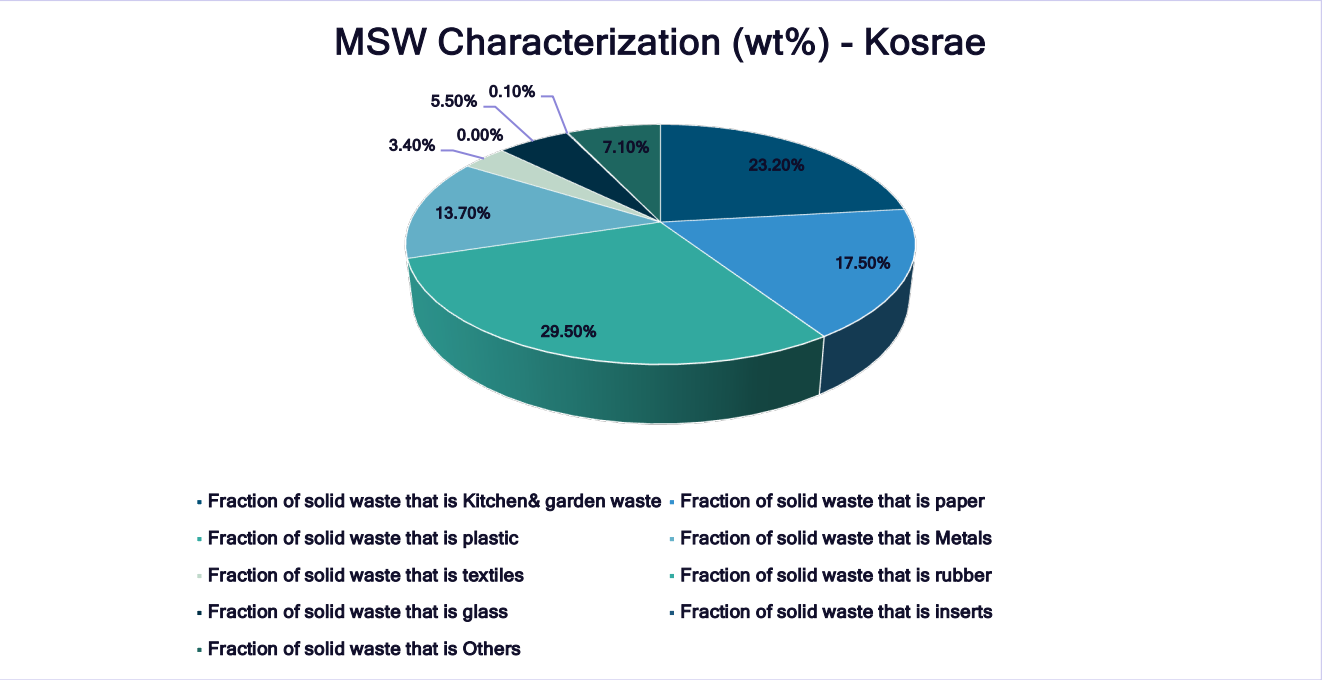
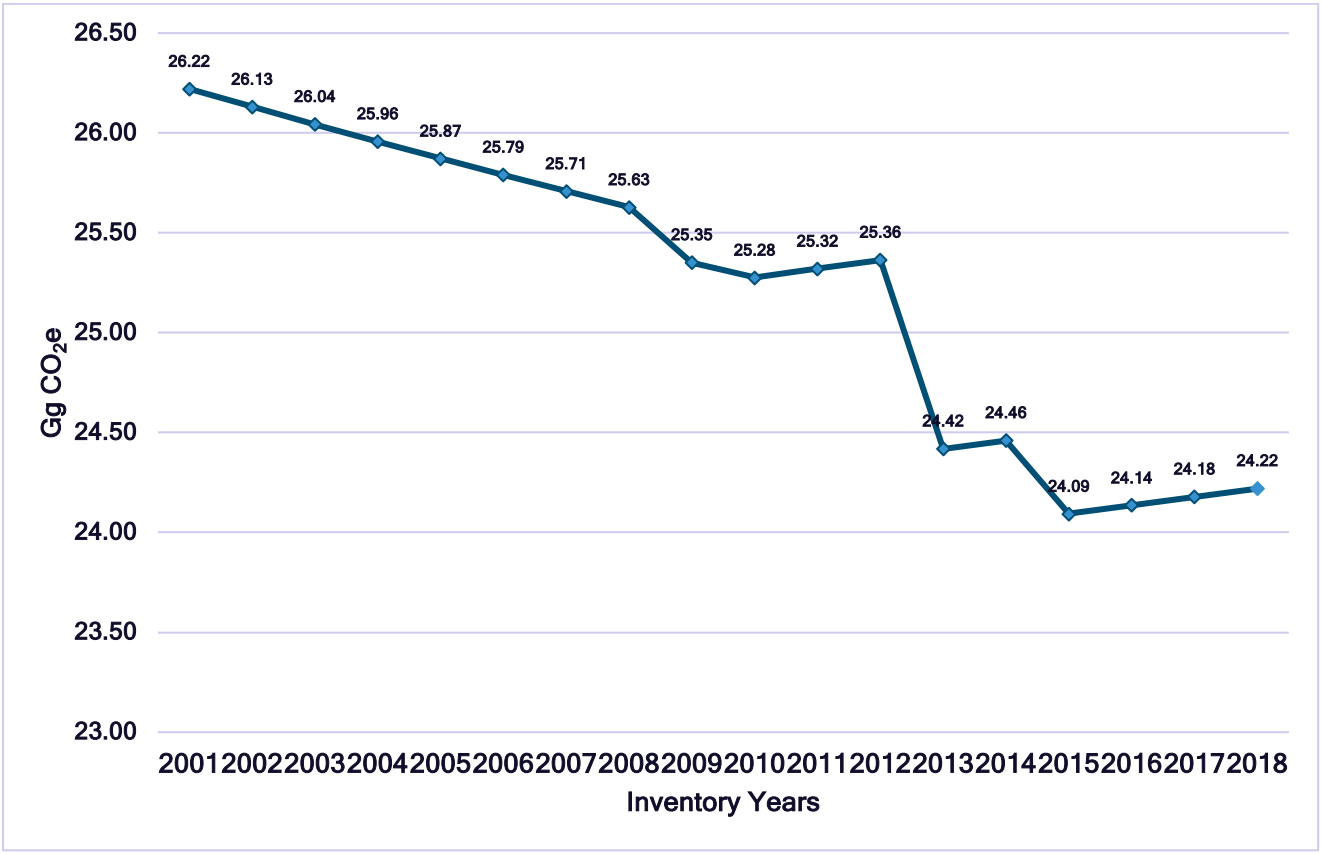


Figure 34: GHG emissions from Solid Waste Disposal- MSW: 2001-2018



The GHG emissions from this sub-sector has decreased over the inventory period, reduced to 24.22 Gg CO_2e in 2018 from 26.22 Gg CO_2e in 2001. This decrease is mainly attributed to decreasing population, rehabilitation and upgrading of the several landfills from unmanaged to semi-aerobic site.

Wastewater Treatment and Discharge

Wastewater treatment and Sanitation system is a major concern in FSM. A large proportion of households in the country still have limited access to public sanitation services and use pit latrines, septic tanks or other unhygienic excreta disposal systems. Access to the public sanitation services provided and managed by the different departments of states government are confined only to urban areas and to very small population. This allows the discharge of waste water in nearby waterbodies and sea.

The GHG emissions contribution from the wastewater treatment and discharge subsector is about 2.6% of the total GHG emissions of the country and about 11% of total GHG emissions from waste sector. The GHG emissions from this sector includes Methane and Nitrous oxide emissions. The quantity of wastewater generated and IPCC default parameter for Oceania region have been used for estimating GHG emissions due to lack of monitored data. The Tier1 method has been applied to estimate GHG emissions form the sub-sector, that uses the default values for the emission factor and activity parameters and is considered good practice for countries with limited data. The following table presents the parameters used for estimation of GHG emissions from this sub-sector.

Table 19: Parameter used for estimating GHG emissions from Wastewater treatment and discharge

Parameter	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Population	Number	1065559	1061783	1056257	1048838	1044025	1040021	1036031	1032431	1028043	1023302	1033383	1035562	1037744	1039241	1041005	1042487		
Wastewater's source		Domestic																	
Organic content in the wastewater - in inventory year	TOWi	kg BOD/yr	29170553	29049533	28930722	28814140	28699400	28584634	28470520	28365625	28259449	28153227	28202555	28251555	28301100	28350100	28399920	28449204	28498874
Specific per capita BOD in inventory year, BOD	g/person/day	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Annual per capita protein consumption	kg/person/yr	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075	22.075
Factor to adjust for non-consumed protein, FNON-CON		1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Fraction of nitrogen in protein, FNPR	kg N/kg protein	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16

The Wastewater emissions i.e., CH_4 and N_2O estimated using the IPCC methodology and default value for Oceania region are presented in the following table:

Table 20: GHG emissions from Wastewater treatment and discharge: 2001-2018

Wastewater treatment and disch	Units	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018

arge emissions																		
Total CH_4 emissions	(Gg)	0.061	0.061	0.061	0.061	0.060	0.060	0.060	0.060	0.059	0.059	0.059	0.059	0.059	0.060	0.060	0.060	0.060	0.060
Total N_2O emissions	(Gg)	0.052	0.052	0.051	0.051	0.051	0.051	0.051	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.051	0.051
CO_2e	(Gg)	3.087	3.074	3.061	3.049	3.037	3.025	3.013	3.002	2.990	2.979	2.984	2.989	2.995	3.000	3.005	3.010	3.016	3.021

The total GHG emissions from this sub-sector reached to 3.021 Gg CO_2e decreasing from 3.087 Gg CO_2e in 2011, representing a decrease of about 2% during the inventory period 2001-2018. This decrease is mainly attributed due to decline in the population of the country. Further, the data uncertainty and default values used for the waste sector emission shall be overcome by the proper data monitoring and reporting.

Key Category Analysis-2018

As per the Decisions 17/CP.8 and 2/CP.17 the Non-Annex I Parties are encouraged, to the extent possible, to undertake any key category analysis (level/trend or both) to assist in developing inventories that better reflect their national circumstances. Key category Analysis (KCA) is prominent for the national GHG inventory development and it provides a framework for identifying the most important categories in the GHG inventory. Key categories identified are emission or removal categories that contribute most to the total or trend in emissions level of the country. KCA aids the country to prioritize efforts in improving the GHG inventory over time.

The FSM's National GHG Inventory key categories have been identified in terms of their contribution to the absolute level of national GHG emissions and removals. Basic Approach 1 has been adopted for quantitative analysis in objective manner, accounting uncertainties and suggested aggregation level of analysis, as presented in the table below:

Table 21: KCA: Aggression Level of Analysis for Approach-1

IPCC Category code	IPCC Category	Greenhouse gas	Remarks
Energy			
1.A	Fuel Combustion Activities	CO_2, CH_4, N_2O	All fuel
Agriculture, Forestry and Other Land Use			
3.A.1	Enteric Fermentation	CH_4	All category of Livestock
3.A.2	Manure Management	CH_4, N_2O	All category of Livestock
3.C.4	Direct N_2O Emissions from managed soils		All category of Livestock
3.C.5	Indirect N_2O Emissions from managed soils		All category of Livestock
3.C.6	Indirect N2O Emissions from manure management	N_2O	All category of Livestock
Waste			
4.A	Solid Waste Disposal	CH_4	MSW Waste- Entire Country
4.D	Wastewater Treatment and Discharge	CH_4, N_2O	Domestic Waste Water- Entire Country

In Approach 1, key categories are identified using a pre-determined cumulative emissions threshold. The approach 1 identify key categories assesses the influence of various categories of sources and sinks on the level, and possibly the trend, of the national greenhouse gas inventory. Key categories are those that, when summed together in descending order of magnitude, add up to 95% of the total level; however as per GPG key categories identified between threshold of 95% and 97%. The result of approach 1 level KCA analysis for Solomon Islands National GHG Inventory for the recent year i.e., 2018 presented in the tables below:

Table 22: Summary of key category analysis Inventory year 2018

IPCC Category code	IPCC Category	Greenhouse gas	Criteria
1.A	Fuel Combustion Activities	CARBON DIOXIDE (CO2)	L1, T1
4.A	Solid Waste Disposal	METHANE (CH4)	L1, T1
3.A.2	Manure Management	METHANE (CH4)	L1, T1
3.C.4	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	L1, T1
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	T1

The notation keys: L = key category according to level assessment; T = key category according to trend assessment; and Q = key category according to qualitative criteria.

Uncertainty Analysis

Uncertainty estimates are an essential element of a complete emissions inventory. Uncertainty analysis has been carried out in accordance with the IPCC general guidance on uncertainty assessment14. In accordance with the 2006 IPCC Guidelines, Approach 1 of uncertainty assessment is used. Approach 1 is based upon error propagation and is used to estimate uncertainty in individual categories, in the inventory as a whole, and in trends between a year of interest and a base year. The Uncertainties from disaggregated levels are combined by multiplying the default uncertainty values. The overall uncertainty in national emissions i.e., Percentage uncertainty in total inventory was estimated as 7%; and the trend in national emissions between the base year and the current year has been estimated as 8%. The major uncertainty contributed from the AFOLU and Waste sector followed by the Energy sector. Note: what is the ideal %? what uncertainty percentage do we strive for in the next round of reporting? If AFOLU and WASTE were separated, would the Energy uncertainty percentage improve?

The key uncertainties are mainly attributed with data availability, missing information, data archiving, and lack of country-specific emission factors. It is recognized that the detailed activity data and country-specific emission factors will reduce uncertainty in future inventory. The Inventory Team has also prepared the inventory improvement plan (IIP) to abate the uncertainties as far as it is practically possible for the future GHG inventories. Note: excellent. Looking forward to reviewing this IIP.

[14] The IPCC 2006 Guidelines, http://www.ipccnggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

Table 23: Uncertainty range for key Sector emissions

IPCC Categories	Gas	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty
		Input data	Input data	
		%	%	%
1 - Energy	CO2	0.95	0.00	0.95
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	CH4, N2O	0.30	0.00	0.25
3.C - Aggregate sources and non-CO2 emissions sources on land	N2O	0.30	0.00	0.40
4 - Waste	CH4, N2O	0.50	0.00	0.40

Conclusion

This inventory serves as a key source of evidence on FSM's National greenhouse gas emissions trends and aids in monitoring progress made towards reduction of GHG emission. It also acts as an important tool for FSM's policy recommendations on climate change and enables to measure success of such policies. The current GHG inventory provides comprehensive information on GHG emissions for the years 2001 to 2018 and also reflects the trend in emission levels since 1994. The GHG emissions results for the inventory period 2001-2018 reveals a varying trend over the reporting period with the annual variation dominated by fuel consumption in energy sector.

The compilation of the GHG inventory continues to remain a major challenge, especially in terms of the availability of activity data for estimation of GHG emissions. The key findings and recommendations of this inventory development exercise have been identified during and highlighted in previous sections of the report. However, data collection, monitoring and verification for GHG emission sector is key takeaway of this exercise. For the future GHG inventory FSM shall minimize the data gaps and uncertainty specifically in Energy, Livestock and Waste sector.

National GHG Inventory Improvement Plan (NIIP)

- Precursor gases: The estimation and reporting of the precursors for national inventories emissions i.e., carbon monoxide (CO), oxides of nitrogen (NOx), non-methane volatile organic compounds (NMVOCs), and sulphur dioxide (SO_2) may be considered to the extent possible and based on national circumstances and possibilities.
- Key Category Analysis: The activity data collection and review process will be improved and higher tier (tier-2) analysis of GHG from the key categories and sub-categories identified for Vanuatu proposed for the next inventory. The activity data collection, review process and QA/QC procedure will be developed and implemented for all the key categories and sub-categories.
- Trend Analysis: The GHG emissions from the previous year will be recalculated for trend analysis, if there is change in the methodologies used during the reporting period.
- Procedural arrangements: (a) Data Collection: The activity data collection from the industry, public and private sector as well as institutions and department shall be formalized via suitable instrument e.g., legal contracts, MoUs, MoAs, or other legal documents. (b) The Department of Environment, Climate Change and Emergency Management (DECCEM) will initiate the regulation to formalize the database management, archives and institutional setup for the above. (c) Department of Environment, Climate Change and Emergency Management (DECCEM) will establish arrangements for implementing improved QA/QC procedures, manage and operate the inventory database, and document and archive inventory information and the operation of the inventory.
- Implementation Integrated Monitoring, Reporting and Verification (MRV Tool) for National GHG Inventory: Department of Environment, Climate Change and Emergency Management (DECCEM) will implement and operationalize the web based integrated monitoring, reporting and verification system for national GHG inventory.
- Energy sector data: Limited data was available on quantity of fuels imported to the country (data for the inventory years 2001-2009 not available). Hence, GHG emissions was computed using only reference approach. More data on fuel distribution and their consumption in different fuel combustion activities like electricity generation, transportation, etc. will be obtained from FSMPC and national statistics department for computing emissions using sectoral approach in the future inventory.
- Livestock Data: More detailed and granular data on livestock species and their population will be obtained from animal husbandry department for the future inventory.
- Forestry and Other Land Use: Limited data and information available from this sub-sector hence emissions/removals are not estimated in this report. Data will be collected for the future inventory.
- Waste Sector Data: The waste (Solid waste and waste water) sector activity data monitoring and reporting needs to be initiated in urban centres.
- Capacity building and training activities will be conducted for the stakeholders involved mainly for monitoring and data collection. Further the stakeholders will be sensitizing on accuracy, traceability and transparency of data, QA/QC and reporting aspects of national GHG inventory.
- GHG Inventory Software: Latest version of IPCC GHG inventory software will be used.

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Annexures

Annexure-1: FSM's GHG Inventory Coverage

Categories	Remark
Total National Emissions and Removals	
1 - Energy	Estimated
1.A - Fuel Combustion Activities	Estimated
1.A.1 - Energy Industries	NE
1.A.2 - Manufacturing Industries and Construction	NE
1.A.3 - Transport	NE
1.A.4 - Other Sectors	NE
1.A.5 - Non-Specified	NO
1.B - Fugitive emissions from fuels	NO
1.B.1 - Solid Fuels	NO
1.B.2 - Oil and Natural Gas	NA
1.B.3 - Other emissions from Energy Production	NO
1.C - Carbon dioxide Transport and Storage	
1.C.1 - Transport of CO2	NO
1.C.2 - Injection and Storage	NO
1.C.3 - Other	NO
2 - Industrial Processes and Product Use	NE
2.A - Mineral Industry	NE
2.A.1 - Cement production	NO
2.A.2 - Lime production	NE
2.A.3 - Glass Production	NO
2.A.4 - Other Process Uses of Carbonates	NO
2.A.5 - Other (please specify)	NO
2.B - Chemical Industry	NO
2.B.1 - Ammonia Production	NO
2.B.2 - Nitric Acid Production	NO
2.B.3 - Adipic Acid Production	NO
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	NO
2.B.5 - Carbide Production	NO
2.B.6 - Titanium Dioxide Production	NO
2.B.7 - Soda Ash Production	NO
2.B.8 - Petrochemical and Carbon Black Production	NO
2.B.9 - Fluorochemical Production	NO
2.B.10 - Other (Please specify)	NO
2.C - Metal Industry	NO
2.C.1 - Iron and Steel Production	NO
2.C.2 - Ferroalloys Production	NO
2.C.3 - Aluminium production	NO
2.C.4 - Magnesium production	NO
2.C.5 - Lead Production	NO

2.C.6 - Zinc Production	NO
2.C.7 - Other (please specify)	NO
2.D - Non-Energy Products from Fuels and Solvent Use	NE
2.D.1 - Lubricant Use	NE
2.D.2 - Paraffin Wax Use	NE
2.D.3 - Solvent Use	NE
2.D.4 - Other (please specify)	NE
2.E - Electronics Industry	NO
2.E.1 - Integrated Circuit or Semiconductor	NO
2.E.2 - TFT Flat Panel Display	NO
2.E.3 - Photovoltaics	NO
2.E.4 - Heat Transfer Fluid	NO
2.E.5 - Other (please specify)	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE
2.F.1 - Refrigeration and Air Conditioning	NE
2.F.2 - Foam Blowing Agents	NE
2.F.3 - Fire Protection	NE
2.F.4 - Aerosols	NE
2.F.5 - Solvents	NE
2.F.6 - Other Applications (please specify)	NE
2.G - Other Product Manufacture and Use	NE
2.G.1 - Electrical Equipment	NE
2.G.2 - SF6 and PFCs from Other Product Uses	NE
2.G.3 - N2O from Product Uses	NE
2.G.4 - Other (Please specify)	NE
2.H - Other	NE
2.H.1 - Pulp and Paper Industry	NE
2.H.2 - Food and Beverages Industry	NE
2.H.3 - Other (please specify)	NE
3 - Agriculture, Forestry, and Other Land Use	Estimated
3.A - Livestock	Estimated
3.A.1 - Enteric Fermentation	Estimated
3.A.2 - Manure Management	Estimated
3.B - Land	NE
3.B.1 - Forest land	NE
3.B.2 - Cropland	NE
3.B.3 - Grassland	NE
3.B.4 - Wetlands	NE
3.B.5 - Settlements	NE
3.B.6 - Other Land	NE
3.C - Aggregate sources and non-CO2 emissions sources on land	Estimated
3.C.1 - Emissions from biomass burning	NE
3.C.2 - Liming	NO
3.C.3 - Urea application	NE

3.C.4 - Direct N2O Emissions from managed soils	Estimated
3.C.5 - Indirect N2O Emissions from managed soils	Estimated
3.C.6 - Indirect N2O Emissions from manure management	Estimated
3.C.7 - Rice cultivations	NO
3.C.8 - Other (please specify)	NO
3.D - Other	NE
3.D.1 - Harvested Wood Products	NE
3.D.2 - Other (please specify)	NO
4 - Waste	Estimated
4.A - Solid Waste Disposal	Estimated
4.B - Biological Treatment of Solid Waste	NO
4.C - Incineration and Open Burning of Waste	NE
4.D - Wastewater Treatment and Discharge	Estimated
4.E - Other (please specify)	NO
5 - Other	NE
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NE
5.B - Other (please specify)	NO
Memo Items (5)	
International Bunkers	NE
1.A.3.a.i - International Aviation (International Bunkers)	NE
1.A.3.d.i - International water-borne navigation (International bunkers)	NE
1.A.5.c - Multilateral Operations	NO
Notation Keys: NE: Not estimated (Emissions and/or removals occur but have not been estimated or reported) NO: Not occurring (An activity or process does not exist within a country)	
