Ministry of Environment, Climate, Tourism and Hospitality Industry
GOVERNMENT OF ZIMBABWE
2022





ZIMBABWE

Fourth National Communication to the United Nations Framework Convention on Climate Change

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Ministry of Environment, Climate, Tourism and Hospitality Industry

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ZIMBABWE

UNEP

Foreword

The impacts of climate change and variability are becoming more evident with increased incidences of droughts, cyclones, floods, hailstorms, windstorms and heat waves. This has adversely affected key sectors of the country's economy. The Government of Zimbabwe views climate change as a serious threat to the achievement of its development aspirations. Zimbabwe has seen increased frequency and magnitude of droughts, prolonged dry spells, violent storms and tropical cyclones over the past two decades impacting on human settlements and sectors such as agriculture, energy, health and infrastructure. By becoming a Party to the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, the Kyoto Protocol in 2009 and the Paris Agreement in 2017, Zimbabwe reaffirmed its commitment to be an active participant in efforts to tackle the climate change challenge.

Zimbabwe has prepared its Fourth National Communication to the UNFCCC, in accordance with the Climate Convention's Article 4: 1, which calls on all Parties to develop, periodically update, publish and make available to the Conference of the Parties (COP) a National Communication every four years. In addition, Article 12 of the Convention provides for parties to submit national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the COP. In addition to the national greenhouse gas inventory, the National Communication also reports on the climate change risks, vulnerability and adaptation status, on-going climate change education, awareness and trainings, research and systematic observations as well as constraints, gaps and technology needs.

The National Communication was compiled through literature reviews, field research, data collection, analysis, and stakeholder consultations. The National Communication went through expert reviews and validation to ensure accuracy of the information presented and national ownership. The main objective of this communication is to inform the Conference of Parties, as well as decision-makers, specialists, and the public on the status of climate change, the country's priorities and needs in order to successfully implement the climate change agenda. The Fourth National Communication follows submissions of the First, Second and Third National Communications and the First Biennial Update Report to the UNFCCC in 1998, 2012, 2017 and 2021, respectively.

To enhance the effective implementation of the national response to climate change and the international climate change regime, the Government of Zimbabwe during the reporting period has developed and adopted the National Climate Policy (2017) which provides guidance on climate actions being undertaken in the country and implemented in line with the National Climate Change Response Strategy (NCCRS). To support the implementation of the National Climate Policy and international commitments; a Climate Smart Agriculture Manual for Agricultural Education and a Climate Change and Gender Action Plan have been adopted. Furthermore, Zimbabwe adopted its Low Emission Development Strategy (LEDS) and revised its Nationally Determined Contribution in 2021 in line with provisions of the Paris Agreement. A National Adaptation Plan (NAP) for Zimbabwe will be in place before the end of 2022.

As I conclude, I would like to express sincere gratitude to the Global Environment Facility (GEF), UNEP, authors and editors of the Fourth National Communication Report, stakeholders and UNEP/UNDP Global Support Programme (UNEP/UNDP - GSP) for National Communications for the financial and technical support.

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Nqobizitha Mangaliso Ndhlovu (MP)
Minister of Environment, Climate, Tourism and Hospitality Industry

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Acronyms

AFOLU	Agriculture, Forestry and Other Land-Use
ARDA	Agricultural and Rural Development Authority
AWOS	Automatic Weather Observing Systems
AWS	Automatic Weather Systems
AR4	Fourth Assessment Report
AQI	Air Quality Index
BAU	Business As Usual
BBR	Beitbridge Bulawayo Railways
BCSDZ	Business Council for Sustainable Development Zimbabwe
BNR	Biological Nutrient Removal
BOD_5	Biological Oxygen Demand
BOT	Build, Operate and Transfer
BUR1	First Biennial Update Report
CO_2	Carbon Dioxide
CA	Conservation Agriculture
CAAZ	Civil Aviation Authority of Zimbabwe
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CBIT	Capacity Building Initiative for Transparency
CCMD	Climate Change Management Department
CDM	Clean Development Mechanisms
CDU	Curriculum Development Unit
CH_4	Methane
CIAT	International Centre for Tropical Agriculture
CDTS	Curriculum Development and Technical Services Department
CO	Carbon monoxide
COD	Chemical Oxygen Demand
CO_2	Carbon Dioxide
CO_2eq	Carbon Dioxide Equivalent
CORDEX	Coordinated Downscaling Experiment
COVID 19	Corona Virus Disease of 2019
CRU	Climate Resource Unit
CSA	Climate Smart Agriculture
CSIRO MK	Commonwealth Scientific and Industrial Research Organisation Mark
CSO	Civil Society Organisations
CTCN	Climate Technology Centre & Network
DEVPROMIS	Development Projects Management Information System
DPSIR	Driver, Pressure, State, Impact and Response
DRR	Disaster Risk Reduction
EAT	Education, Awareness and Training
EFDB	Emission Factor Database
EMA	Environmental Management Agency
Evs	Electric Vehicles
ETF	Enhanced Transparency framework
FAO	Food And Agriculture Organisation

FAOSTAT	Food and Agriculture Organisation Corporate Statistical Database
NC4	Fourth National Communication
FBO	Faith Based Organisations
FOD	First Order Decay
FOLU	Forestry and Other Land-Use
GCF	Green Climate Fund
GCM	Global Circulation Models
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GFCS	Global Framework for Climate Services
Gg	Gigagram
GHG	Greenhouse Gas
GNI	Gross National Income
GoZ	Government of Zimbabwe
GWP	Global Warming Potential
GWPSA	Global Water Partnership for Southern Africa
Ha	Hectares
HDI	Human Development Index
HFCs	Hydro-fluorocarbons
Hvs	Hydrogen Vehicles
ICAT	Initiative for Climate Action Transparency
IDBZ	Infrastructure Development Bank of Zimbabwe
IDRC	International Development Research Centre
IEA	International Energy Agency
IKS	Indigenous Knowledge Systems
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
IOM	International Organisation for Migration
IPCC	Intergovernmental Panel on Climate Change
IPPs	Independent Power Producers
IPPU	Industrial Processes and Product Use
LEAP	Low Emission Analysis Platform
LEDS	Low Emission Development Strategy
LF	Load Factor
LPG	Liquefied Petroleum Gas
LTOsS	Landings and Takes-Offs
MCF	Methane Correction Factor
MECTHI	Ministry of Environment, Climate, Tourism and Hospitality Industry
MIC	Manufacturing Industries and Construction
MIASMD	Modelling framework for the Health Impact Assessment of Man Induced Atmospheric changes
MoEPD	Ministry of Energy and Power Development
MoTID	Ministry of Transport and Infrastructure Development
MoU	Memorandum of Understanding
MRR	Monitoring, Reporting and Reviewing
MRV	Measurement , Reporting and Verification
MSD	Meteorological Services Department
MSW	Municipal Solid Waste

MSWDs	Municipal Solid Waste Disposal Site
Mt	Metric Tonnes
MW	Megawatt
N_20	Nitrous Oxide
N_2O	Nitrous Oxide
NAP	National Adaptation Plan
NC4	Fourth National Communication
NCCRS	National Climate Change Response Strategy
NCs	National Communications
NDCs	Nationally Determined Contributions
NDS	National Development Strategy
NE	Not Estimated
NFCS	National Framework for Climate Services
NIR	National Inventory Report
NMVOC	Non Methane Volatile Organic Compounds
NO	Not Occurring
NO_X	Nitrogen Oxide
NRZ	National Railways of Zimbabwe
NWP	Numerical Weather Prediction
ODS	Ozone Depleting Substances
OPC	Office of the President and Cabinet
PA	Paris Agreement
PDC	Provincial Development Committee
PFCs	Perfluorocarbons
PPP	Public-Private Partnerships
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RCM	Regional Circulation Models
RCPs	Representative Concentration Pathways
RCZ	Research Council of Zimbabwe
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RSO	Research and Systematic Observation
RTGS	Real Time Gross Settlement
RWIMMS	Rural WASH Information & Services Management System
SAR	Second Assessment Report
SDGs	Sustainable Development Goals
SF_6	Sulphur Hexafluoride
SMES	Small to Medium Enterprises
SNC	Second National Communication
SO_2	Sulphur Dioxide
STIZ	Support Towards the Implementation of Zimbabwe NDCs
TACCC	Transparency, Accuracy, Completeness, Comparability and Consistency
TJ	Tera Joule
TNC	Third National Communication
TSP	Transitional Stabilisation Programme
UNCC: Learn	United Nations Climate Change Learning Programme
UNDP	United Nations Development Programme

UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollar
UZ	University of Zimbabwe
WFP	World Food programme
WMO	World Meteorological Organisation
WtE	Waste to Energy
WVI	Water Vulnerability Index
WWTP	Wastewater Treatment Plant
ZAIP	Zimbabwe Agriculture Investment Plan
ZBC	Zimbabwe Broadcasting Cooperation
ZERA	Zimbabwe Energy Regulatory Authority
ZESA	Zimbabwe Electricity Supply Authority
ZESCO	Zambia Electricity Supply Company
ZimASSET	Zimbabwe Agenda for Sustainable Socio Economic Transformation
ZIMSTAT	Zimbabwe National Statistics Agency
ZINGSA	Zimbabwe National Geospatial and Space Agency
ZINWA	Zimbabwe National Water Authority
ZNIDP	Zimbabwe National Industrial Development Policy

List of Authors of the Fourth National Communication

Chapter	Role/Area	Name	Institution
National Circumstances	Statistics, Team Leader	Mr. Manasa Viriri	Zimbabwe National Statistics Agency
	Meteorology	Mr. Collen Mutasa	University of Zimbabwe
Inventory of Greenhouse Gases & Climate Change Mitigation	Team Leader	Dr. Dingane Sithole	BCA Consultancy
	Energy	Mr. Tendayi Marowa	Comprehensive Energy Solutions
		Dr. Dingane Sithole	BCA Consultancy
	Industrial Processes & Product Use	Mrs Caroline Tagwireyi	Infrastructure Development Bank of Zimbabwe
		Ms. Fadzai Muputisi-Muwidzi	Grindale Engineering
	Agriculture Forestry & Other Land Use	Prof. Farai Mapanda (PhD)	University of Zimbabwe
		Dr. Walter Svinurai	Marondera University of Agricultural Sciences & Technology
		Mr. Anderson Muchawona	Forestry Commission of Zimbabwe
		Mr. Tatenda Gotore	Forestry Commission of Zimbabwe
		Mr. Robert Mwase	National University of Science and Technology
	Waste	Mr. Julius Madzore	BCA Consultancy
		Ms. Gamuchirai Takavingofa	Alfa Packaging
		Ms. Samantha Chigoverah	ZFC Limited
Vulnerability & Adaptation Assessments (Hydro Consult	Team Leader	Prof Hodson Makurira (PhD)	University of Zimbabwe
	Agriculture	Dr. Raymond Mugandani	Midlands State University

	Water Resources	Mr. Wellington Dzvairo	Glimss Consulting
	Public Health	Mrs Margret Tawodzera	Ministry of Health & Child Care
	Ecosystem & Wildlife	Dr. Munyaradzi D. Shekede	University of Zimbabwe
	Infrastructure	Dr Isiah Gwitira	University of Zimbabwe
Education, Training & Public Awareness	Education, Team leader	Dr Tinashe Muromo	University of Zimbabwe
	Education	Dr Lazarus Zanamwe	University of Zimbabwe
Research & Systematic Observation,	Meteorology & Hydrology	Mrs Juliet Gwenzi	University of Zimbabwe
Policy, Constraints and Gaps Technology Transfer	Policies, Gaps & Constraints	Mr. Terrence Mukuze	Ministry of Justice, Legal & Parliamentary Affairs

Report Compilation:

W. Dzvairo

Review and Editorial Team:

W. Zhakata, K. Ndidzano, T. Muhwati, A. Tsiga, M. Machona, D. Sithole, F. Mapanda, C. Tagwireyi, W. Svinurai, T. Dhlakama, L. Mashungu, E. Matingo, T. Mutasa, T. Marowa, A. Muchawona, T. Mukonoweshuro, W. Dzvairo, S. Chigoverah

Project Manager.

Mr. Alois Tsiga - Climate Change Management Department, Ministry of Environment, Climate, Tourism and Hospitality Industry.

Project Administrative and Financial Assistant:

Ms. Mercy Machona - Climate Change Management Department, Ministry of Environment, Climate, Tourism and Hospitality Industry.

Executive Summary

National Circumstances

Zimbabwe's area covers 390,757km². The country lies wholly within the tropics with a subtropical climate. The annual rainfall ranges from below 400mm in the south to over 1,000 mm in the eastern parts of the country. Notable changes in the climate include an increase in average temperatures, decrease in annual precipitation, change in spatial extent of the country's Natural Regions, change in the onset and cessation dates of the rainy season and an increase in the duration of the mid-season dry spell. Observed extreme weather events that have increased in intensity include: tropical cyclones; droughts; dry spells; floods and; heat waves.

Zimbabwe's population was 12,973,808 according to the last census in 2012. The National Industrial Development Policy (2019-2023) is the country's blueprint for industrialization. The major industrial sectors are agriculture; manufacturing; wholesale and retail trade; and mining. Gold and platinum mainly contribute the highest income. Zimbabwe's energy sources are biofuels (mainly firewood), coal, petroleum products and electricity. Fuelwood is the country's primary energy source as 68 percent of the population depend on wood for fuel.

Zimbabwe is predominantly serviced by road transport. Agriculture is the backbone of Zimbabwe's economy. The sector provides direct and indirect employment to approximately 60-70% of the population, supplies 60% of the industrial raw materials and contributes approximately 40% towards export earnings. Manufacturing, wholesale and retail trade; repair of motor vehicles and motorcycles, and accommodation and food service activities mainly contribute to industrial GDP. Zimbabwe's total trade has decreased from US$10.4billion in 2013 to US$9.1 billion in 2019. Housing projects have been dominated by residential, largely driven by the rural to urban migration which averaged 4.3 per cent.

Major Policies

The main policies impacting on the economy include the land reform programme implemented in the 1980s and 1990s, Economic Structural Adjustment Programme (ESAP)-1992, as well as the Fast Track Land Reform Programme which commenced in 2000. Major agricultural strategies include Zimbabwe Agriculture Investment Plan (2013–2018) (ZAIP); Comprehensive National Agricultural Policy Framework (2018 – 2030); Agricultural Policy Framework (2012-2032). The main policies in the Energy sector include the Energy Policy (2012); Renewable Energy Policy (2019); Bio-fuels Policy (2020); National Transport Master Plan; and the Zimbabwe Motor Industry Development Policy (2018-2030). In the industrial sector the main policies include the Industrial Development Policy (2019-2023). Climate specific policies and strategies include the National Climate Policy (2017); National Climate Change Response Strategy (2014); NDC (2015) and; the Low Emission Development Strategy (2020-2050). The main barriers to implementing mitigation priorities include: lack of skilled personnel; limited financial resources; low uptake of new technologies and; weak institutional arrangements.

Institutional Arrangements

The High-Level Committee in the Office of the President and Cabinet (OPC) is responsible for oversight of all climate change activities at national level. The Committee comprises Permanent Secretaries for all Government ministries and is chaired by the OPC. The Ministry of Environment, Climate, Tourism and Hospitality Industry (MECTHI) is responsible for coordinating environmental issues in the country including climate change. The Climate Change Management Department is mandated with coordinating and implementing national climate change programmes.

The MRV system is not yet fully developed. The GHG Inventory System is currently under development. The elements that are already in place include the designation of a focal point to the United Nations Framework Convention on Climate Change (UNFCCC); and appointment of the coordinator of the National Communication (NC) and Biennial Update Report (BUR1). The government appointed a team leader of the Greenhouse Gas (GHG) Inventory and has engaged sectoral experts. The mapping of stakeholders was also completed. An MRV for the NDCs was developed focusing on solar water pumping systems to assist the Government of Zimbabwe in its NDC implementation framework. An MRV for support needed and support received is not yet in place. The Ministry of Finance and Economic Development as the Aid Coordination Agency is in the process of developing the Development Projects Management Information System (DevProMIS).

National Greenhouse Gas Inventory Report for 1990-2017

Zimbabwe's greenhouse gas (GHG) inventory in the Fourth National Communication (NC4) covers carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and hydro-fluorocarbons (HFCs). The GHG inventory covers the Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land-Use (AFOLU) and Waste sectors for the reporting year 2010 for all identified sources and sinks. The work was coordinated by the NC4 Project Manager in the Ministry of Environment, Climate, Tourism and Hospitality Industry (MECTHI). The inventory was compiled by a consultancy company comprising sector experts organised into sectoral teams coordinated by a team leader.

The 2006 IPCC Guidelines methodologies were used, an improvement from the previous national communications where the Revised 1996 IPCC Guidelines were largely used. Tier 1 methodological approaches were used in compiling the entire inventory due to lack of disaggregated activity data and country specific emission factors, except for Cement Production for which tier 2 was used. The IPCC GHG Software (Version 2.691 of January 2020) was used for computation.

The activity data and their uncertainty levels were provided by data providers, most of whom were government agencies, government departments, local authorities and individual private companies. Default IPCC Emission Factors and their uncertainties were obtained from the 2006 IPCC Guidelines and the online Emission Factor Database. The data were archived in the GHG database developed under the same project. For computation of CO_2eq, Global Warming Potential (GWP) of CO_2, CH_4 and N_2O were obtained from the IPCC Second Assessment Report (SAR). The TNC used the

Fourth Assessment Report (AR4) GWPs, hence recalculations were performed in the current inventory. Carbon monoxide (CO), nitrous oxide (NO_x), sulphur dioxide (SO_2) and non-methane volatile organic compounds (NMVOCs) emissions were estimated using the Low Emissions Analysis Platform (LEAP). The emission factors for the pre-cursor gases were obtained from the 2019 EMEP/EEA emission inventory guidebook and the 2006 IPCC Guidelines.

EST 1 shows the national GHG inventory for Zimbabwe by gas for the report year 2010. The total national GHG emissions in 2010 was 60,743.64 Gg CO_2 eq., while total national GHG removals in the same year was 22,799.63 Gg CO_2 eq., giving a net total of 37,944.01 Gg CO_2 eq. Thus, country was able to remove 37.5% of its total GHG emissions largely through the increase in carbon stocks in forest land. Emissions from Cropland (3.B.2) and Grassland (3.B.3) contributed significantly to the net emissions as a result the considerable loss in carbon stocks due to land use change from forestland to cropland and grassland.

EST 1: National GHG Emissions for Zimbabwe in 2010

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO2
Total National Emissions and Removals	19,048.36	492.58	26.46	348.40	0.00	0.00	0.00	0.00	2,573.53	2,993.68	5,858.62	189.42
1 - Energy	8,510.73	89.46	1.28						394.33	268.1	1,589.64	189.42
1.A - Fuel Combustion Activities	8,510.73	84.55	1.28						1,805.80	242.05	1,589.27	189.42
1.B - Fugitive emissions from fuels	0.00	4.91	0.00						NE	NE	0.16	NE
1.B.1 - Solid Fuels	NE	4.91	NE						NE	NE	0.16	NE
1.B.2 - Oil and Natural Gas	NO	NO	NO						NO	NO	NO	NO
1.B.3 - Other emissions from Energy Production	NO	NO	NO						NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2 - Industrial Processes and Product Use	528.51	0.00	0.65	348.40	0.00	0.00	0.00	0.00	0.72		4.27	
2.A - Mineral Industry	314.49	0.00	0.00						0.72		4.27	
2.B - Chemical Industry			0.65						NE	NE	NE	NE
2.C - Metal Industry	202.12	0.00	0.00						NE	NE	NE	NE
2.D - Non-Energy Products from Fuels and Solvent Use	11.90	0.00	0.00						NE	NE	NE	NE
2.E - Electronics Industry	NO	NO	NO	NO	NO	NO	NO					
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0.00	0.00	0.00	348.40	0.00	0.00	0.00					
2.G - Other Product Manufacture and Use					NE	NE		NE	NE	NE	NE	NE
2.H - Other	NE	NE	NE						NE	NE	NE	NE
3 - Agriculture, Forestry, and Other Land Use	10,008.44	377.15	24.39						47.61	2,751.63	0.00	0.00
3.A - Livestock	0.00	204.04	0.26						NE	NE	NE	NE
3.B - Land	9,800.47								NE	NE	NE	NE
3.C - Aggregate sources and non-CO2 emissions sources on land	24.21	173.11	24.13						47.61	2,751.63	NE	NE
3.D - Other	183.76	0.00	0.00						NE	NE	NE	NE
3.D.1 - Harvested Wood Products	183.76								NE	NE	NE	NE
3.D.2 - Other (please specify)	NE	NE	NE						NE	NE	NE	NE

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO2
4 - Waste	0.68	25.97	0.14						NE	NE	NE	NE
4.A - Solid Waste Disposal	0.00	21.61	0.00						NE	NE	NE	NE
4.B - Biological Treatment of Solid Waste	0.00	0.00	0.00						NE	NE	NE	NE
4.C - Incineration and Open Burning of Waste	0.68	0.29	0.00						NE	NE	NE	NE
4.D - Wastewater Treatment and Discharge	NE	4.07	0.14						NE	NE	NE	NE
4.E - Other (please specify)	NE	NE	NE						NE	NE	NE	NE
5 - Other	NE	NE	NE						NE	NE	NE	NE
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NE	NE	NE						NE	NE	NE	NE
5.B - Other (please specify)	NE	NE	NE						NE	NE	NE	NE
Memo Items												
International Bunkers	19.75	NE	NE						NE	NE	NE	NE
1.A.5.c - Multilateral Operations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Completeness of Data

There has been an improvement in data completeness between the current reporting period and that of the TNC. In the current inventory, trend analysis was done for the period from 2000 to 2017 as some categories had missing data for the period 1990 to 1999. Other reasons that also affected completeness of data relate to restriction due to the Census and Statistics Act [Chapter 10:29] that does not allow release of data and information by the national statistical agency in circumstances where there are less than three companies in a sector. To address the data gaps, the recommended IPCC splicing methods, namely interpolation, extrapolation and surrogate data were applied.

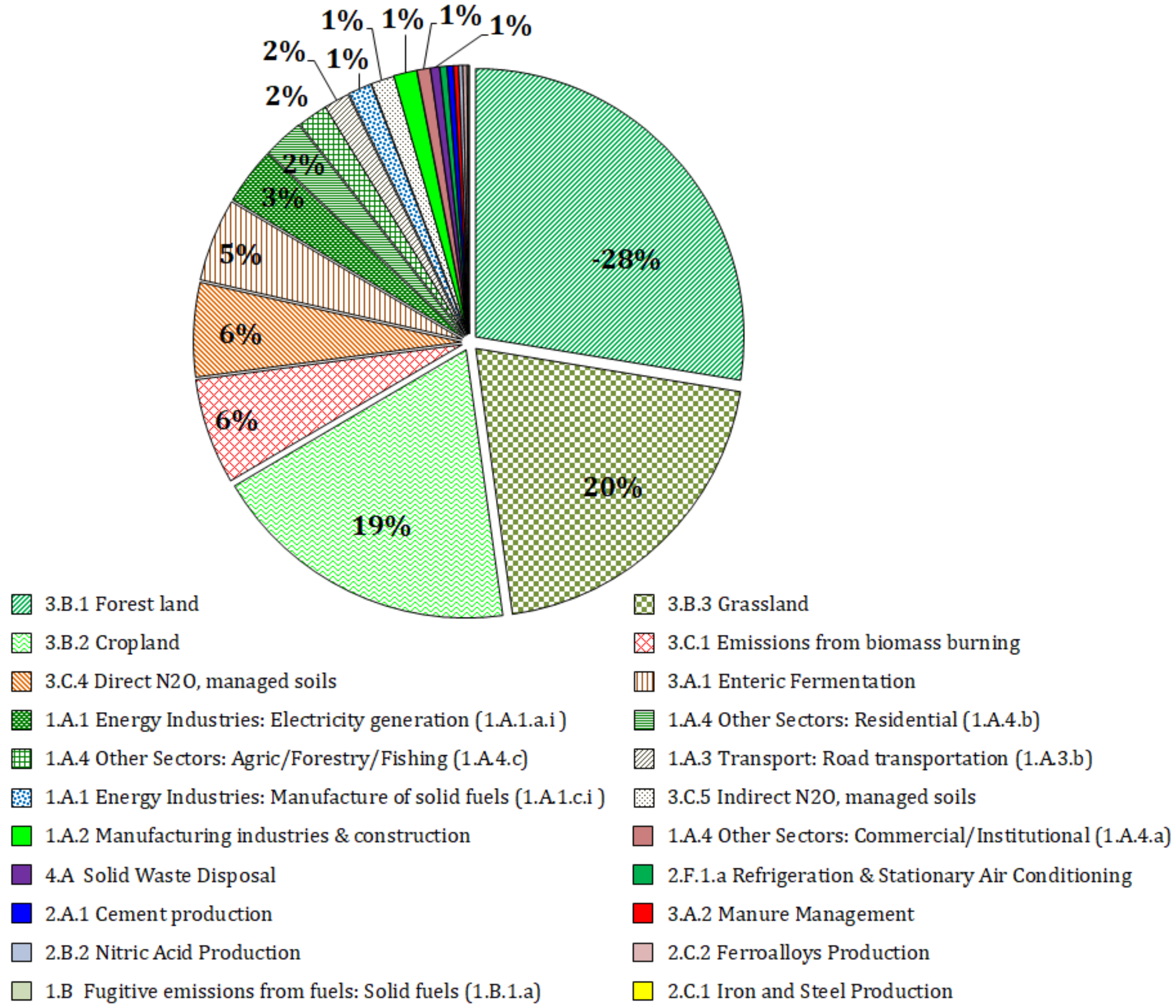
Quality Assurance and Quality Control

Zimbabwe does not currently have a Quality Assurance and Quality Control (QA/QC) plan. In the TNC the USA Environmental Protection Agency (US/EPA) QA/QC guidebook was used as the reference tool. The quality of the current inventory was improved through applying general and category specific QA/QC procedures provided in the 2006 IPCC Guidelines. In addition to applying the QA/QC procedures from the 2006 IPCC Guidelines, recommendations from the international review of the TNC by a team of experts from the UNFCCC in February 2020 also assisted. Considerable attempt was made to improve the quality of activity data by engaging the Data providers also participated training sessions on GHG inventory compilation using the 2006 IPCC Guidelines and Inventory Software organised by MECTHI.

Peer reviews were conducted to improve on the Transparency, Accuracy, Completeness, Comparability and Consistency (TACCC). Results of calculations were compared with international sources such as FAOSTAT and the International Energy Agency (IEA) for verification. For the energy sector CO_2 emissions from fuel combustion were calculated using both the sectoral and reference approaches. Data for the sectoral approach was obtained from the Ministry of Energy and Power Development (MoEPD) while that for the reference approach was obtained from the energy balances compiled by the International Energy Agency (IEA).

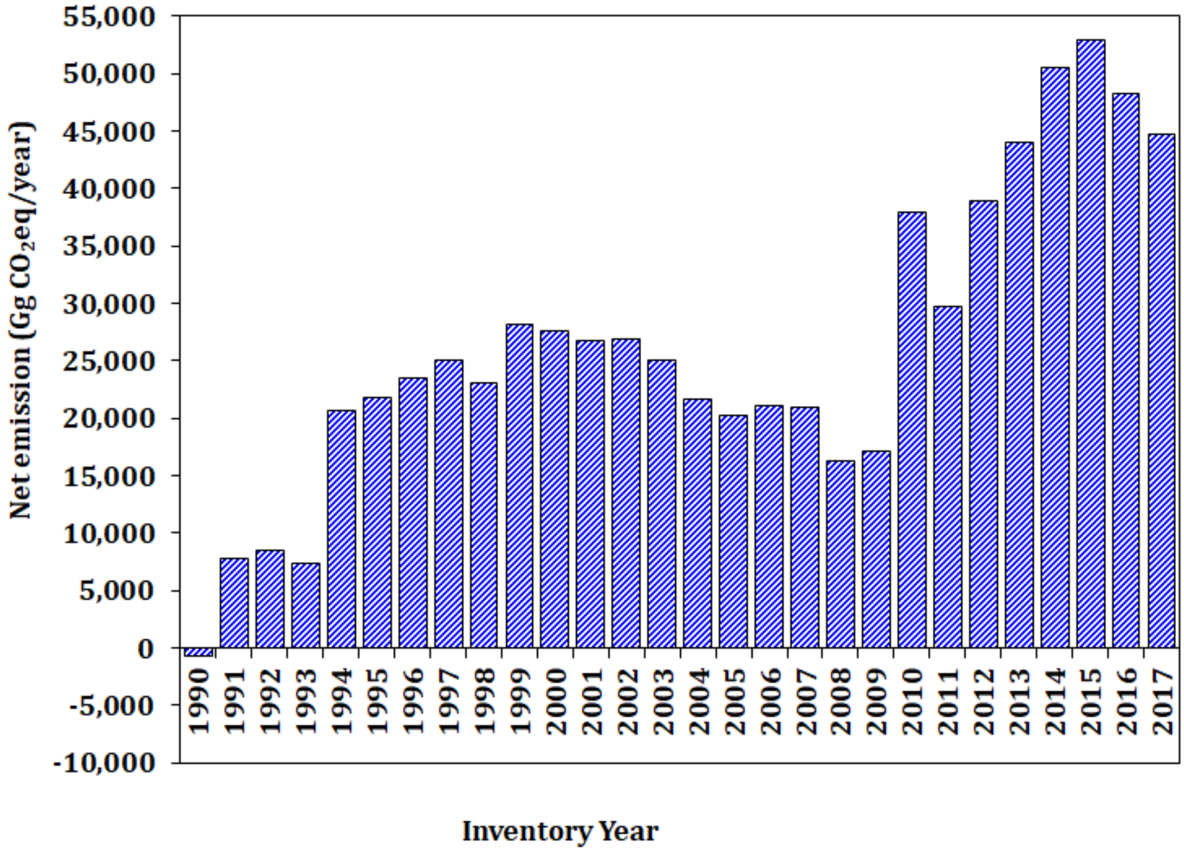
GHG emissions and removal

The total net GHG in 2010 including FOLU were 37,944.01 CO_2eq.



ESF 1: Total 2010 GHG emissions and removals with AFOLU

The net total GHG emissions show that the country ceased to be a net sink of GHG emissions in 1990 (-647.70 Gg CO_2 eq.). During the period from 1991 – 2009, GHG emissions have been maintained between 5,000 and 26,000 Gg CO_2eq. After 2009 the emissions increased gradually to year 2015 (53,016.81Gg CO_2eq) which was the highest estimate of the emissions in the whole time series.



ESF 2: Net GHG Emission Trend for the Period 1990 to 2017

Changes in GHG emissions and removals

The total GHG emissions for the reporting years 1994 (INC), SNC (2000), TNC (2006) and current inventory (2010) are presented in Table EST 2.

EST 2: Total aggregate GHG Emissions and Removals by Year and Gas (Gg)

Gas	***Emissions/Removals by year (Gg)***					***Change: 1994-2017 (%)***	***Change: 2000-2017 (%)***
	1994	***2000***	***2006***	***2010***	***2017***		
Net CO_2	14,754.30	14,884.35	10,803.45	8,510.73	9,863.58	-33.1	-33.7
CH_4	276.08	317.77	296.34	492.58	543.66	96.9	71.1
N_2O	21.12	22.68	19.33	26.46	25.74	21.9	13.5
HFCs (CO_2 eq)	9.15	86.82	209.82	348.40	546.54	5,873.1	529.5
Total emissions CO_2 eq	60,149.18	62,732.68	56,405.79	60,743.64	63,191.86	5.1	0.7
Total removals (CO_2 eq)	-39,479.7	-35,063.4	-35,298.6	-22,799.6	-18,447.9	-53.3	-47.4
Net (CO_2 eq)	20,669.46	27,669.31	21,107.25	37,944.02	44,744.00	116.5	61.7

Table EST3 presents sectoral GHG emissions for 1994 (INC), SNC (2000), TNC (2006) and current inventory (2010)

EST 3: GHG emissions by sector in CO_2eq

Sectors	***Emissions/Removals by year (Gg CO_2 eq))***					***Change: 1994-2017 (%)***	***Change: 2000-2017 (%)***
	1994	***2000***	***2006***	***2010***	***2017***		
Energy	16,407.03	17,094.3	13,025.48	10,785.51	13,777.54	-16.0	-19.4
IPPU	863.8988	1768.176	1102.465	1077.817	1447.045	67.5	-18.2
AFOLU	3,134.36	8,361.53	6,362.24	25,489.79	28,746.38	817.1	243.8
Waste	264.17	445.30	617.06	590.90	773.03	192.6	73.6
Net (CO_2 eq)	20,669.46	27,669.31	21,107.25	37,944.02	44,744.00	116.5	61.7

Key Category Analysis with FOLU

Key category analysis was carried out using both approaches 1 (level analysis) and 2 (trend analysis). Key categories for level were largely dominated by CO_2 emissions from AFOLU accounting for over 60 per cent of the GHG emissions (Table EST 4).

EST 4: Key Categories with FOLU-Level Assessment 2010

IPCC Category code	IPCC Category	Greenhouse gas	2010 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.B.1.b	Land Converted to Forest land	CO_2	-24,524.15	24,524.15	0.25	25%
3.B.2.b	Land Converted to Cropland	CO_2	23,242.97	23,242.97	0.24	49%
3.B.3.b	Land Converted to Grassland	CO_2	19,357.20	19,357.20	0.20	68%
1.A.1	Energy Industries - Solid Fuels	CO_2	4,753.03	4,753.03	0.05	73%
3.A.1	Enteric Fermentation	CH_4	4,193.59	4,193.59	0.04	77%
3.C.4	Direct N2O Emissions from managed soils	N_2O	3,915.40	3,915.40	0.04	81%
3.C.1	Emissions from biomass burning	CH_4	3,633.68	3,633.68	0.04	85%
3.B.1.a	Forest land Remaining Forest land	CO_2	-3,528.90	3,528.90	0.04	89%
1.A.4	Other Sectors - Biomass	CH_4	1,696.05	1,696.05	0.02	90%
3.C.1	Emissions from biomass burning	N_2O	1,632.84	1,632.84	0.02	92%
1.A.4	Other Sectors - Solid Fuels	CO_2	1,378.98	1,378.98	0.01	93%
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	995.65	995.65	0.01	94%
3.C.5	Indirect N2O Emissions from managed soils	N_2O	953.41	953.41	0.01	95%

The key categories in terms of trend analysis were dominated by land conversions between forestland, grassland and cropland, contributing over 70%. The other sectors that were significant in terms of trend include emissions from: Biomass burning; energy industries - solid fuels; other sectors – biomass burning; enteric fermentation; road transportation manufacturing industries and construction - solid fuels and other sectors - solid fuels (EST 5).

EST 5: Key Category due to Trend Analysis -2000 to 2017

IPCC Category code	IPCC Category	Greenhouse gas	1990 Year Estimate Ex0 (Gg CO2 Eq)	2010 Year Estimate Ext (Gg CO2 Eq)	Trend Assessment (Txt)	% Contribution to Trend	Cumulative Total of Column G
3.B.1.a	Forest land Remaining Forest land	CO_2	-39,344.58	-3,528.90	2.01	29%	29%
3.B.1.b	Land Converted to Forest land	CO2	-24,533.26	-24,524.15	1.44	21%	50%
3.B.2.b	Land Converted to Cropland	CO_2	23,242.97	23,242.97	1.36	20%	70%
3.B.3.b	Land Converted to Grassland	CO_2	19,357.20	19,357.20	1.14	17%	87%
3.C.4	Direct N2O Emissions from managed soils	N_2O	4,218.70	3,915.40	0.25	4%	90%
3.A.1	Enteric Fermentation	CH_4	4,197.48	4,193.59	0.25	4%	94%
3.C.1	Emissions from biomass burning	N_2O	1,222.51	1,632.84	0.07	1%	95%

Uncertainty Analysis

Uncertainties analysis was performed in the IPCC Inventory Software Version 2.691.7327 of 2020 employing error propagation approach.

Recalculations

All sectors performed recalculations since in the TNC GWPs from the AR4 were used. Further, the Revised 1996 IPCC Guidelines were used in the TNC while in the NC4 the 2006 Guidelines were used. Data quality improvements, especially in FOLU and IPPU, also resulted in recalculations.

Planned Improvements

The main planned improvement relate to;

- Strengthening the institutional and procedural arrangements for the GHG system,
- Capacity building on uncertainty analysis,
- Strengthening the QA/QC system,
- Establishing an archiving system and;
- Addressing identified data gaps

Vulnerability and Adaptation Assessment

There is differential vulnerability to climate change among livelihood groups and sectors such as agriculture, water, infrastructure, health, ecosystems and wildlife due to differences in exposure, sensitivity and adaptive capacity. In addition, infrastructure such as roads, schools, dams, power and communication lines are adversely affected annually by the impacts of reoccurring floods and droughts countrywide. The vulnerability of communities is worsened by over-reliance on natural resources, limited technology, high levels of poverty, inadequate infrastructural and institutional capacity and poor health service and delivery.

A vulnerability and adaptation assessment study was carried out in Muzarabani District to determine vulnerability to the impacts of Climate Change. The majority of the population in the district depend on rain-fed agriculture in an area that is predominantly semiarid. Sodic soils dominate the district with rich alluvial soils along flood plains in Lower Muzarabani District.

The high overall vulnerability in terms of agriculture is attributed to low adaptive capacity. This shows that much of the vulnerability to climate change in Lower Muzarabani District does not necessarily emanate from exposure to drought but other factors on the ground. Thus, policy interventions that result in use of improved agricultural technologies are critical to build resilience in a variable climate. Irrigation development is key to build adaptive capacity in smallholder farming systems in Lower Muzarabani District since drought is the major agricultural risk. In this regard, government has prioritized the construction of Silverstroom Dam, which is envisaged to support about 2,000 hectares of irrigable land in the district in an effort to build resilience against climate change impacts, especially droughts.

Extension services to train farmers on good agronomic practices and crop selection are crucial to increase the viability of the crop. In addition, more support is required on crop value addition and exploring the dynamics of high valued markets. Increased product quality and productivity is however crucial in all this and is clearly missing in the District.

Normalised Water Vulnerability Index (WVI) analysis showed that wards in the Lower Muzarabani District more vulnerable to climate change than those in the upper part. The Lower part of the district has a WVI more than twice that of the upper district for all projections. There is a marginal increase of water vulnerability in some of the upper parts of the district for projections to 2030 and 2040. The general increase in vulnerability in the district especially in the Lower part supports the need to develop more water resources in the district. More boreholes and other water harvesting techniques can be developed in the lower part of the district where the terrain is generally flat, making it unfeasible to develop medium to large dams.

In addition, to water resources development, the district needs investments in groundwater and meteorological monitoring points in addition to the existing thin hydrological monitoring network. The complete data set obtained will assist in the downscaling of the models with better ground truthing.

Climate change is expected to result in changes in transmission of vector-borne diseases. It was observed that the upper part of the district is characterised by free to low or sporadic malaria patterns while the lower part is classified as having high and perennial malaria cases. Results of health impacts show that most people do not seek treatment at health centres because of the long distances they have to travel to access the services. As a result, they end up using alternative medicines to treat common diseases such as malaria. In the process, compromised health leads to incapacitation in attending to productive activities such as farming and, hence, affects food security efforts.

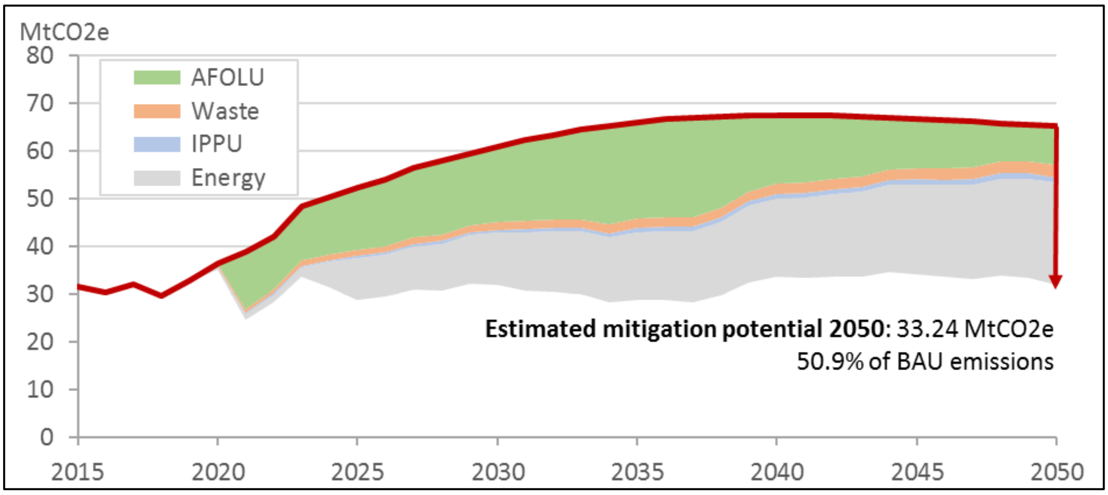
Using future climate scenarios, the distribution of dominant woody species in Muzarabani district shows mixed results. For instance, under RCP 4.5 *B.boehmii* is projected to dominate the central and upper parts of the district while the range of *C.apiculatum* shows marginal changes. Under the same climate scenario, the suitable habitat for *C. mopane* is expected to decrease and will be mostly confined to the lower parts of the district.

On the wildlife sector climate change is likely to affect wildlife distribution and survival in semi-arid savannas. It was noted that the main effects of climate change on wildlife includes contraction of monthly range due to low rainfall, animal deaths due to heat waves, decrease in water supply and forage, destruction of forests and extinction of certain species. The negative effects of climate change are also being exacerbated by habitat fragmentation and increase in human wildlife conflicts. Out of the dominant species in the area, baboons, bucks, hyenas, monkeys, elephants and warthogs were identified as responsible for destroying people's crops leading to human-wildlife conflicts. The shortage of food for the animals is also made worse by the frequent fires.

The frequent flooding resulting from excessive rains also damages bridges which link the different wards in the district making the communities even more vulnerable as access to some places is cut-off. The destruction of critical infrastructure such as houses, roads, schools, boreholes and clinics weakens the community's social, economic and human systems. The disruption of water and sanitation services results in frequent illness, malnutrition and overall discomfort that lower earning potential among adults. Development and implementation of climate proofed building codes and standards, and mobilisation of resources for infrastructure development through private-public-partnerships in addition to government funds must be prioritised.

Climate Change Mitigation

Zimbabwe conducted economy-wide mitigation analyses during the preparation of the Low Emission Development Strategy (2020) and in 2021 during the preparation of the country's revised Nationally Determined Contribution (NDC). In the LEDS (2020-2050), Zimbabwe identified 38 economy-wide mitigation measures. These mitigation measures projected a 50% reduction of Zimbabwe's GHG emissions, amounting to 33.2 $MtCO_2eq$ below the BAU scenario by 2050. In the LEDS, the largest abatement potential is expected to come from the AFOLU sector (46.9%), followed by the energy sector (44.4%), waste (6.1%), and the IPPU (2.7%) as presented in Figure ESF 3.



ESF 3: Economy wide mitigation scenario in the LEDS (2020-2050)

The updated mitigation contribution of Zimbabwe's Revised NDC draws on an economy-wide GHG mitigation assessment. A total of 17 mitigation measures were selected for inclusion in the Revised NDC. The mitigation analysis covered Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land use (AFOLU) and Waste sectors. The analysis was mainly informed by the Zimbabwe National Climate Policy, National Climate Change Response Strategy (NCCRS), LEDS and the National Development Strategy 1 (NDS1). Zimbabwe used a multi-criteria analysis to prioritise the sectoral mitigation policies and measures that are eligible for use in the mitigation assessment based on:

- Existence of a local implementing agent
- Clear emission reduction/sink enhancement target/ mitigation potential
- Definite and current medium to long-term timeline
- Alignment with national development goals and targets
- Responsiveness to available Measurement, Reporting and Verification (MRV) methods/frameworks

The analysis determined the baseline emission growth, expected emission targets, and emission reduction measures. The mitigation measures were analysed using the Low Emissions Analysis Platform (LEAP) model. Three scenarios were developed, that is, a) historical emissions between 2010 and 2017, b) baseline projections of emissions from 2018 and 2030, and c) mitigation analysis through 2030.The direct GHG gases covered, include Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O) and Hydrofluorocarbons (HFCs). The biggest reduction in emissions from the BAU in 2030 comes from the AFOLU sector (25.35 MtCO2eq), followed by the energy sector (4.2 MtCO2eq), with smaller reductions from waste (0.65 MtCO2eq) and IPPU (0.45 MtCO2eq) sectors. The economy-wide GHG abatement potential is 30.65 MtCO2eq which corresponds to around 41% of BAU GHG emissions in the same year as shown in Table EST 6.

EST 6: Sectoral reductions in GHGs in 2030 compared to a baseline scenario

Sector	2030 baseline GHG Emissions (10^6 tonnes CO_2-eq)	2030 GHG emissions (10^6 tonnes CO_2-eq)-with mitigation actions	Absolute Reduction (10^6 tonnes CO2-eq)	Percentage Reduction
Energy	26.62	22.42	4.20	14
IPPU	4.20	3.75	0.45	2
Agriculture, Forestry & Other Land Use	41.57	16.22	24.35	82
Waste	3.00	2.35	0.65	2
Overall	75.39	44.74	29.65	100

Challenges in Emissions Reduction in the Different Sectors

Some cross cutting barriers were identified that would affect the effectiveness of implementing the mitigation measures. These include;

- Lack of a national climate change mitigation MRV framework.

- Inadequate financial capacity to implement the mitigation measures.
- Inadequate trained mitigation experts and key stakeholders such as data providers and implementing entities.
- Low stakeholder involvement in relevant inter-sectoral planning processes & implementation of mitigation measures due to limited knowledge of the subject

Research and Systematic Observations

Zimbabwe participates in systematic observations of the climate and the environment through a number of government departments such as the Meteorological Services Department (MSD) and the Zimbabwe National Water Authority (ZINWA) both under the Ministry of Environment, Climate, Tourism and Hospitality Industry and the Department of Agriculture, Research and Extension (AGRITEX). These departments cooperate with research and academic institutions to provide the research component for the various fields. Since the submission of the Third National Communication (NC), a number of developments have taken place in systematic observations. The Zimbabwe National Geospatial and Space Agency was established to complement earth and atmosphere observations and to support research in terms of data provision, the purchase of automatic weather stations and the data rescue program aimed at improving data quality and completeness.

To support the Global Climate Observation Systems (GCOS), Zimbabwe has 47 operation synoptic stations and at least 300 rainfall stations. However none of the upper air stations is providing data due to the absence of radiosondes and hydrogen. All meteorological data are hosted by the MSD in a Climsoft based database management system. The establishment of the National Framework for Climate Services (NFCS) is envisaged to improve data availability and utilisation as AGRITEX takes part in co-generation of products. The ZINWA has at least 240 gauging stations for monitoring surface water runoff and siltation. Additional resources to compliment observing stations have been provided from several projects which include the Green Climate Fund (GCF), Global Environment Facility (GEF) and the African Development Bank (AfDB) among others. The Environmental Management Agency (EMA) monitors the air quality and provides an Air Quality Index (AQI), using data from the Plume Labs, however the use of the index remains low. Each of the institution archives its own data set, and therefore access of a composite data set remains a challenge. Limitation arises from data in different formats and availability of incomplete data sets.

Systematic observations are the main source of activity data for scientific analysis of climate and climate change. Therefore the data play a pivotal role in research and the absence or paucity of data limits the levels to which research can be carried out. In Zimbabwe research remain suboptimal as the incomplete data sets reduce the scale to which research may be carried out. Current research has focused on the use of indigenous knowledge systems in weather and climate forecasting, future climate change scenarios as a contribution to the National Adaptation Plan (NAP) Readiness project, greenhouse gas (GHG) emissions from agriculture and agroecological zoning which led to the development and commissioning of a new Agro-ecological zone map for Zimbabwe. The Research Council of Zimbabwe (RCZ) hosts a yearly symposium focusing on a variety of climate change related themes. Research on climate change impacts is available however the focus has been on agriculture and water resources. Research in other sectors such as forestry, transportation and energy among others, remain limited. On climate science aspects, institution of higher learning are doing research on past trends in climate indices. Future research should include environmental quality monitoring, inclusion of several other global circulation models apart from CSIRO MK3 model and parameterization of indigenous knowledge systems.

Constraints and Gaps

Various constraints, gaps as well as needs were noted in Vulnerability Assessment and Adaptation, Systematic Observation and EAT. The constrains and gaps identified include low adoption of climate smart agriculture practices; limited real time data availability, backup, data quality and gaps and communication network; inadequate climate resilient infrastructure; Poor water resources development and limited de-risking instruments and guarantees to support private sector investment in Agri business markets. In order to close this identified gap, technical, capacity and financial needs identified include training farmers on scaling up climate smart agriculture and climate risk management accompanied by corresponding technologies, enabling policies and infrastructure; developing an integrated early warning systems which includes, health, agriculture, water, energy and disaster risk reduction sectors; designing climate resilient infrastructure accompanied by improved building codes.

In the mitigation sector, constraints, gaps as well as needs identified include limited presence of large-scale renewable energy and grid connected solar PV projects. Furthermore, there is;

- Low capacity for tracking mitigation actions,
- Lack of production and infrastructure capacity of EVs and HV,
- Limited de-risking instruments and guarantees to support private sector investment for mitigation projects, and
- Lack of research for green technology in metal industry.

CHAPTER 1.0 National Circumstances and Institutional Arrangements

1.1 National Circumstances

Zimbabwe implements its climate action cognizant of its national circumstances. The country is a developing nation situated in Southern Africa, pursuing a vision to becoming an upper middle-income economy by 2030. Zimbabwe's economy is anchored on natural resources, with agriculture and extractive industries contributing significantly to the country's gross domestic product (GDP). The country's Constitution (2013) gives every person environmental rights. It further stipulates that the State must take reasonable legislative and other measures, within the limits of the resources available to it, to achieve the progressive realisation of the rights set out in that section.

The national greenhouse gas (GHG) profile and related climate change mitigation efforts are reflective of the country's profile and its development trajectory. The country's risks and vulnerabilities to climate change are largely factors of its physical and socio-economic status. Zimbabwe collaborates with the global community in its efforts in climate action. Climate action is also mainstreamed in the country's development plans and programmes.

1.1.1 Geographic Profile

Zimbabwe is situated in Southern Africa between Latitudes: 15°30'S and 22°30'S; Longitudes: 25°00'E and 33°10'E. The country covers 390,757 km^2 divided into 10 administrative provinces, namely Bulawayo, Harare, Manicaland, Mashonaland Central, Mashonaland East, Mashonaland West, Masvingo, Matabeleland North, Matabeleland South and Midlands. Zimbabwe's land use as at 2011 was estimated to be 42.5, 39.5 and 18 percent for agricultural land, forest and other land uses respectively. Agricultural land is further divided into arable land (10.9%), permanent crops (0.3%) and permanent pasture (31.3%). Other land uses include built up areas, roads, barren land or wasteland. The country is divided into five agro-ecological zones on the basis of annual rainfall, soil type and vegetation. These zones are shown in Figure 1.1. Rainfall amounts and crop production progressively deteriorate from agro-ecological zones I to V. Characteristics of the different regions are shown in Table 1.1.

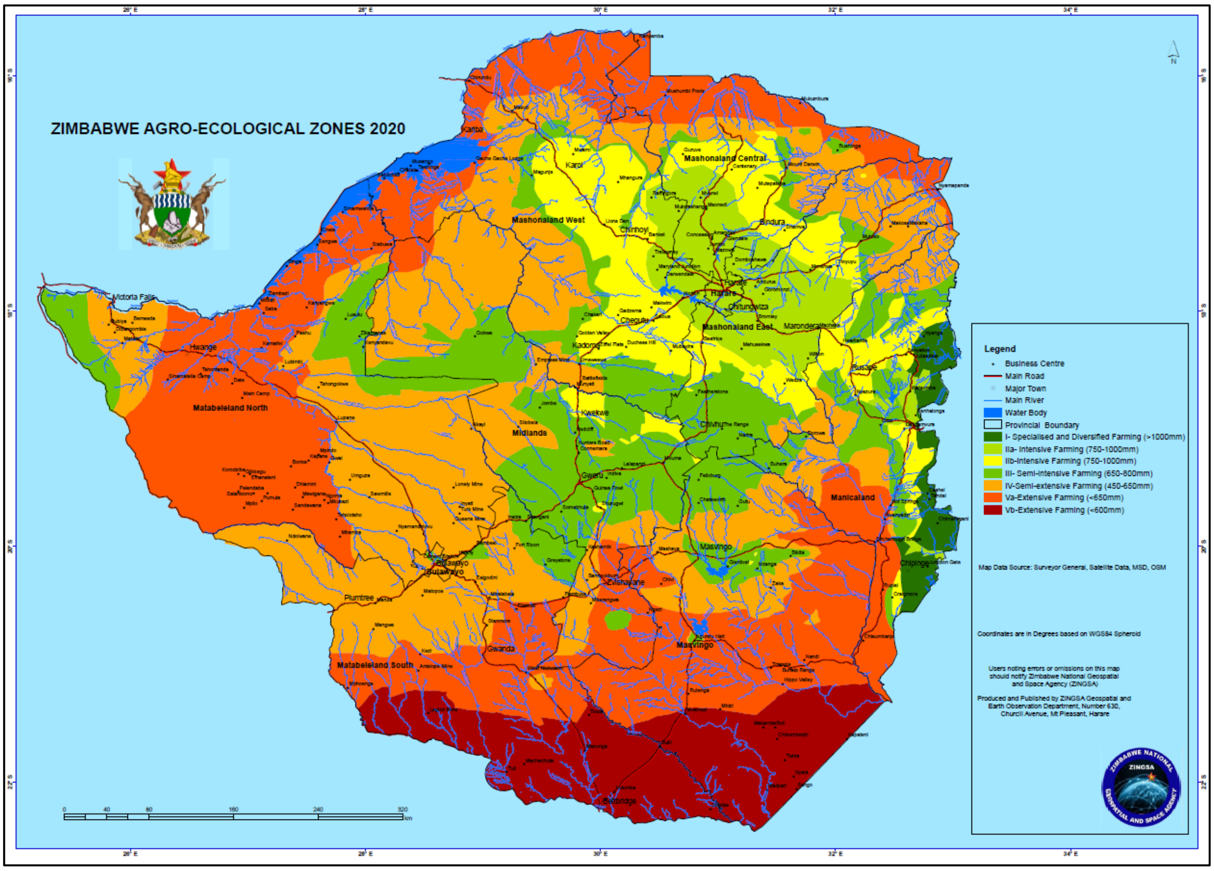


Figure 1.1: Revised Agro-Ecological Zones of Zimbabwe

(Zimbabwe National Geospatial and Space Agency, Agro-Ecological Zones, 2020)

Table 1.1: Characteristics of Agro-Ecological Zones of Zimbabwe

Agroecological Zones	Area (km^2)	Rainfall (mm per year)	Farming System
I	6,008.8	>1,000	Specialized and Diversified farming
IIa	22,085.4	750 – 1,000	Intensive farming
IIb	36,304.7	750 – 1,000	Intensive farming
III	63,215.2	650 – 800	Semi - intensive farming
IV	113,594.9	450 – 650	Semi- extensive farming
Va	115,041.2	<650	Extensive farming
Vb	34,499.8	<600	Extensive farming

1.1.1.1 Ecosystems

Zimbabwe’s ecosystems include gazetted forests, wetlands, national parks, botanical reserves, botanical gardens, safari areas, recreational parks and sanctuaries. These provide essential goods and services that support livelihoods and increase community resilience to climate variability. However, ecosystems have come under threat due to various human activities, invasive alien species and climate change.

1.1.1.2 Climate Profile

Zimbabwe lies wholly within the tropics and experiences a sub-tropical climate that is influenced by altitude. Mean monthly temperature varies from 15°C in July to 24°C in November. Mean annual temperature varies from 18°C in the Highveld to 23°C in the Lowveld. The national annual mean surface temperature warmed by about 0.9°C from 1900 to 2019, with greatest warming occurring since the 1980s. Zimbabwe experiences a unimodal rain season extending from October to March of the following year. Annual average rainfall ranges from about 400 mm in the south to over 1,000 mm in the eastern parts of the country. Figure 1.2 shows the variation of seasonal rainfall from 1981 to 2020. According to meteorological observations, Zimbabwe's climate has been changing since the 1900s. Notable changes include an increase in average temperatures, decrease in annual precipitation, change in spatial extent of the country's Agro-Ecological Zones, change in the onset and cessation dates of the rainy season and an increase in the duration of the mid-season dry spell.

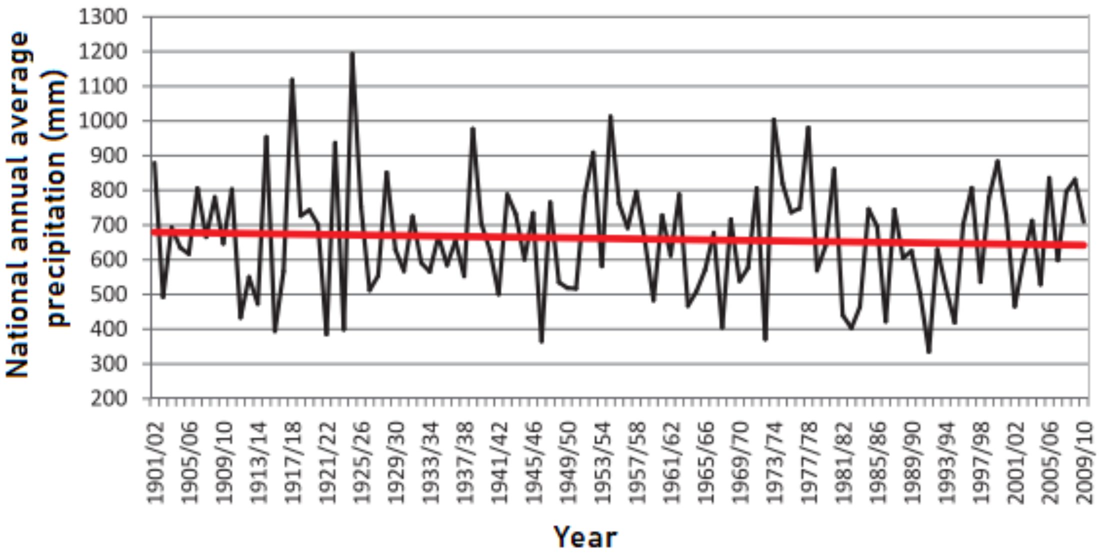


Figure 1.2: Seasonal Precipitation Trends

(Source: Zimbabwe Meteorological Services Department)

The country experiences four seasons namely Cool season (Mid-May to mid-August), Hot season (Mid-August to mid-November), Main rainy season (Mid-November to mid-March) and Post rainy season (Mid-March to mid-May). Frequently, country experiences the following extreme weather events:

- Tropical cyclones: - These occur from November to April of the following year with a peak in February. Depending on their positions in the Mozambique Channel, they can cause flooding or dry spells in Zimbabwe. Tropical cyclones that affect Zimbabwe emanate from the South West Indian Ocean Basin and an average of nine of these occur every season. Not all of the tropical cyclones that form, however, reach the country. By far the most devastating tropical cyclone in terms of human deaths and infrastructural damage to affect Zimbabwe was tropical cyclone Idai of March 2019. In 2000, the country experienced cyclone Eline, in 2003 cyclone Japhet and in 2017 cyclone Dineo which all damaged infrastructure including roads, bridges, power lines, and human settlements.

- Droughts and dry spells: - The frequency of droughts increased from 10% between 1902 and 1979 to 25% between 1980 and 2018. Major drought seasons that have occurred include 1911/12; 1913/14; 1915/16; 1921/22; 1923/24; 1946/47; 1959/60; 1967/68; 1972/73; 1981/82; 1982/83; 1986/87; 1991/92; 1994/95; 1997/98; 2001/02; 2006/07; 2011/12; 2012/13; 2015/16. The worst drought to affect the country occurred in the 1991/2 season, with the country receiving a seasonal rainfall total average of only 335mm, a deficit of 327mm when compared with the seasonal normal of 662mm. The mid-season dry spell occurs during the cropping season from the end of December to second week of January. Duration of the dry spell has been increasing.
- Floods: - Despite the frequency of occurrence of extreme wet events declining from ±20% from 1902 to 1979 to ±13% from 1980 to 2011 floods occur every year and are usually as a result of intense precipitation, tropical cyclones or dam failure. They are usually confined to low lying areas to the extreme north and south of the country. The areas are shown in Figure 1.3.

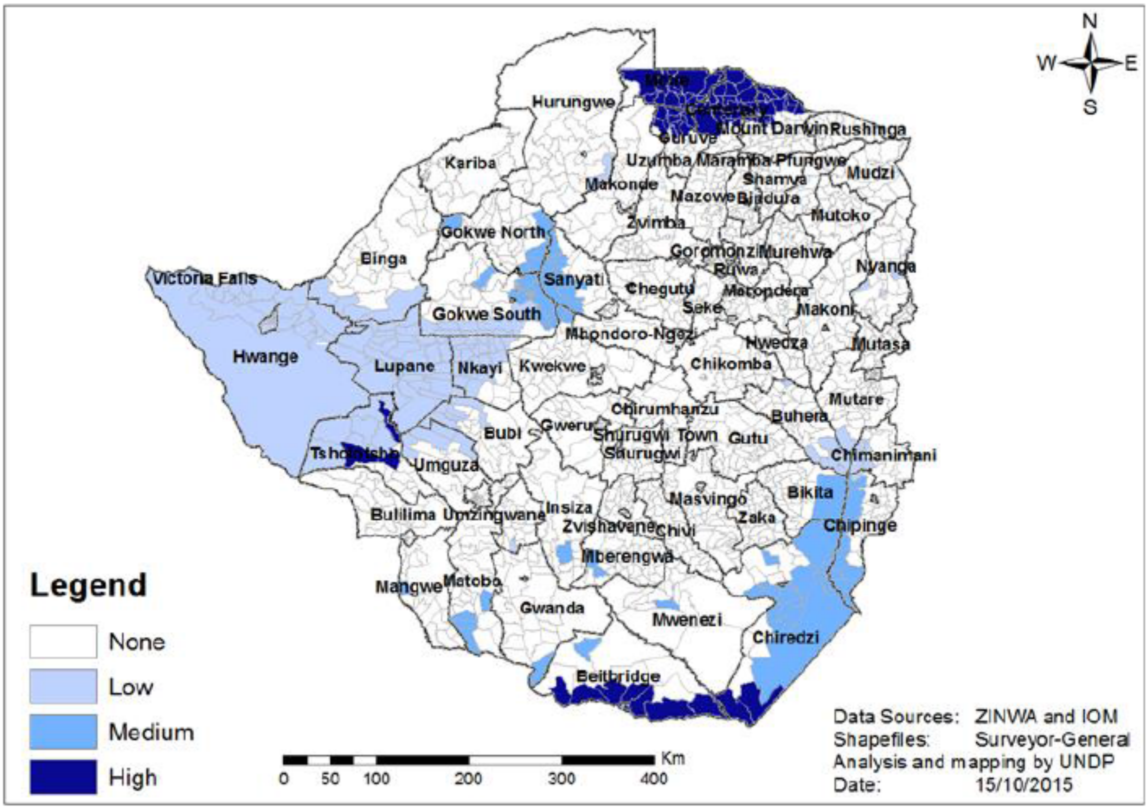


Figure 1.3: Areas Prone to Flooding in Zimbabwe

(Source, Zimbabwe National Water Authority and International Organization for Migration)

- Heat waves: - The highest number of heat waves (five or more consecutive days during which the daily maximum temperature exceeds the average maximum temperature by at least 5°C) occurs over the southern areas of the country, notably in the Limpopo basin.

1.1.1.3 Future Climate Projections

Zimbabwe's future projections are based on the Global Circulation Models (GCMs) and seven Regional Circulation Models (RCMs) in various combinations under Representative Concentration Pathways (RCP) 4.5 and 8.5 of the IPCC (2014). These projections show that;

- Temperature: - Under the RCP4.5 scenario, annual mean temperature is expected to warm by 1 to 1.5°C (2020-2040), 1.5 to 2.0°C (2041-2060) and by more than 2°C (2061-2080). For the RCP8.5 scenario, future warming is 1 to 1.5°C (2020-2040), 2.0 to 2.5°C (2041 to 2060) and 2.0 to 3.5°C (2061 to 2080).
- Precipitation: - According to RCP4.5 and RCP8.5 scenarios across all three respective periods, the mean national annual precipitation shows a decline to 10% compared to the 1986-2005 baseline.
- Droughts and dry spells: - Using an ensemble of hydrological and climate models and the RCP8.5 scenario, droughts over Southern Africa are projected to increase in frequency and severity during the 2070 to 2099 period when compared to the 1976 to 2005 reference period.
- Floods: - Using the RCP4.5 emission scenario, Southern Africa is projected to experience future increases in intense extreme precipitation events and more frequent flooding for the periods, 2016–2035, 2046–2065 and 2080 to 2099 when compared to the 1986 to 2005 reference period.
- Tropical cyclones: - Future projections point to fewer tropical cyclones and an increase in the occurrence of the most intense tropical cyclones by 2100 in the South West Indian Ocean basin as a result of climate change.
- Heat waves: - Projections for the time period 2071–2100 relative to 1961–1990, indicate the occurrence of 20–80 annual heat-waves over subtropical Southern Africa.

1.1.2 Population Profile

Zimbabwe's population according to 2012 census was estimated at 12,973,808 with males constituting 48 % while females constituted 52%. The population is fairly young with 40% below 15 years and those aged 65 years and above constituting 6%. About 68% of population lives in rural areas while the remainder lives in urban areas. Harare province has the largest population of 2,098,199 (16%) with Bulawayo province having the lowest population of 655,675. Other provinces' contribution to the total population is shown in Figure 1.4. The country's average population density is 33 persons per square kilometre. Harare has the highest population density of 2,406 per square kilometre, while Matabeleland North has the lowest population density of 10 people per square kilometre. In 2002 Zimbabwe's population was 11,631,657 while in 2012 it was 12,973,808. This gives a population growth rate of 1.1% between 2002 and 2012.

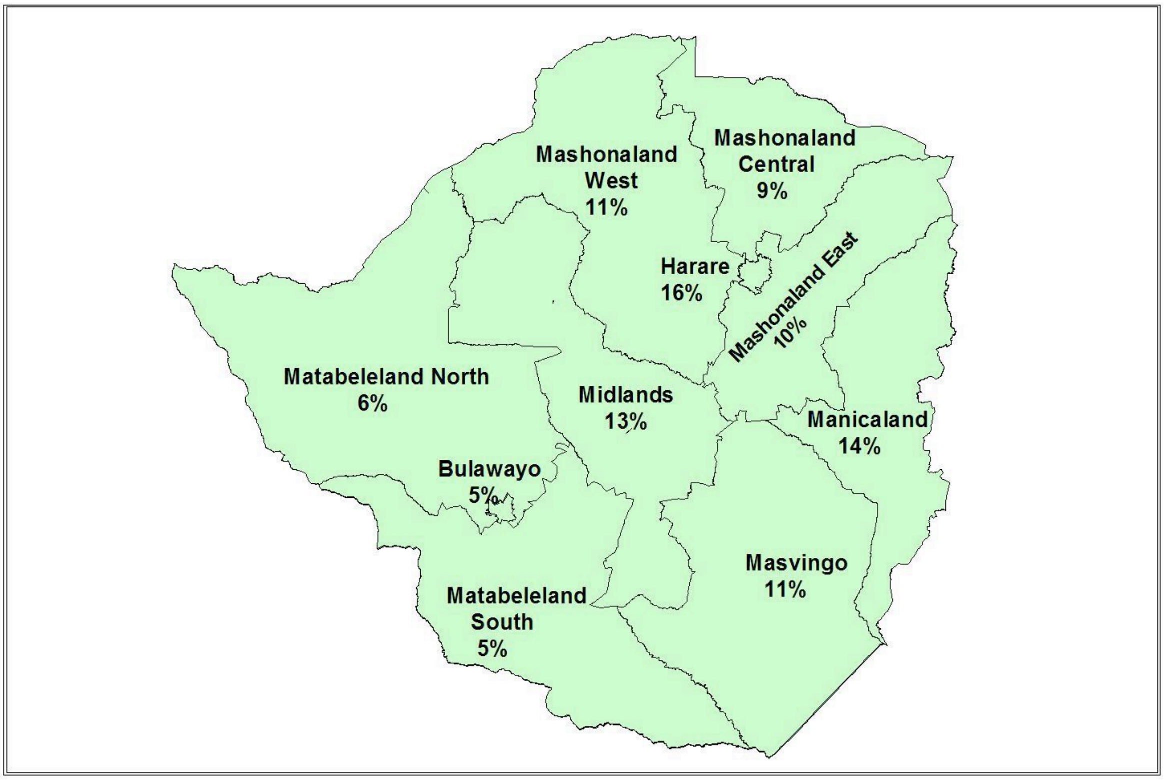


Figure 1.4: Distribution of the Population by Province

(2012 Zimbabwe Census)

Table 1.2 shows that Zimbabwe's Human Development Index (HDI) increased from 0.498 to 0.563 (13.2%) between 1990 and 2018. Each of the HDI indicators namely life expectancy at birth, mean years of schooling, expected years of schooling also increased over the same period. However, Gross National Income (GNI) per capita decreased by about 1.2% between 1990 and 2018.

Table 1.2: Zimbabwe HDI Trends from 1990 to 2018

Year	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2011 PPP$)	HDI
1990	58.1	9.8	4.5	2,693	0.498
1995	50.5	9.8	5.5	2,574	0.472
2000	44.6	9.8	6.5	2,747	0.452
2005	43.2	9.5	6.8	1,853	0.425
2010	50.6	10.1	7.3	1,689	0.472
2015	59.5	10.3	8.3	2,226	0.543
2016	60.3	10.4	8.3	2,246	0.549
2017	60.8	10.5	8.3	2,318	0.553
2018	61.2	10.5	8.3	2,661	0.563

1.1.3 Economic Profile

1.1.3.1 National Developments

Zimbabwe's industrial sector is divided into several sub-sectors which include but not limited to non-metallic mineral products, chemicals, fertilizers, metals and metal products and, food and beverages. The industry sector has traditionally been the leading sector in the economy in terms of contribution to GDP, formal employment, and foreign exchange earnings through exports.

Socio-economic development in Zimbabwe is guided by the Vision 2030 aiming at transforming the country into an upper middle-income economy with an average per capita income US$5,000. The vision is supported by the National Development Strategies (NDS) with a five-year cycle. The NDS1 (2021-2025) builds on earlier national economic blueprints namely Transitional Stabilisation Programme (TSP) (October 2018 – December 2020) and the Zimbabwe Agenda for Sustainable Socio Economic Transformation (ZimASSET), (2013-18). It is supported by a number of national and sectorial policies, one of which is the National Industrial Development Policy (2019-2023), the blueprint for industrialization. The policy is aimed at creating a conducive business environment, modernise, industrialize and promote investment.

The country has committed itself to implementing all the Strategic Development Goals (SDGs) with an emphasis on SDGs 1, 2, 3, 4, 5, 6, 7, 8, 9, 13 and 17 guided by national development priorities. The SDGs were mainstreamed and integrated into national development plans. Major infrastructure projects have been launched in the areas of utilities, transportation and connectivity, and industrial zones in response to SDG 9.

In the past two decades, the economy suffered de-industrialisation because of several challenges which impacted negatively on all productive sectors. This resulted in the closure of many companies across various sub-sectors, job losses, declining manufacturing sector capacity utilisation and output as well as a decline in the sector's contribution to GDP and exports. As at 2017, the sector's contribution to GDP was estimated at US$2,314 million which at 12.1% of GDP, fared well relative to other sectors but was below the average of 24% experienced in the 1980s when the country reached its peak of industrial development. The manufacturing sector capacity utilization declined to an all-time low of 10% in 2008 and picked up to 57% in 2011 following the introduction of the multicurrency system. Thereafter, capacity utilization fluctuated, dropping to 34.3% in 2015, then rising to 47.4% in 2016 before registering a slight drop to 45.1% in 2017. Potential exists for Zimbabwe to increase manufacturing sector capacity utilization to above 70% by 2023 if structural and economic challenges affecting the sector are addressed. Table 1.3 shows the GDP trends by industry at constant 2012 prices for the period 2009 to 2018.

Table 1.3: Trend in GDP by Industry at Constant 2012 Prices

(Source: Zimbabwe National Statistical Agency (ZIMSTAT)

Industry	GDP by year (USD million)									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Agriculture, Hunting and Fishing and forestry	1,174	1,259	1,277	1,377	1,341	1,650	1,564	1,503	1,654	1,957
Mining and quarrying	560	792	985	1,064	1,188	1,148	1,153	1,200	1,242	1,350
Manufacturing	1,157	2,004	2,282	2,404	2,389	2,267	2,272	2,285	2,314	2,344
Electricity, gas, steam and air conditioning supply	352	420	447	448	471	496	468	460	478	473
Water supply; sewerage, waste management and remediation activities	40	45	43	44	37	36	40	39	41	43
Construction	213	184	305	376	391	418	435	441	458	467
Wholesale and retail trade; repair of motor vehicles and motorcycles	2,054	2,264	2,362	2,463	2,560	2,624	2,724	2,903	3,138	3,305
Transportation and storage	559	577	578	615	658	666	698	706	730	748
Accommodation and food service activities	484	534	557	581	603	618	642	692	730	738
Information and communication	657	687	687	733	784	793	832	841	895	920
Financial and insurance activities	899	666	639	1,137	1,088	924	974	1,020	1,052	1,120
Real estate activities	120	128	190	303	305	319	354	400	404	417
Professional, scientific and technical activities	108	242	280	351	362	359	365	398	399	389
Administrative and support service activities	92	133	138	131	137	135	137	144	149	148
Public administration and defence; compulsory social security	345	498	910	1,272	1,280	1,396	1,414	1,507	1,524	1,448
Education	359	684	997	1,326	1,509	1,588	1,499	1,335	1,416	1,350

Industry	GDP by year (USD million)									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Human health and social work activities	70	132	209	279	305	339	379	401	437	438
Arts, entertainment and recreation	2	3	5	7	7	8	10	12	12	14
Other service activities	102	191	212	189	180	174	166	167	172	195
Domestic Services	22	42	42	41	43	44	45	46	50	49
GDP at Market Prices	10,735	12,847	14,670	17,115	17,455	17,870	18,188	18,326	19,188	20,115
Population (millions)	12	12	13	13	13	14	14	14	15	15
GDP per capita in US$	878	1,041	1,177	1,310	1,306	1,309	1,304	1,285	1,315	1,348

During the period under review the major contributors to GDP were Agriculture, Mining; Hunting and Fishing and Forestry; Manufacturing; and Wholesale and retail trade and repair of motor vehicles and motorcycles. The annual contributions were about 10% for each of the sectors. The population has been growing at a slow rate while the GDP per capita has been steadily increasing.

The country's major exports are minerals (gold, platinum group metals, chrome, and diamonds). The imports are dominated by mineral fuels, mineral oils and products of their distillation; bituminous substances; and mineral waxes. It also imports significant volumes of food products; electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles; and vehicles others than railway or tramway rolling-stock, and parts and accessories thereof. Zimbabwe also import all controlled Ozone Depleting Substances (ODS) and ODS substitutes for use.

Table 1.4 shows the distribution of establishments by industry and province. Most establishments are in the major contributors to GDP industries, which are manufacturing, wholesale and retail trade; repair of motor vehicles and motorcycles, and accommodation and food service activities. Most establishments are found in Harare province and the least number is in Mashonaland Central.

Table 1.4: Distribution of Establishments by Industry and Province

Industrial Classification	Bulawayo	Man	Mash Central	Mash East	Mash West	Mat North	Mat South	Midlands	Masvingo	Harare	Total
Mining & quarrying	8	7	10	0	28	2	14	28	4	21	122
Manufacturing	411	833	338	682	474	279	228	666	739	1,660	6,310
Electricity, gas, steam and air conditioning supply	15	14	7	7	15	7	8	17	10	20	120
Water supply; sewerage,	4	2	0	1	0	0	1	0	2	117	127

Industrial Classification	Bulawayo	Man	Mash Central	Mash East	Mash West	Mat North	Mat South	Midlands	Masvingo	Harare	Total
waste management & remediation activities											
Construction	76	23	3	6	17	2	1	21	14	91	254
Wholesale and retail trade; repair of motor vehicles and motorcycles	1,832	5,211	2,639	3,973	3,896	2,013	2,809	4,337	4,333	3,226	34,269
Transportation and storage	81	58	2	10	35	21	76	44	21	152	500
Accommodation and food service activities	318	300	171	222	347	184	260	352	245	450	2,849
Information and communication	67	52	17	26	39	19	19	32	29	129	429
Financial and insurance activities	109	152	48	66	114	26	50	105	124	426	1,220
Real estate activities	95	39	6	20	10	32	_	14	23	90	329
Professional, scientific and technical activities	190	69	22	31	83	14	11	77	47	435	979
Administrative and support service activities	116	56	24	44	94	37	23	79	65	199	737
Public administration and defence; compulsory social security	5	13	3	10	22	1	12	16	10	85	177
Education	206	770	554	553	560	580	337	764	590	365	5,279
Human health and social work activities	124	167	107	94	104	62	54	156	84	207	1,159
Arts, entertainment & recreation	34	14	2	7	8	9	3	11	3	50	141
Other service activities	378	248	98	288	433	90	226	307	277	760	3,105
Activity Not Stated	11	7	1	4	1	5	4	0	34	4	71
National	4,080	8,035	4,052	6,044	6,280	3,383	4,136	7,026	6,654	8,487	58,177

1.1.3.2 Mining

There are 13 major minerals which contribute significant income to the fiscus of Zimbabwe (Table 1.5 The export of asbestos is affected by the decline in the use of asbestos due to health reasons. Overall, mining and quarrying contribution to GDP rose significantly from US$560 million in 2009 to US$1,350 million in 2018.

Table 1.5: Contribution of Major Minerals to National Income between 2016 and 2018

Mineral	Year		
	2016	2017	2018
Gold	905,681.1	628,580.8	-
Platinum	415,402.9	274,254.5	218,645.8
Palladium	207,438.2	189,443.4	193,429.9
Nickel	123,140.0	75,864.2	155,638.1
Chrome	-	99,754.1	137,925.3
Rhodium	24,087.6	23,310.6	40,688.9
Copper	31,434.6	26,360.5	20,935.6
Iridium	6,419.0	6,054.5	5,799.3
Graphite	2,875.3	741.1	-
Cobalt	4,192.4	-	6,368.6
Coal	53,015.2	12,524.2	3,852.4
Ruthenium	951.0	846.4	3,196.3
Diamond	-	-	103,057.5

1.1.3.3 Energy

Zimbabwe's primary energy sources are biofuels (mainly fuelwood 61%), coal and petroleum products (36%) and electricity (13%). Fuelwood is the country's major energy source as 68% of the population depend on wood for fuel. The Zimbabwe Electricity Supply Authority (ZESA) is the utility responsible for the generation, transmission and distribution of electricity. Zimbabwe's total energy supply as at 2017 was estimated at 473,689TJ and the respective final consumption was 415,657TJ. The difference is accounted by transformational loses and energy industry own use. ZESA has both hydro and thermal power stations. Kariba is the major hydro power station and is jointly owned by ZESA and Zambia Electricity Supply Company (ZESCO). About 50% of coal produced in the country is used for generation of electricity at the four-utility owned thermal power stations in the country which are Hwange, Munyati, Bulawayo and Harare. The other 50% of the coal produced is used in the other sectors of the economy which are manufacturing, mining, agriculture, commercial and transport sectors. There has been recent increase in solar, mini hydro and biomass power uptake. However their combined contribution is below 5%.

To meet the total electricity demand for the nation, ZESA imports some of the electricity from neighbouring countries namely Mozambique, Zambia and South Africa. It also buys electricity from Independent Power Producers (IPPs) in the country. However, the country continues to experience constrained energy supplies, a factor that has adversely affected business and public transport operations. The Government has adopted coping strategies by blending fuel and liberalising the fuel market in order to alleviate the energy shortages.

Most of the energy supplied is mainly for the domestic market, with little exports in the form of coke and electricity. Almost all petroleum products (diesel, gasoline, jet kerosene, other kerosene, Liquefied Petroleum Gas (LPG), etc.) are imported. Zimbabwe requires 1,700MW of electricity while it generates about 1,400MW, with deficit met by imports as well as load shedding. Independent power producers' contribution is increasing. The prices of petroleum products have a high transport component considering the country is landlocked. Prices of electricity are agreed upon by the utility and IPPs with Zimbabwe Energy Regulatory Authority regulating the market.

Taxes are levied on electricity sold at 6% and the money is channelled to the Rural Energy Fund for increased clean energy access. Carbon taxes are charged on gasoline and diesel. Solar products are exempted from duty as a way of promoting the use of renewable energy technologies. Currently there are no direct subsidies for all energy products. The trade pattern for 2017 energy commodities is shown in

Table 1.6. As Zimbabwe aspires to become an upper middle-income economy by 2030, key development priorities in the energy sector are required. The priorities include renewable energy development (as enunciated in the Renewable Energy Policy, 2019) and promoting energy efficiency (National Energy Efficiency Policy, 2021). Zimbabwe is now implementing net metering regulations which will go a long way in promoting solar energy projects development. Zimbabwe is currently developing a national policy roadmap for energy efficient appliances, i.e. domestic refrigerators and distribution transformers.

Table 1.6: Trade Pattern for 2017 Energy Commodities

Transactions	Commodity (Tera Joule, TJ)					
	Primary Coal & Peat	Coal &Peat Products	Oil Products	Biofuels and Waste	Electricity	Total Energy
Primary production	79,071	0	0	333,442	14,288	426,802
Imports	675	0	50,167	0	9,248	60,090
Exports	0	-5,602	0	0	-1,264	-6,866

1.1.3.4 Transportation

Zimbabwe is a landlocked country and is predominantly serviced by road transport. Other forms of transport are air, rail and water transport in the inland water bodies such as the Kariba dam and the Zambezi river. Most of the international road routes radiate from Harare, the country's capital city, to neighbouring countries. Access to the sea is either by road or rail transport through ports in South Africa, Namibia or Mozambique. Air Zimbabwe has a very limited fleet of aircraft that services domestic and regional routes. It is, however, complemented by foreign airlines.

The four road authorities (Department of Roads, Urban Local Authorities, Rural District Councils and District Development Fund) are responsible for the road types. Zimbabwe National Road Administration (ZINARA) provides financial support to the four authorities. In the year 2012 the total road network was approximately 88,133km. The state roads lengths were as follows:

- Department of Roads - 18,818 km
- Urban Local Authorities - 8,194 km

- Rural District Councils - 36,121 km
- District Development Fund - 25,000 km

The Rural District Councils roads and District Development Fund roads are predominantly gravel roads.

The rail network of Zimbabwe is owned and operated by two organisations, namely National Railways of Zimbabwe (NRZ) and Beitbridge Bulawayo Railways (BBR). NRZ operates a railway network with a route length of about 2,760 kilometres (Cape gauge) for both freight and passenger transport, linking to the networks of South Africa, Mozambique, Zambia and Botswana. BBR operates a 385kilometres direct line from Bulawayo to Beitbridge (also Cape gauge), linking Zimbabwe to South Africa. The line is under a 30-year Built, Operate and Transfer (BOT) concession which began in 1999.

Other forms of transportation include a pipeline from Beira in Mozambique to Harare for transportation of petroleum products. The import capacity of the pipeline is 120 million litres per month.

The formulation of sector-specific policies in the transportation sector pertains to the development, rehabilitation, and upgrade of infrastructure and systems that allow for the development of climate-resilient infrastructure and the adoption of clean technologies like Zero-Emission Vehicles. Given the basis of the policy direction, the transport industry emerges in two dimensions: infrastructure and services. Road rehabilitation and dualisation, rail infrastructure maintenance and rehabilitation, the expansion of inland water transport systems, and the improvement of aviation infrastructure, particularly international airports and aircraft, are all part of transportation infrastructure. To buttress these efforts, the drive by Government towards integrated road transport systems will ensure the adoption of smart transportation systems that integrate transportation and services for road transport, which is critical in the promotion of efficiency in the transport sector and contributing towards reduction of GHG emissions in road transport.

1.1.3.5 Trade

Zimbabwe's major trading partner for both imports and exports is South Africa. Zimbabwe's total imports for the period 2015 to 2019 showed no definite trend, but was highest in 2018 (Table 1.7). There was an increase of total exports and 99% of the exports were domestic. Major imports relates to mineral fuels, mineral oils and products of their distillation, bituminous substances and mineral waxes. Major exports are natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation jewellery; coin; and tobacco and manufactured tobacco substitutes; ores, slag and ash.

Table 1.7: Summary of External Trade (US$)

Period	Total Imports	Domestic Exports	Re-Exports	Total Exports
2015	6,029,726,909	3,321,399,024	22,991,005	3,344,390,029
2016	5,270,412,573	3,324,341,095	10,338,555	3,334,679,650
2017	5,063,876,441	3,446,056,499	34,495,643	3,480,552,142
2018	6,390,573,528	4,036,758,709	20,596,784	4,057,355,493
2019	4,817,222,159	4,252,090,438	16,922,451	4,269 012,889

1.1.3.6 Building Stock and Urban Structure

Estimates of housing demand in Zimbabwe range from 1.3 million to 1.5 million housing units. Demand for housing in Zimbabwe is largely driven by rural-urban migration which averages 4.3% per annum. Low cost housing developments have historically been undertaken by municipalities. In recent years, most municipalities in Zimbabwe have not been able to provide new low-cost housing stock due to financial constraints. The government has since opened up housing development to private developers, and as from 2006 there has been an increase in urban housing projects.

Zimbabwe's urbanization rate was about 13% in the 1960s, and rose to about 31% in 1992, and to 32% in 2019. The low acceleration of urbanisation rate from the 1990s can be attributed to the poor performance of industry coupled with the 2000 land reform programme. In addition, new suburbs are emerging in peri-urban areas, particularly around cities, exerting pressure on the social service delivery system.

1.1.3.7 Agriculture

Agriculture is the backbone of Zimbabwe's economy. The sector provides direct and indirect employment to approximately 60-70% of the population, supplies 60% of the industrial raw materials and contributes approximately 40% towards export earnings. The sector also contributes about 15-18% to GDP. Agriculture in Zimbabwe is however mainly rain fed and as such is vulnerable to erratic rainfall, recurrent droughts and floods. Agriculture uses about 42% of total land area, and of this area approximately 365,000ha is suitable for irrigated agriculture. However, only about 123,000ha is irrigated, mostly by commercial farmers, government and smallholder farmers.

In the late 1980s, government took measures to stimulate production through export incentives, introducing the Export Retention Scheme and the Export Revolving Fund and foreign exchange allocations in favour of exporters. In addition, government policy indirectly stimulated exports through the relatively low government-set producer price for maize, which made many commercial farmers diversify into cash crops such as tobacco and cotton destined for the more lucrative export markets.

In the early 1990s government embarked on market-oriented reforms aimed at market deregulation, liberalization and export promotion. Controls on domestic prices were removed except for a few commodities. The devaluation of the Zimbabwean dollar also continued to stimulate exports. In the mid-1990s government adopted a comprehensive agricultural policy for the period 1995-2020.

Zimbabwean agriculture is divided into four major sectors namely; Large Scale Commercial Farms, Small Scale Commercial Farms, Communal Lands and Resettlement Schemes which comprise the Old Resettlement Schemes and new resettlement schemes (A1 and A2). Since independence Zimbabwean government embarked on a series of land reform programmes that sought to reallocate land more equitably. More than 14 million hectares of large scale commercial farms were transferred to more than 230,000 households on A1 and A2 farms (Table 1.8)

Table 1.8: Changes in Land Holdings over Time in Zimbabwe

(Source: Kasiyano, 2017)

Land Category	Area by year (million hectares)		
	1980	2000	2009
Communal land	16.4	16.4	16.4
Old Resettlement scheme[a]	0.0	3,5	3.5
A1 Resettlement scheme[b]	0.0	0,0	4.1
A2 Resettlement scheme[c]	0.0	0.0	3.5
Small-scale commercial farms	1.4	1.4	1.4
Large-scale commercial farms	15.5	11.7	3.4
State farms	0.5	0.7	0.7
Urban Land	0.2	0.3	0.3
National Parks and Forest land	5.1	5.1	5.1
Unallocated/State land	0.0	0.0	0.7

Note: a Areas where land was redistributed in the 1980s
b Areas where land was redistributed from 2000 comprising 6ha arable on average and common grazing
c Areas where land was redistributed from 2000, similar to small and large scale commercial farms

Zimbabwe has a diversified agricultural sector, producing food crops, cash crops, and livestock. Over 23 types of food and cash crops are grown. The major food crops produced include maize, small grains, wheat, groundnuts and beans. Tobacco, cotton, tea, coffee, sugarcane, soya beans and horticulture crops are the main cash crops. Tobacco is the major agricultural export commodity. The other agricultural products exported are sugar, coffee, tea and cotton, and in years of surplus, maize. Zimbabwe also exports flowers and other horticultural products.

Table 1.9 shows the top five exported agricultural produce from 2001 to 2018. Imports of agricultural products are limited mainly to wheat and maize in drought years. Imports of agricultural products are limited mainly to wheat and maize in drought years. The area suitable for maize which is the staple food crop has decreased and may continue to decrease in future according to future climate projections.

Table 1.9: Exports of Five Agricultural Produce Between 2016 and 2019 (US$)

Year	**Tobacco**	**Cotton**	**Trees ***	**Sugar**	**Vegetables & tubers**
2016	926,312,523	24,926,818	3,533,763	59,035,793	4,369,172
2017	837,204,598	34,344,263	2,775,781	53,958,847	3,967,190
2018	888 008,197	75,431,961	7,079,736	44,518,685	8,857,468
2019	809,207,573	41,623,619	4,869,239	62,859,561	7,078,323

*Live trees & other plants, bulbs, roots, cut flowers & ornamental foliage

Zimbabwe's agricultural performance has over the years generally declined resulting in the country relying on imports to supplement domestic production. Total maize production declined from a peak of over 2 million tonnes in 1996 to 1.3 million tonnes in 2010, against national requirements of 1.8 million tonnes. The historical patterns of maize production are shown in Figure 1.4 and Figure 1.5 and shows production trends for 13 crops between 1990 and 2017. Zimbabwe's production of major cash crops has also been declining.

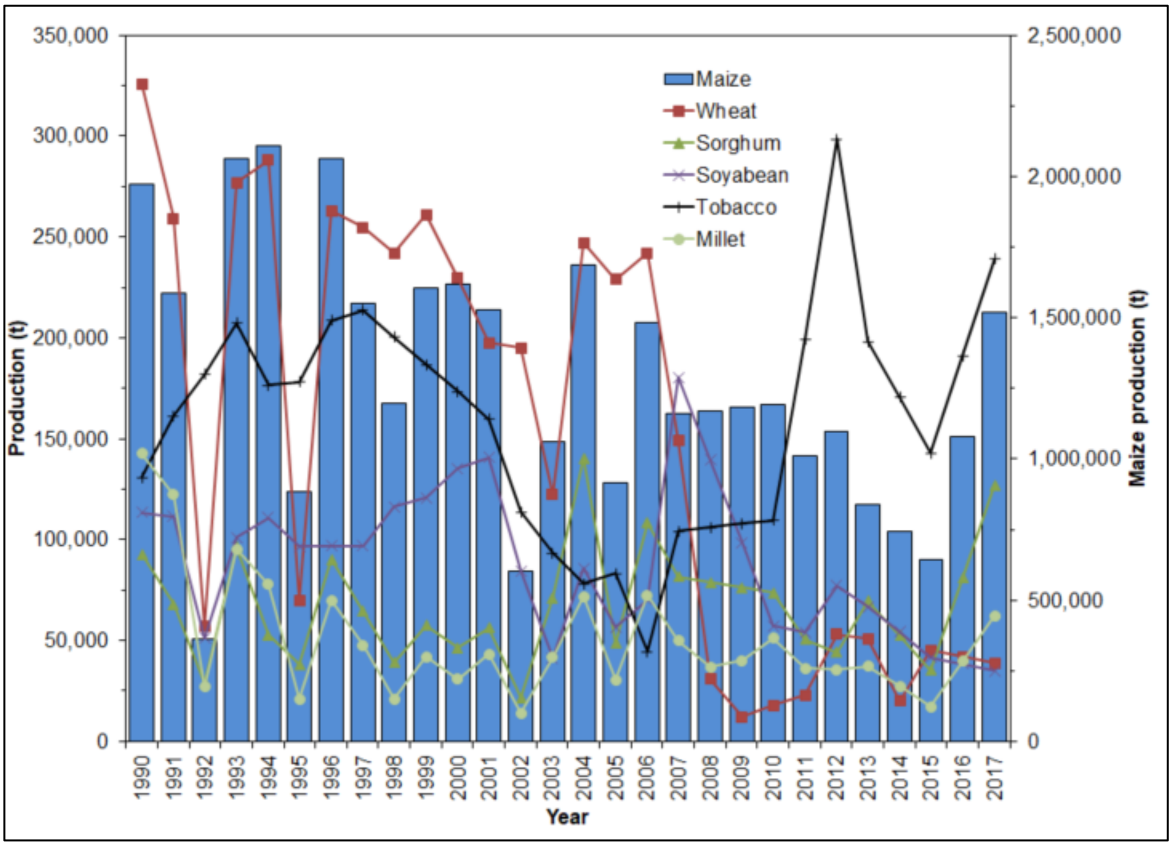


Figure 1.5: Production Levels for Maize and Other Crops in Zimbabwe (Source: ZIMSTAT)

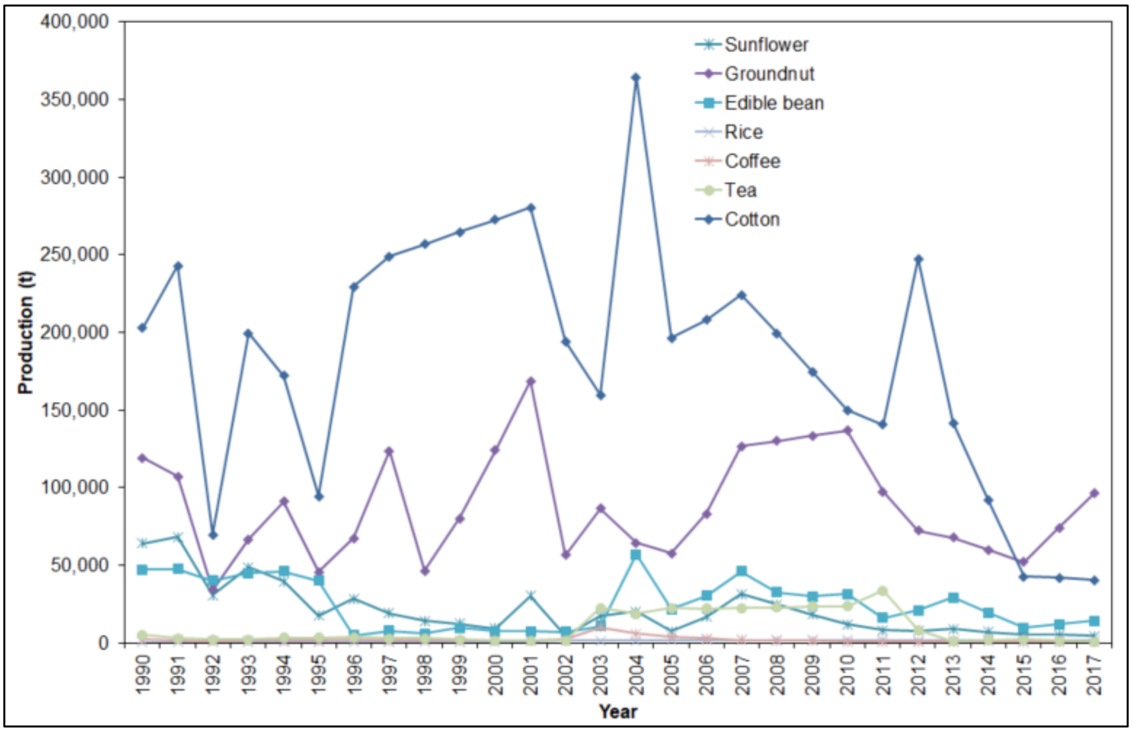


Figure 1.6: Production Levels for Other Crops in Zimbabwe

(Source: ZIMSTAT)

The livestock sector mainly consists of beef and dairy cattle, goats, sheep, pigs and poultry (Table 1.10). The importance of livestock in rural livelihoods and food security lies in the provision of meat, milk, eggs, hides, draught power and manure. They also act as strategic household investment. Small ruminants (sheep and goats) and non-ruminants, particularly poultry, are an important safety net in the event of a drought.

Table 1.10: Livestock Production Statistics (2009 – 2019)

Year	Cattle	Goats	Sheep	Donkeys	*Poultry	Pigs
2,009	5,370,660	4,207,111	315,193	562,098	3,619,853	356,592
2,010	5,815,040	4,448,134	309,005	562,768	3,681,532	391,174
2,011	6,058,387	4,719,280	309,432	603,739	4,005,908	396,272
2,012	6,203,502	5,375,118	341,622	581,654	4,249,281	565,917
2,013	5,535,930	4,978,071	355,836	551,992	3,987,547	618,923
2,014	4,875,837	4,581,023	369,971	522,333	3,725,812	671,926
2,015	5,035,198	4,618,277	363,257	520,877	3,693,721	528,485
2,016	5,184,271	4,655,531	356,542	529,921	3,645,584	385,046
2,017	5,333,343	4,692,784	349,828	538,967	3,629,538	241,605
2,018	5,482,416	4,730,037	343,114	548,012	3,613,493	241,605
2,019	5,631,487	4,767,291	336,399	567,558	3,597,447	241,605

*Includes broiler, layer, turkey, indigenous chicken

In Zimbabwe, cattle are the most important of all the livestock species and are owned by 88% of households among smallholder farmers. About 89% of smallholding farmers own poultry, up to 73% of households own goats while up to 11% own sheep. Pigs are owned by less than 10% of households while less than 5% of smallholder households own rabbits. Natural Regions IV and V, which together account for 73.9% of smallholder settlements hold 50-80% of all livestock since these areas are characterised by poor crop performance. Drier, semi-arid areas are the location for goats and sheep while cattle are spread more evenly. Most small ruminants (70%-75%) are found in Natural Regions IV and V. Matabeleland North, Matabeleland South, Midlands and Masvingo Provinces are the areas most suited for livestock production.

Agricultural Strategies and Policies

The country has a number of past and current agricultural strategies, policies and development strategies with the aim of boosting agricultural productivity, improving competitiveness, promoting investment in agriculture or ensuring food and nutrition security. The following is a list of some of the strategies:

- Comprehensive Agricultural Policy Framework
- Food and Nutrition Security Policy
- Irrigation Policy
- National Agricultural Policy Framework
- National Policy and Programme on Drought Mitigation
- National Drought Plan
- National Nutrition Strategy
- Climate Smart Agriculture Policy Framework
- Zimbabwe Agriculture Investment Plan

1.1.3.8 Forestry

As of 2017, Zimbabwe's forestry resources covered approximately 45% of the total land area (Table 1.11). Forests generate a wide range of both timber and non-timber products and services. Most of the country is covered by mopane and miombo woodland and savanna. The biggest area of commercial plantations (~108,000ha), mainly eucalypti and pines, is found in Manicaland. Commercial timber harvested from indigenous woodlands in communal lands is mainly teak and mukwa species.

Table 1.11: Zimbabwe Land Use Statistics

(Source: Forestry Commission)

Land use	Area(ha) 1992	% of land	Area(ha) 2017	% of land
Natural Forest	20,788,106.41	53.2	1,7401,762.85	44.6
Wooded grassland	6,175,828.49	15.8	7,965,520.50	20.4
Wetland	295,172.43	0.8	416,615.49	1.1
Settlement	139,349.43	0.4	247,877.42	0.6
Other land	78,520.10	0.2	133,643.10	0.3
Grassland	689,104.79	1.8	1,474,990.41	3.8
Forest plantation	155,117.49	0.4	179,832.26	0.5
Cropland	10,737,372.16	27.5	11,238,329.27	28.8
Total	39,058,571.30		39058,571.30	

Forest Cover Changes

Between 1990 and 2010, Zimbabwe lost an average of 327,000 hectares of forest per year (Table 1.12). Major drivers of this deforestation include; agricultural expansion, fuelwood gathering, excessive livestock numbers, commercial logging, veld fires, harvesting construction timber, settlements, mining, tobacco curing and charcoal making.

Table 1.12: Trends in Total (Net) Forest cover, 1990 – 2010 for Zimbabwe

Total forest cover				
Year	1990	2000	2005	2010
Area (1,000 ha)	22,164	18,894	17,259	15,624
Annual change rate (1000 ha) Negative numbers represent deforestation				
Period		1990 - 2000	2000 - 2005	2005 - 2010
Area change [a] (1000 ha)		-327	-327	-327

Notes [a] The Area change was averaged since data for other years was not available

Exports from Forests

The forestry industry contributes between 3 and 5% to the country's GDP. The country mainly exports transmission poles and other forest products to neighbouring countries. In an effort to promote exports, in 2017 the Forestry Commission of Zimbabwe de-centralised issuance of timber movement and export permits to district offices and reduced the cost of export documentation by 50%. The Forestry Commission has also stepped up enforcement of a ban on the exportation of unprocessed and semi-processed indigenous hardwoods, in preference for finished wood products to enhance the country's foreign currency earnings.

Forestry Management in Zimbabwe

Forestry management is governed by government policies and community level initiatives. The Forest Commission is the forestry authority in Zimbabwe in terms of the Forest Act. Sustainably managed forests provide essential goods and services and ensure sustenance of livelihoods. Its functions include regulation of the forestry sector, management of gazetted forests, forest research, forestry training and development and implementation of the forest policies. The following are pieces of legislation that govern the management of forest resources in Zimbabwe, and each has provisions pertaining to forests:

- Forest Act (Chapter 19: 05 as amended in 1999)
- Communal Lands Forest Produce Act (No. 20 of 1987)
- Communal Lands Act (1985)
- Rural District Councils Act 1988
- Land Acquisition Act 1993
- National Parks and Wildlife Management Act (1975 and amended 1982)
- Environmental Management Act Cap 20:27
- Traditional Leaders Act, 2000

In communal areas, management practices include:

- Afforestation and reforestation by communities, traditional leaders Civil Society Organisations (CSOs), schools and government departments and agencies.
- The sharing of benefits between governments and local communities from the protected area which tends to ensure conservation of existing forests. Examples are the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) and Reducing Emissions from Deforestation and Forest Degradation (REDD+) programmes.
- Cultural practices which include rules, beliefs and taboos regarding the general use and harvesting of trees and other natural resources.

1.1.3.9 Waste

Zimbabwe produces waste mainly from domestic, industrial and commercial sectors. The major types of waste produced from these sectors include solid, hazardous waste and wastewater. An average of 2.5 million tonnes of domestic solid waste is generated per year. Major components of urban solid waste in Zimbabwe include food waste, paper and card board, plastics, glass, ceramics, metals, textiles, rubber and leather. The major drivers of waste population growth, urbanization, industrialisation and increased use of non-biodegradable plastics and bottles, obsolete equipment and poor management practices. Waste disposal methods often employed include open dumping, burning and landfilling with open dumping being the most common in Zimbabwe urban environments.

Significant population increases have led to large increases in solid waste generation over the years. The amount of waste generated per person per year is increasing. In 2005, the average waste generation rate was about 0.5kg per capita per day. By 2025 the country is projected to generate about 0.7kg per capita per day.

The major sources of wastewater are urban areas, rural service centres, mines and agricultural estates. Wastewater from these sources largely consists of a mixture of industrial and domestic sewage. In urban areas and rural services centres wastewater is conveyed through sewer reticulation to treatment works. The most common methods of wastewater treatment are Biological Nutrient Removal (BNR), anaerobic ponds, activated sludge removal and anaerobic digesters. The amount of wastewater generated in Zimbabwe has been increasing over the years partly due to urbanization and population growth. The waste treatment plants are being overloaded as they were designed to process lower volumes than they are currently handling.

Zimbabwe urban local authorities are experiencing major challenges in managing waste due to inadequate infrastructure. In addition, facilities available cannot match current waste generation rates.

1.1.4 Priorities Related to Climate Change Action

Zimbabwe's climate change action takes into account its low GHG emissions per capita and substantial vulnerability to the impacts of climate change. Zimbabwe is a small net emitter by global standards, responsible for 0.07% (2.5 tonnes CO_2 eq emissions per capita in 2017) of global emissions. On the other hand, Zimbabwe is among the World's

50 most vulnerable countries according to the ND~GAIN Index.3. Hence, Zimbabwe's climate change actions focus as much on adaptation as it does on mitigation.

Zimbabwe scaled up its efforts in climate change through the development of the following

- National Climate Change Response Strategy (2014)
- National Climate Policy (2017)
- Low GHG Emission Development Strategy (2020-2050)
- First Biennial Update Report (2021)
- Revised Nationally Determined Contributions (NDCs) (2021)
- Communication Strategy for the National Adaptation Planning Process in Zimbabwe (2021)
- National Climate Change Learning Strategy (2021)

The country has also developed sector specific strategies and policies which addresses adaptation and mitigation measures and these are covered later in the relevant sections

1.1.5 Barriers to implementing Climate Change Actions

The country is faced with a number of challenges that militate against its efforts to implement Climate Change actions. These include;

- Inadequate skilled personnel
- Limited financial resources
- Low uptake of new technologies
- Weak Institutional arrangements
- COVID-19

1.2 Institutional Arrangements for Climate Change Management in Zimbabwe

1.2.1 Government Structure Relevant to MRV

The High-Level Committee in the Office of the President and Cabinet (OPC) is responsible for oversight of all climate change activities at national level. The committee comprises permanent secretaries for all government ministries and is chaired by the OPC. The Ministry of Environment, Climate, Tourism and Hospitality Industry, through the Climate Change Management Department (CCMD) is mandated with coordinating and implementing national climate change programmes. The Department is responsible for the development of the National Communications (NCs) and Biennial Update Reports (BURs) is supported by a multi-sectoral National Climate Change Committee for sector-specific and cross-sector implementation, coordination, advice and guidance. Figure 1.7 illustrates the institutional arrangement relevant to NCs and BUR1 in Zimbabwe in terms of Measurement, Reporting and Verification (MRV).

1.2.2 Overall Description of MRV

There is no integrated MRV system in operation as yet.

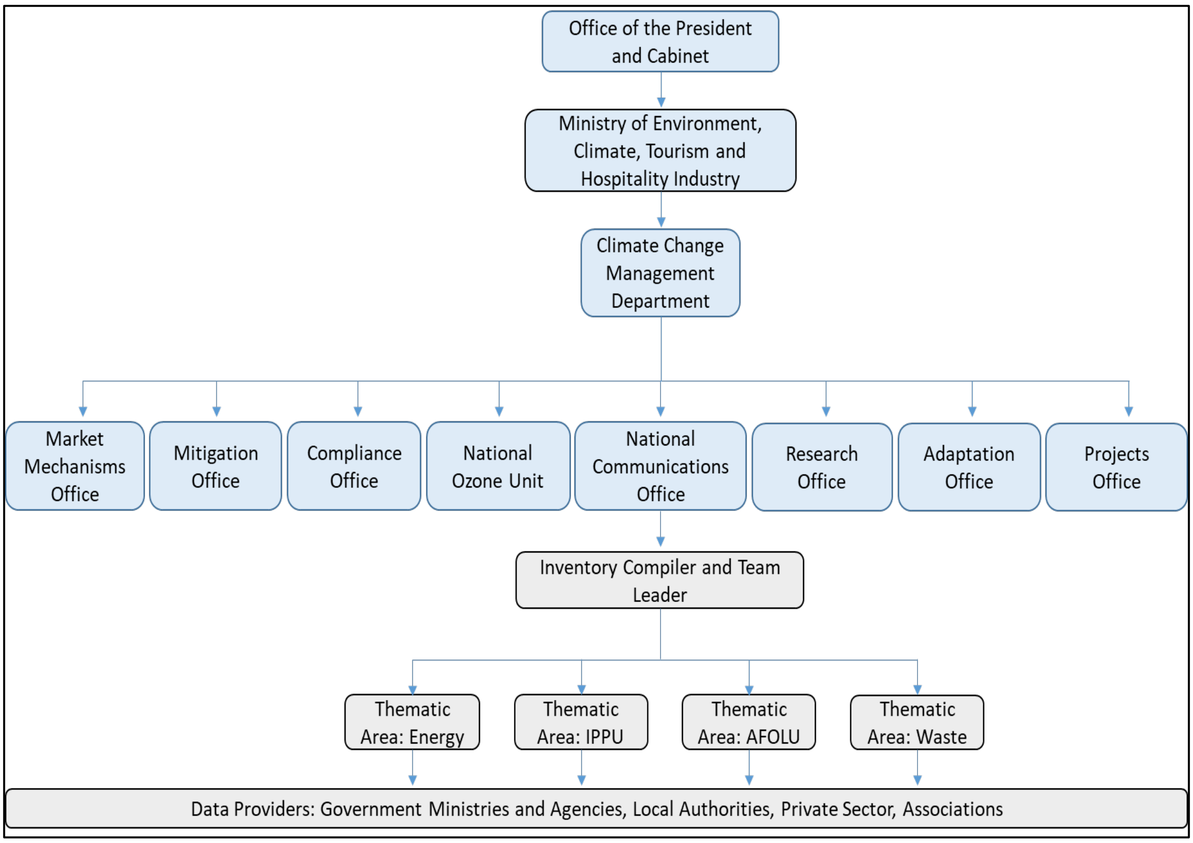


Figure 1.7: Institutional Arrangements for Zimbabwe NC and BUR1

1.2.3 MRV for GHG Inventory

The GHG Inventory Management System is currently under development. The elements that are already in place include:

- The designation of a focal point to the United Nations Framework Convention for Climate Change (UNFCCC).
- Appointment of the coordinator of the NC and BUR1.
- Team leader of the GHG Inventory appointed.
- Sectoral experts engaged.
- Stakeholder mapping has been done
- Focal points in government and the private sector have been identified – formalization of working arrangements is still pending.
- A GHG emissions database has been designed.

1.2.4 MRV for Climate Change Mitigation

Under the Paris Agreements' Enhanced Transparency Framework, the country is expected, among other things, to fulfil two mandatory reporting requirements which are to report on (i) its GHG Inventory and (ii) information necessary to track progress in the implementation of its Nationally Determined Contributions. Zimbabwe has not yet developed a functional NDC MRV tracking tool. However, the country has implemented a number of projects that form a strong basis for the development of a robust NDC tracking tool. The projects include Support Towards the Implementation of Zimbabwe NDC (STIZ) and Initiative for Climate Action and Transparency. The STIZ project developed the Low Emission Development Strategy (LEDS), a draft framework for MRV of the mitigation was developed including tables and protocols for each sector. In order to initiate the development of the necessary tools to fulfil these requirements, the Initiative for Climate Action Transparency (ICAT) supported the Government of Zimbabwe in undertaking a study on NDC Implementation Tracking in Zimbabwe. The ICAT project assisted in analysing the MRV landscape in the country for NDC implementation and also proposed procedures and tools for data collection. It also developed a GHG QA/QC procedure manual for GHG database and an impact assessment for Biofuels and Renewable Energy Policy. Table 1.13 indicates institutions, their roles and level of formalization in place.

The country is currently working on the development of an NDC MRV tracking tool under the Capacity Building Initiative for Transparency (CBIT) project. The CBIT project will develop a system for the evaluation and tracking of the NDC as well as assessing impacts of mitigation actions or policies and measures. This will facilitate the analysis of the best options for the tracking system for the Zimbabwean NDC. This project will also support the development of baseline GHG projections on a continuous basis to rigorously evaluate the progress against intermediate targets, and to assess whether the current mitigation efforts are sufficient to meet the set of targets. CBIT work will build capacity to regularly develop sectoral baseline GHG projections across all the IPCC sectors. Training on projections will be delivered to the institutions involved in the compilation of the GHG emission inventory. CBIT project will further support ongoing work on GHG mitigation assessment to support Zimbabwe's NDC revision. Other key considerations for development of an MRV system, and tracking of NDC implementation, include a framework for the continuous assessment and reporting of constraints, gaps and related financial, technical and capacity needs and support needed and received.

Table 1.13: Status of Key Institutions Involved in MRV for Solar Water Pumping Systems for Irrigation

Institution	Role	Legal status
Climate Change Management Department	NDC and LEDS MRV coordination	Mandated by Government to coordinate climate change issues
Ministry of Lands, Agriculture, Water, Fisheries & Rural Resettlement	Implementing agency	Not yet in place
Ministry of Energy & Power Development - Zimbabwe Energy Regulatory Authority	Data Collection	Not yet in place

1.2.5 MRR for Climate Change Adaptation

The Monitoring, Reporting and Reviewing (MRR) for Vulnerability and Adaptation is being developed under the National Adaptation Planning process.

1.2.6 MRV for Support Needed and Support Received

At present there is no coordination mechanism for tracking climate finance data in a systematized way. A major challenge for the design of a climate change tracking system is that climate change is not recognized as a category of public expenditure in the national government financial system, which would allow an automatic compilation of relevant spending. As a result, an examination of budget spending, potentially leading to a tailored budget-tracking tool, is required to identify climate change-relevant expenditures. To ensure consistency, such a tool may have to adopt a specific definition of climate finance.

The Paris Agreement (PA) calls for a robust system of MRV to provide information on the measures taken and the support needed and support received or accounted for in the NDC or internationally transferred. The Ministry of Finance is working on a climate finance strategy and is developing a finance tracking tool- Development Projects Management Information System (DEVPROMIS) in consultation with the Infrastructure Development Bank of Zimbabwe (IDBZ) who are hosting the climate finance facility. The design and installation of the system has been delayed due to the COVID-19 pandemic and project completion has been delayed to March 2022. This tool will be linked to the proposed online climate transparency data management platform developed under this project.

This output will enable development of capacity for public institutions reporting their climate expenditures and support needed and support received as well as developing a guide for reporting public expenditure including climate finance. The IDBZ is working on establishing a Climate Finance Facility that will designate the bank to handle climate finance in collaboration with the Ministry of Finance under the DEVPROMIS. This will provide a focal point for public institutions to report climate finance expenditure. The online climate transparency data management platform will be used as an online location to store information on climate finance generated through this project.

1.2.7 Planned Improvements for Reporting under the Enhanced Transparency Framework (ETF)

Zimbabwe is currently working on improving national institutional arrangements. The objective is to establish a legal framework to support reporting under an enhanced transparency framework, online MRV portal, reporting tools for GHG inventories, mitigation, adaptation, and climate support received/given, development of a national climate communication strategy and data templates.

CHAPTER 2.0 National Greenhouse Gas Inventory Report for 1990-2017

2.1 Introduction

Zimbabwe has compiled its National Inventory Report (NIR) in compliance with Article 4 of the UNFCCC, covering carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and for the first time hydro-fluorocarbons (HFCs). The GHG inventory was compiled using the methods reported in the 2006 IPCC Guidelines, covering all the four sectors, namely: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land-Use (AFOLU) and Waste. The current GHG inventory is for the reporting year 2010 and is preceded by the Third National Communication (TNC) submitted to the UNFCCC in 2016, the Second National Communication (SNC) submitted in 2013 and the Initial National Communication (INC) submitted in 1998.

2.2 Structure and Process of Greenhouse Gas Inventory

The inventory was compiled by a consultancy company comprising sector experts, majority of whom were involved in the compilation of the TNC, complemented by additional trained national experts. The sector experts were organised into sectoral teams which were responsible for data collection from the data providers and analysis of the data. An inventory team leader was assigned to coordinate the NIR process. The inventory team reported to the Fourth National Communication (NC4) Project Coordinator in the Ministry of Environment, Climate, Tourism and Hospitality Industry (MECTHI). Four separate internal capacity building workshops were undertaken involving participatory exchange of knowledge and information with data providers from each sector. The workshop provided background information to the activity data. Workshops were also held to go through the data and methods used in order to improve the quality of the data. The whole inventory compilation process also benefited from the international review of the TNC and face to face feedback by a team of experts from the UNFCCC. Recommendations from the review were used to improve on the quality of the inventory.

2.3 The Inventory Methodology

2.3.1 Data Sources and Computation Methods

The GHG emissions by sources and removals by sinks were compiled using the 2006 IPCC Guidelines for GHG Inventories. The details of source/sink categories covered and methodologies are presented in Table 2.1. Processed data and information were entered into the IPCC GHG Software (Version 2.691.7327.20936 of January 2020) for both computation of the inventory and archiving data. The data were also archived in the GHG database developed under the same project. From the INC (1998) to the TNC (2016), Zimbabwe reported its GHG inventory largely using the Revised 1996 IPCC Guidelines. For the first time, the country has reported its GHG inventory in all sectors using the 2006 IPCC Guidelines.

The Tier 1 methodological approach was used in the computation of the entire inventory with the exception of the Cement Production category (2.A.1) where Tier 2 approach was used. This was due to lack of disaggregated activity data and country specific emission factors. The activity data and their uncertainty levels were provided by government agencies, respective government departments under each sector, local authorities, individual private companies and other sources indicated in Table 2.1. Default IPCC Emission Factors and their uncertainties were obtained from the 2006 IPCC Guidelines and the online Emission Factor Database. For computation of CO_2eq, Global Warming Potential (GWP) of CO_2, CH_4 and N_2O were obtained from the IPCC Second Assessment Report (SAR). The TNC used the Fourth Assessment Report (AR4) GWPs, hence recalculations were performed in the current inventory.

To improve on the Transparency, Accuracy, Completeness, Comparability and Consistency (TACCC) Principles, all procedures on selection of activity data and emission factors were peer reviewed and documented. The IPCC approved methodologies for data gap filling, including interpolation and extrapolation were used. Comparison of the inventory software output with other computations from international sources such as FAOSTAT and the International Energy Agency (IEA) was done and in the case where the differences were significant investigations were carried out and documented.

Table 2.1: Summary of methods and data sources used in compiling the national GHG Inventory.

Source and Sink Category		***Carbon dioxide (CO_2)***				***Methane (CH_4)***				***Nitrous oxide (N_2O)***			
		M	***AD***	***CF***	***EF***	***M***	***AD***	***CF***	***EF***	***M***	***AD***	***CF***	***EF***
1	Energy												
1.A	Fuel Combustion Activities												
1.A.1	Energy Industries	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC
1.A.2	Manufacturing Industries and Construction	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC
1.A.3	Transport	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC
1.A.4	Other Sectors	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC
1.A.5	Non-Specified	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC	T1	MoEPD	IPCC	IPCC
1.B	Fugitive emissions from fuels												
1.B.1	Solid Fuels	NE	NE	NE	NE	T1	MoEPD	IPCC	IPCC	NO	NO	NO	NO
1.B.2	Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3	Other emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.C	Carbon dioxide Transport and Storage												
1.C.1	Transport of CO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.C.2	Injection and Storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.C.3	Other												
2	Industrial Processes and Product Use												
2.A	Mineral Industry												
2.A.1	Cement production	T2	CP		IPCC								
2.A.2	Lime production	NE	NE		NE								
2.A.3	Glass Production	T1	GP		IPCC								
2.A.4	Other Process Uses of Carbonates	T1	ZIMSTAT		IPCC								
2.A.5	Other (please specify)												
2.B	Chemical Industry												
2.B.1	Ammonia Production					NO	NO		NO				
2.B.2	Nitric Acid Production									T1	NAPr		IPCC
2.B.3	Adipic Acid Production									NO	NO		NO
2.B.4	Caprolactam, Glyoxal and Glyoxylic Acid Production									NO	NO		NO
2.B.5	Carbide Production	NO	NO	NO	NO	NO	NO		NO				
2.B.6	Titanium Dioxide Production	NO	NO	NO	NO								
2.B.7	Soda Ash Production	NO	NO	NO	NO								
2.B.8	Petrochemical and Carbon Black Production	NO	NO	NO	NO								
2.B.9	Fluorochemical Production												
2.B.10	Other (Please specify)												
2.C	Metal Industry												
2.C.1	Iron and Steel Production	T1	ISP		IPCC	T1	ISP		IPCC				
2.C.2	Ferroalloys Production	T1	Chamber Mines, USGS, MMCZ		IPCC								
2.C.3	Aluminium production	NO	NO		NO	NO (PFCs)	NO		NO				

Source and Sink Category		Carbon dioxide (CO_2)				Methane (CH_4)				Nitrous oxide (N_2O)			
		M	AD	CF	EF	M	AD	CF	EF	M	AD	CF	EF
2.C.4	Magnesium production	NO	NO		NO								
2.C.5	Lead Production	TI	Lead Producers		IPCC								
2.C.6	Zinc Production	NO	NO		NO								
2.C.7	Other (please specify)												
2.D	Non-Energy Products from Fuels and Solvent Use												
2.D.1	Lubricant Use	TI	ZIMSTAT		IPCC								
2.D.2	Paraffin Wax Use	TI	ZIMSTAT		IPCC								
2.D.3	Solvent Use	NE	NE		NE								
2.D.4	Other (please specify)												
2.E	Electronics Industry												
2.E.1	Integrated Circuit or Semiconductor												
2.E.2	TFT Flat Panel Display												
2.E.3	Photovoltaics												
2.E.4	Heat Transfer Fluid												
2.E.5	Other (please specify)												
2.F	Product Uses as Substitutes for Ozone Depleting Substances	HFCs				PFC				SF_6			
2.F.1	Refrigeration and Air Conditioning	NE	NE		NE								
2.F.2	Foam Blowing Agents	NE	NE		NE								
2.F.3	Fire Protection	NE	NE		NE	NE	NE		NE				
2.F.4	Aerosols	NE	NE		NE	NE	NE		NE				
2.F.5	Solvents	NE	NE		NE	NE	NE		NE				
2.F.6	Other Applications (please specify)												
2.G	Other Product Manufacture and Use												
2.G.1	Electrical Equipment												
2.G.2	SF6 and PFCs from Other Product Uses					NE (PFCs)	NE		NE	NE (SF_6)	NE		NE
2.G.3	N2O from Product Uses									NE (N_2O)	NE		NE
2.G.4	Other (Please specify)												
2.H	Other												
2.H.1	Pulp and Paper Industry												
2.H.2	Food and Beverages Industry												
2.H.3	Other (please specify)												
3	Agriculture, Forestry, and Other Land Use												
3.A	Livestock												
3.A.1	Enteric Fermentation					TI	ZIMSTA T	IPCC	IPCC				
3.A.2	Manure Management					TI	ZIMSTA T	IPCC	IPCC	TI	ZIMSTA T	CS	IPCC
3.B	Land												
3.B.1	Forest land	TI	F.COM	IPCC	IPCC								
3.B.2	Cropland	TI	F.COM ZIMSTAT	IPCC	IPCC								
3.B.3	Grassland	TI	F.COM	IPCC	IPCC								
3.B.4	Wetlands	TI	F.COM	IPCC	IPCC								
3.B.5	Settlements	TI	F.COM	IPCC	IPCC								
3.B.6	Other Land	TI	F.COM	IPCC	IPCC								
3.C	Aggregate sources and non-CO2 emissions sources on land												
3.C.1	Emissions from biomass burning	TI	EMA ZIMSTAT	IPCC	IPCC								
3.C.2	Liming	TI	ZIMSTAT	IPCC	IPCC								
3.C.3	Urea application	TI	ZIMSTAT	IPCC	IPCC								
3.C.4	Direct N2O Emissions from managed soils									TI	ZIMSTA T	IPCC	IPCC
3.C.5	Indirect N2O Emissions from managed soils									TI	ZIMSTA T	IPCC	IPCC
3.C.6	Indirect N2O Emissions from manure management									TI	ZIMSTA T	IPCC	IPCC
3.C.7	Rice cultivation					TI	FAO	IPCC	IPCC				
3.C.8	Other (please specify)												
3.D	Other												
3.D.1	Harvested Wood Products	TI	FAO	IPCC	IPCC								
3.D.2	Other (please specify)												
4	Waste												
4.A	Solid Waste Disposal					TI	ZIMSTAT, EMA, UNEP, FAO, WB,LA						
4.B	Biological Treatment of Solid Waste					TI	ZIMSTA T		D	TI	ZIMSTA TZIMSTAT		D

Source and Sink Category		*Carbon dioxide (CO_2)*				*Methane (CH_4)*				*Nitrous oxide (N_2O)*			
		M	*AD*	*CF*	*EF*	*M*	*AD*	*CF*	*EF*	*M*	*AD*	*CF*	*EF*
4.C	Incineration and Open Burning of Waste	T1	ZIMSTAT		D	T1	ZIMSTA T		D	T1	ZIMSTA TZIMSTAT		D
4.D	Wastewater Treatment and Discharge					T1	LA		D	T1	LA,FAO		D
4.E	Other (please specify)												
5	Other												
5.A	Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3												
5.B	Other (please specify)												
	Memo Items (5)												
	International Bunkers												
1.A.3.a.i	International Aviation (International Bunkers)	T1	IEA	IEA	D	T1	IEA	IEA	D	T1	IEA	IEA	D
1.A.3.d.i	International water-borne navigation (International bunkers)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.5.c	Multilateral Operations												

T1 *= IPCC Tier 1 methodological approach;* ***AD*** *= Activity Data;* ***CF*** *= Conversion Factor;* ***EF*** *= Emission Factor;* ***F. COM*** *= Forestry Commission;* ***USGS****=United States Geological Survey;* ***MMCZ*** *= Minerals Marketing Corporation of Zimbabwe;* ***ZIMSTAT*** *= Zimbabwe National Statistics Agency;* ***EMA*** *= Environmental Management Agency;* ***MoEPD*** *= Ministry of Energy and Power Development;* ***CP*** *= Cement Producers;* ***GP*** *= Glass Producers;* ***NAPr*** *= Nitric Acid Producers;* ***ISP*** *= Iron and Steel Producers;* ***D*** *= IPCC Default;* ***LA*** *= Local Authority;* ***IEA*** *= International Energy Agency;* ***FAO*** *= Food and Agriculture Organisation of the United Nations,* ***WB*** *= World-Bank;* ***NE*** *= Not estimated;* ***NO*** *= Not occurring;* ***NA*** *= Not Applicable*

Where emissions were not estimated (NE), the main reason was lack of activity data.

2.3.2 Selection of Approach for Calculating GHG Emissions/Removals

Prior to data entry into the 2006 IPCC software, activity data and emission factors obtained from data providers, IPCC Emission Factor Database (EFDB) and previous National Communications were entered manually into Excel worksheets. All the data was then entered into the 2006 IPCC software for the computation of CO_2, CH_4, N_2O and HFC emissions and removals. For CO, NO_x, SO_2 and non-methane volatile organic compounds (NMVOC) the emissions were estimated using the Low Emissions Analysis Platform (LEAP). LEAP is a widely-used software tool for energy policy analysis and climate change mitigation assessment. The emission factors for the pre-cursor gases were obtained from the 2019 EMEP/EEA emission inventory guidebook and the 2006 IPCC Guidelines.

2.3.3 Reference Approach

For the energy sector CO_2 emissions from fuel combustion were calculated using both the sectoral and reference approaches. The results of the calculation and explanations are presented in the energy section. Data for the sectoral approach was obtained from the Ministry of Energy and Power Development (MoEPD) while that for the reference approach was obtained from the energy balances compiled by the International Energy Agency (IEA).

2.3.4 Completeness of Data

There has been an improvement in data completeness between the current reporting period and that of the TNC, however, more still needs to be done to improve the quality of the data. In the current inventory, trend analysis was done for the period from 1990 to 2017. Lack of records and poor record keeping systems at company level has continued to contribute to data gaps. To ensure accuracy and completeness in data collection; questionnaires, interviews and discussions were conducted with both primary and secondary data source providers. Other reasons that also affected completeness of data relate to restriction due to legislation on disclosure of information. The Census and Statistics Act [Chapter 10:29], 2007 does not allow release of data and information by the national statistical agency in circumstances where there are less than three companies in a sector. To address the data gaps, interpolation was used and surrogate data, for example, population data where appropriate, was used to estimate the missing activity data.

2.3.5 Data Quality Control and Quality Assurance

Zimbabwe does not currently have a Quality Assurance and Quality Control (QA/QC) plan. In the TNC the US/EPA QA/QC guidebook was used as the reference tool. The quality of the current inventory was improved through applying general and category specific QA/QC procedures provided in the 2006 IPCC Guidelines. In addition to applying the QA/QC procedures from the 2006 IPCC Guidelines, the incorporation of the recommendations from the international review of the TNC by a team of experts from the UNFCCC in February 2020 also assisted. Considerable attempt was made to improve the quality of activity data by engaging the data providers and having them participate in joint training on GHG inventory compilation using the 2006 IPCC Guidelines and Inventory Software.

2.4 GHG Emissions/Removals and Trends

2.4.1 Zimbabwe's GHG Inventory for the Year 2010

Table 2.2 shows the national GHG inventory for Zimbabwe by gas for the report year 2010, while Figure 2.1 shows the relative contribution of each source and sink category for the same year. The total national GHG emissions in 2010 was 60,743.64 Gg CO_2 eq., while total national GHG removals in the same year was 22,799.63 Gg CO_2 eq., giving a net total of 37,944.01 Gg CO_2 eq. Thus, country was able to remove 37.5% of its total GHG emissions largely through the increase in carbon stocks in forest land. Emissions from Cropland (3.B.2) and Grassland (3.B.3) contributed significantly to the net emissions as a result the considerable loss in carbon stocks due to land use change from forestland to cropland and grassland (Figure 2.1).

Table 2.2: National GHG Inventory 2010

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO2
Total National Emissions and Removals	19,048.36	492.58	26.46	348.40	0.00	0.00	0.00	0.00	2,573.53	2,993.68	5,858.62	189.42
1 - Energy	8,510.73	89.46	1.28	0.00	0.00	0.00	0.00	0.00	394.33	268.1	1,589.64	189.42
1.A - Fuel Combustion Activities	8,510.73	84.55	1.28	0.00	0.00	0.00	0.00	0.00	1805.8	242.05	1,589.27	189.42
1.A.1 - Energy Industries	3,976.62	0.10	0.06						215.87	24.28	0.03	24.43
1.A.2 - Manufacturing Industries and Construction	1,127.51	0.25	0.03						3.19	12.62	2.49	9.42
1.A.3 - Transport	1,351.04	0.28	0.08						0.38	2.05	0.21	NE
1.A.4 - Other Sectors	2,055.56	83.93	1.10						174.89	229.15	1,586.75	155.57
1.A.5 - Non-Specified	NE	NE	NE						NE	NE	NE	NE
1.B - Fugitive emissions from fuels	0.00	4.91	0.00	0.00	0.00	0.00	0.00	0.00	NE	NE	0.16	NE
1.B.1 - Solid Fuels	0.00	4.91	0.00						NE	NE	0.16	NE
1.B.2 - Oil and Natural Gas	NO	NO	NO						NO	NO	NO	NO
1.B.3 - Other emissions from Energy Production	NO	NO	NO						NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.C.1 - Transport of CO2	NO								NO	NO	NO	NO
1.C.2 - Injection and Storage	NO								NO	NO	NO	NO
1.C.3 - Other	NO								NO	NO	NO	NO
2 - Industrial Processes and Product Use	528.51	0.00	0.65	348.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A - Mineral Industry	314.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0.00	4.27	0.00
2.A.1 - Cement production	313.53								NE	NE	NE	NE
2.A.2 - Lime production	0.00								NE	NE	NE	NE
2.A.3 - Glass Production	0.54								NE	NE	NE	NE
2.A.4 - Other Process Uses of Carbonates	0.43								NE	NE	NE	NE
2.A.5 - Other (please specify)	0.00	0.00	0.00						NE	NE	NE	NE
2.B - Chemical Industry	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.1 - Ammonia Production	0.00								NO	NO	NO	NO
2.B.2 - Nitric Acid Production			0.65						NE	NE	NE	NE
2.B.3 - Adipic Acid Production			NO						NO	NO	NO	NO
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			NO						NO	NO	NO	NO
2.B.5 - Carbide Production	0.00	0.00							NO	NO	NO	NO

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO2
2.B.6 - Titanium Dioxide Production	0.00								NO	NO	NO	NO
2.B.7 - Soda Ash Production	NO								NO	NO	NO	NO
2.B.8 - Petrochemical and Carbon Black Production	NO	NO							NO	NO	NO	NO
2.B.9 - Fluorochemical Production				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.10 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	202.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.1 - Iron and Steel Production	1.48	0.00							NE	NE	NE	NE
2.C.2 - Ferroalloys Production	200.64	0.00							NE	NE	NE	NE
2.C.3 - Aluminium production	NO				NO			NO	NO	NO	NO	NO
2.C.4 - Magnesium production	NO					NO		NO	NO	NO	NO	NO
2.C.5 - Lead Production	NO								NO	NO	NO	NO
2.C.6 - Zinc Production	NO								NO	NO	NO	NO
2.C.7 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use	11.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D.1 - Lubricant Use	10.08								NE	NE	NE	NE
2.D.2 - Paraffin Wax Use	1.82								NE	NE	NE	NE
2.D.3 - Solvent Use									NE	NE	NE	NE
2.D.4 - Other (please specify)	0.00	0.00	0.00						NE	NE	NE	NE
2.E - Electronics Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.1 - Integrated Circuit or Semiconductor				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display					NO	NO	NO	NO	NO	NO	NO	NO
2.E.3 - Photovoltaics					NO			NO	NO	NO	NO	NO
2.E.4 - Heat Transfer Fluid					NO			NO	NO	NO	NO	NO
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0.00	0.00	0.00	348.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.1 - Refrigeration and Air Conditioning				348.40				NE	NE	NE	NE	NE
2.F.2 - Foam Blowing Agents				NE				NE	NE	NE	NE	NE
2.F.3 - Fire Protection				NE	NE			NE	NE	NE	NE	NE
2.F.4 - Aerosols				NE				NE	NE	NE	NE	NE
2.F.5 - Solvents				NE	NE			NE	NE	NE	NE	NE

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO2
2.F.6 - Other Applications (please specify)				NE	NE			NE	NE	NE	NE	NE
2.G - Other Product Manufacture and Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G.1 - Electrical Equipment					NE	NE		NE	NE	NE	NE	NE
2.G.2 - SF6 and PFCs from Other Product Uses					NO	NO		NO	NO	NO	NO	NO
2.G.3 - N2O from Product Uses			NE						NO	NO	NO	NO
2.G.4 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H.1 - Pulp and Paper Industry	NE	NE							NE	NE	NE	NE
2.H.2 - Food and Beverages Industry	NE	NE							NE	NE	NE	NE
2.H.3 - Other (please specify)	NE	NE	NE						NE	NE	NE	NE
3 - Agriculture, Forestry, and Other Land Use	10,008.44	377.15	24.39	0.00	0.00	0.00	0.00	0.00	47.61	2,751.63	0.00	0.00
3.A - Livestock	0.00	204.04	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1 - Enteric Fermentation		196.46							NE	NE	NE	NE
3.A.2 - Manure Management		7.58	0.26						NE	NE	NE	NE
3.B - Land	9,800.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1 - Forest land	-22,799.63								NE	NE	NE	NE
3.B.2 - Cropland	15,479.71								NE	NE	NE	NE
3.B.3 - Grassland	16,729.09								NE	NE	NE	NE
3.B.4 - Wetlands	164.18		0.00						NE	NE	NE	NE
3.B.5 - Settlements	104.42								NE	NE	NE	NE
3.B.6 - Other Land	122.70								NE	NE	NE	NE
3.C - Aggregate sources and non-CO2 emissions sources on land	24.21	173.11	24.13	0.00	0.00	0.00	0.00	0.00	47.61	2,751.63	0.00	0.00
3.C.1 - Emissions from biomass burning		173.03	5.27						47.61	2,751.63	NE	NE
3.C.2 - Liming	3.20								NE	NE	NE	NE
3.C.3 - Urea application	21.01								NE	NE	NE	NE
3.C.4 - Direct N2O Emissions from managed soils			15.10						NE	NE	NE	NE
3.C.5 - Indirect N2O Emissions from managed soils			3.73						NE	NE	NE	NE
3.C.6 - Indirect N2O Emissions from manure management			0.03						NE	NE	NE	NE
3.C.7 - Rice cultivation		0.07							NE	NE	NE	NE

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO2
3.C.8 - Other (please specify)		NE	NE						NE	NE	NE	NE
3.D - Other	183.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.1 - Harvested Wood Products	183.76								NE	NE	NE	NE
3.D.2 - Other (please specify)	NE	NE	NE						NE	NE	NE	NE
4 - Waste	0.68	25.97	0.14						NE	NE	NE	NE
4.A - Solid Waste Disposal	0.00	21.61	0.00						NE	NE	NE	NE
4.B - Biological Treatment of Solid Waste	0.00	0.00	0.00						NE	NE	NE	NE
4.C - Incineration and Open Burning of Waste	0.68	0.29	0.00						NE	NE	NE	NE
4.D - Wastewater Treatment and Discharge	NE	4.07	0.14						NE	NE	NE	NE
4.E - Other (please specify)	NE	NE	NE						NE	NE	NE	NE
5 - Other	NE	NE	NE						NE	NE	NE	NE
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NE	NE	NE						NE	NE	NE	NE
5.B - Other (please specify)	NE	NE	NE						NE	NE	NE	NE
Memo Items												
International Bunkers	19.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a.i - International Aviation (International Bunkers) (1)	19.75	NE	NE						NE	NE	NE	NE
1.A.3.d.i - International water-borne navigation (International bunkers) (1)	NO	NO	NO						NO	NO	NO	NO
1.A.5.c - Multilateral Operations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key

NO: *Not occurring;* ***NE****-Not estimated;*

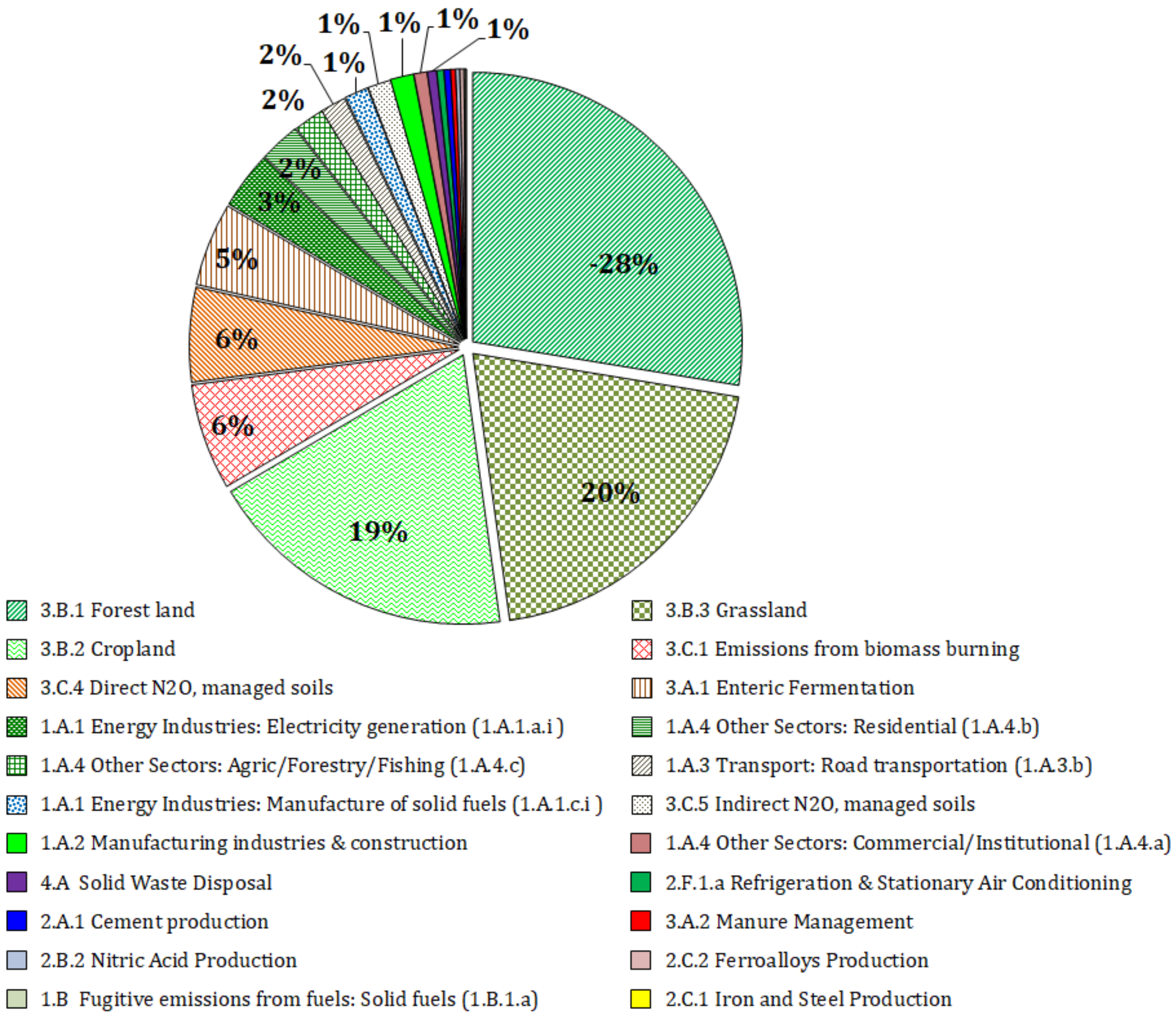


Figure 2.1: Total 2010 GHG emissions and removals with FOLU

2.4.2 GHG Emissions/Removals Trend

Figures 2.2 and 2.3 show emission and removal trends by gas and by sector, respectively, for the period 1990 to 2017. The trend shows a gradual decrease in the GHG removal between 1990 and 2009, followed by a considerable decrease in the sinks in 2010. The decrease in GHG sink between 1990 and 2017 (total removals range: -58,624.42 to -22,799.63 Gg CO_2 eq./year) corresponds to the increase in annual area of forest land that is disturbed largely due to forest fires and removal of vegetation due to changes in land use. On the other hand, total GHG emissions (emissions range: 53,668.16 to 63,284.29 Gg CO_2 eq./year) have shown no definite trend over the period from 1990 to 2017, which may be attributed to random changes in the country's economy that affect production and consumption trends.

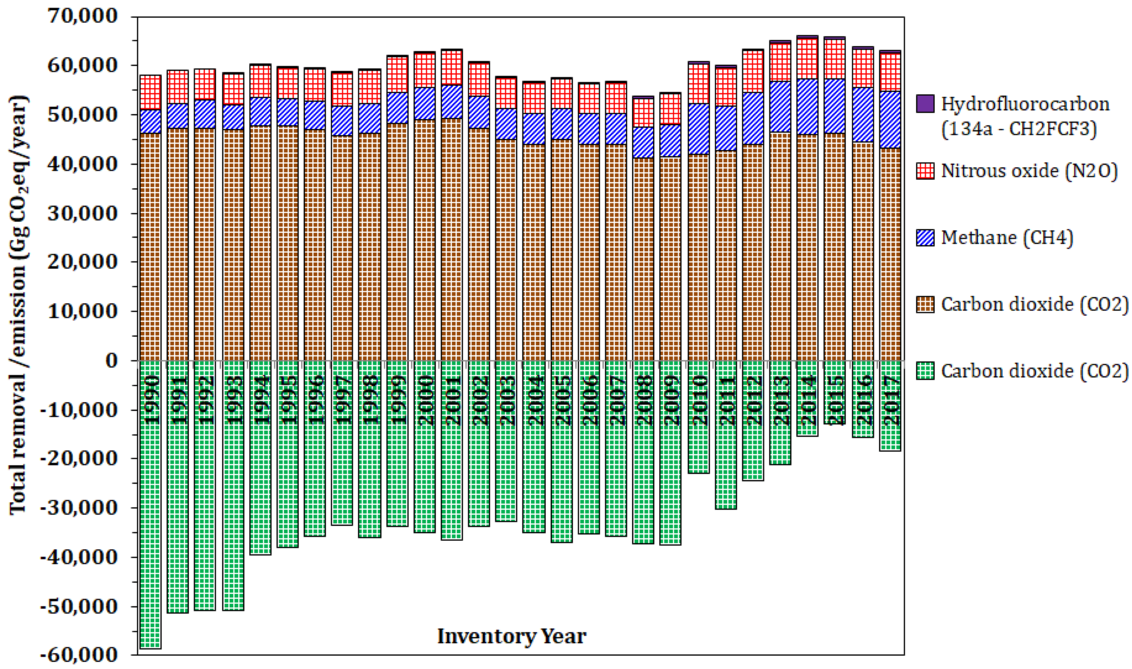


Figure 2.2: GHG Emission Trend by Gas for the Period 1990 to 2017

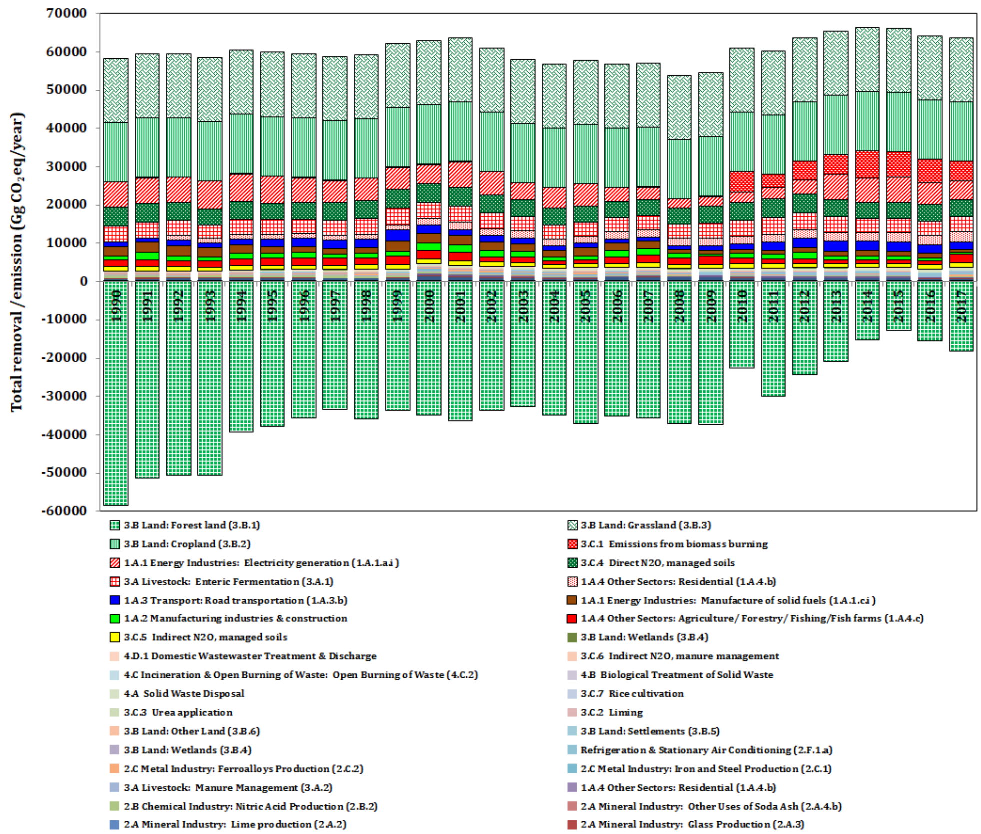


Figure 2.3: GHG Emission Trend by Sector for the period 1990 to 2017

The net total GHG emissions are shown in Figure 2.4, and shows that the country seized to be a net sink of GHG emissions in 1990 (-647.70 Gg CO_2 eq.). During the period from 1991 – 2009, GHG emissions have been maintained between 5,000 and 26,000 Gg

CO_2eq. After 2009 the emissions increased gradually to year 2015 (53,016.81Gg CO_2eq) which was the highest estimate of the emissions in the whole time series.

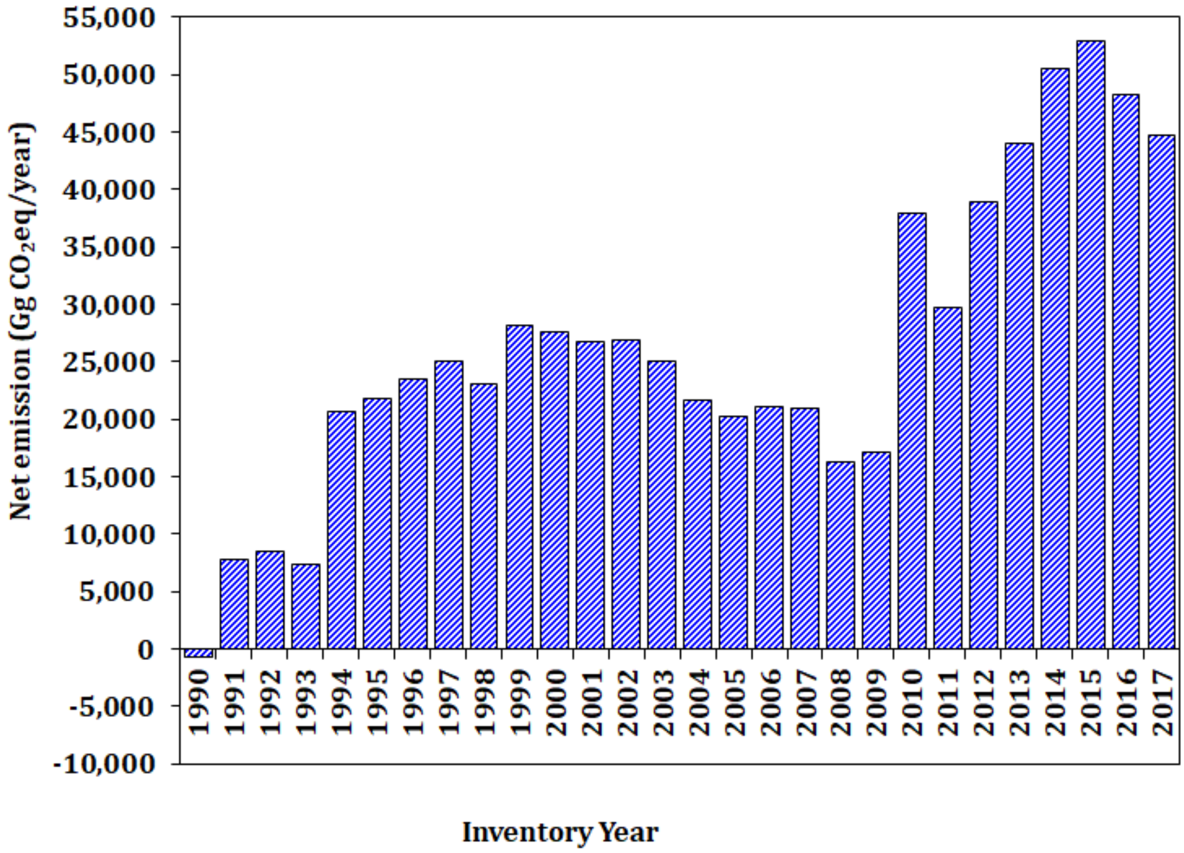


Figure 2.4: Net total GHG Emission Trend for the period 1990 to 2017

The Sector AFOLU contributed significantly to the spikes in GHG emissions from the year 2010, and this was largely due to emissions from biomass burning on forestland. An analysis of the time series emissions indicates a general increase in GHG over time (Table 2.5. and Table 2.6. The trend generally followed the performance of the Zimbabwean economy.)

Table 2.3: Total aggregate GHG Emissions and Removals by Year and Gas (Gg)

Gas	***Emissions/Removals by year (Gg)***					***Change: 1994-2017 (%)***	***Change: 2000-2017 (%)***
	1994	***2000***	***2006***	***2010***	***2017***		
Net CO_2	14,754.30	14,884.35	10,803.45	8,510.73	9,863.58	-33.1	-33.7
CH_4	276.08	317.77	296.34	492.58	543.66	96.9	71.1
N_2O	21.12	22.68	19.33	26.46	25.74	21.9	13.5
HFCs (CO_2 eq)	9.15	86.82	209.82	348.40	546.54	5,873.1	529.5
Total emissions CO_2 eq	60,149.18	62,732.68	56,405.79	60,743.64	63,191.86	5.1	0.7
Total removals (CO_2 eq)	-39,479.70	-35,063.40	-35,298.60	-22,799.60	-18,447.90	-53.3	-47.4
Net (CO_2 eq)	20,669.46	27,669.31	21,107.25	37,944.02	44,744.00	116.5	61.7

Table 2.4: GHG emissions by sector in CO_2eq

Sectors	***Emissions/Removals by year (Gg CO_2 eq))***					***Change: 1994-2017 (%)***	***Change: 2000-2017 (%)***
	1994	***2000***	***2006***	***2010***	***2017***		
Energy	16,407.0	17,094.3	13,025.4	10,785.51	13,777.54	-16.0	-19.4
IPPU	863.90	1,768.176	1,102.47	1,077.82	1,447.05	67.5	-18.2
AFOLU	3,134.36	8,361.53	6,362.24	25,489.7	28,746.3	817.1	243.8
Waste	264.17	445.30	617.06	590.90	773.03	192.6	73.6
Net (CO_2 eq)	20,669.4	27,669.31	21,107.25	37,944.0	44,744.0	116.5	61.7

2.4.3 Key Category Analysis with FOLU

Key category analysis was carried out using both approaches 1 (level analysis) and 2 (trend analysis) and the results are shown in Table 2.5 and
Table 2.6, respectively. Key categories were largely dominated by CO_2 emissions from AFOLU. Over 60%of the GHG emissions in the key category came from FOLU. Energy contributed around 11% to the key categories and the emissions came from power generation (1A1), road transport (1A3.b), combustion of biomass in agriculture (1.A.4.c) and commercial (1.A.4.a). Enteric fermentation in Agriculture (3.A.1) contributing around 7%.

Table 2.5: Key Categories with FOLU-Level Assessment 2010

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2010 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.B.1.b	Land Converted to Forest land	CARBON DIOXIDE (CO2)	-24,524.15	24,524.15	0.25	25%
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	23,242.97	23,242.97	0.24	49%
3.B.3.b	Land Converted to Grassland	CARBON DIOXIDE (CO2)	19,357.20	19,357.20	0.20	68%
1.A.1	Energy Industries - Solid Fuels	CARBON DIOXIDE (CO2)	4,753.03	4,753.03	0.05	73%
3.A.1	Enteric Fermentation	METHANE (CH4)	4,193.59	4,193.59	0.04	77%
3.C.4	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	3,915.40	3,915.40	0.04	81%
3.C.1	Emissions from biomass burning	METHANE (CH4)	3,633.68	3,633.68	0.04	85%
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-3,528.90	3,528.90	0.04	89%
1.A.4	Other Sectors - Biomass	METHANE (CH4)	1,696.05	1,696.05	0.02	90%
3.C.1	Emissions from biomass burning	NITROUS OXIDE (N2O)	1,632.84	1,632.84	0.02	92%
1.A.4	Other Sectors - Solid Fuels	CARBON DIOXIDE (CO2)	1,378.98	1,378.98	0.01	93%
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	995.65	995.65	0.01	94%
3.C.5	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	953.41	953.41	0.01	95%

Notes

Lx – Level assessment for source or sink

Ex – Absolute value of emission or removal

t – Refers to the inventory year

The key categories in terms of trend analysis were dominated by land conversions between forestland, grassland and cropland, contributing over 70%. The other sectors that were significant in terms of trend include emissions from:

- Biomass burning
- Energy Industries - Solid Fuels
- Other Sectors - Biomass
- Enteric Fermentation
- Road Transportation
- Manufacturing Industries and Construction - Solid Fuels
- Other Sectors - Solid Fuels

Table 2.6: Key Category due to Trend Analysis -2000 to 2017

IPCC Category code	IPCC Category	Greenhouse gas	1990 Year Estimate Ex0 (Gg CO2 Eq)	2010 Year Estimate Ext (Gg CO2 Eq)	Trend Assessment (Txt)	% Contribution to Trend	Cumulative Total of Column G
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-39,344.58	-3,528.90	2.01	29%	29%
3.B.1.b	Land Converted to Forest land	CARBON DIOXIDE (CO2)	-24,533.26	-24,524.15	1.44	21%	50%
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	23,242.97	23,242.97	1.36	20%	70%
3.B.3.b	Land Converted to Grassland	CARBON DIOXIDE (CO2)	19,357.20	19,357.20	1.14	17%	87%
3.C.4	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	4,218.70	3,915.40	0.25	4%	90%
3.A.1	Enteric Fermentation	METHANE (CH4)	4,197.48	4,193.59	0.25	4%	94%
3.C.1	Emissions from biomass burning	NITROUS OXIDE (N2O)	1,222.51	1,632.84	0.07	1%	95%

2.4.4 Uncertainty Analysis

Uncertainties analysis was performed in the IPCC Inventory Software Version 2.691.7327 of 2020 employing error propagation approach.

2.4.5 Recalculations

All sectors performed recalculations since in the TNC GWPs were used. Further, the Revised 1996 IPCC Guidelines were used in the TNC while in the NC4 the 2006 Guidelines were used. Data quality improvements, especially in FOLU and IPPU, also resulted in recalculations.

2.4.6 Planned Improvements

The main planned improvements relate to;

- strengthening the institutional and procedural arrangements for the GHG system,
- capacity building on uncertainty analysis,
- strengthening the QA/QC system,
- establishing an archiving system and;
- addressing identified data gaps, sector specific constraints, gaps and planned improvements are given later in the respective sectors.

2.5 Sectoral Emissions

2.5.1 Energy Sector

2.5.1.1 Sector Overview

Zimbabwe's energy portfolio is dominated by biofuels. The total energy consumption for the country is shown in Figure 2.4. Energy consumption increased by 15%, but the energy consumption per capita decreased by 4% between 2000 and 2017. This is because the population increased much faster (i.e. 20%) than the rate at which energy was supplied. Moreover, the contribution in the energy mix of the renewables and waste rose from 65% to 80%. Coal contribution dropped from 14% to 3%, while oil remained at 11%.

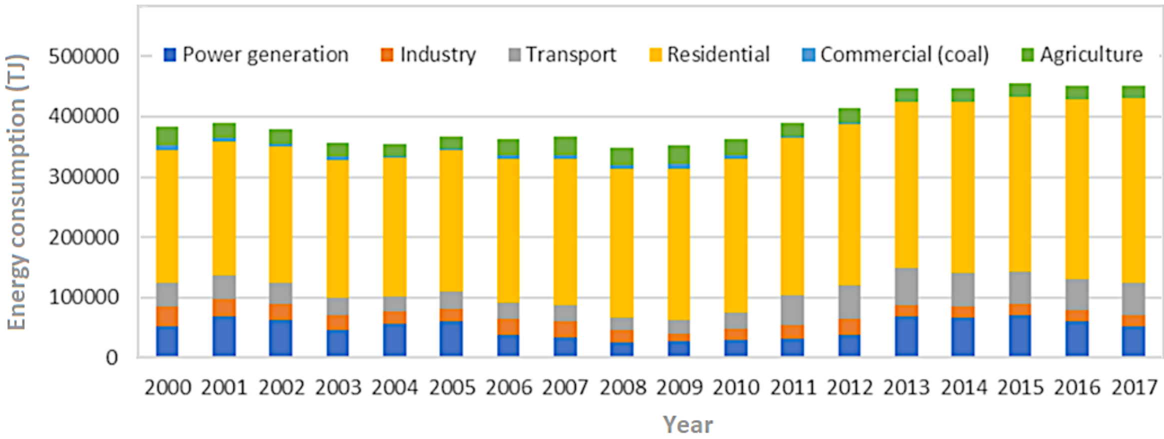


Figure 2.4: National energy consumption for the period 2000-2017 (MoEPD, 2019)

Electricity contribution dropped from 10% in 2000 to 7% in 2017. Zimbabwe has been experiencing very serious energy shortages as indicated by the low energy consumption per capita figures for both total energy and commercial energy. The decreasing emission trends shown in Figure 2.5 are attributable, to a greater extent, to decreasing energy supply and consumption. While the total emissions decreased by 24 percent, the Energy industries, Transport and Non-specified categories increased by 1, 16 and 11 percent, respectively, during the period 2000-2017. The emissions from the Manufacturing Industries & Construction (MIC), Other sectors (including Commercial, Residential and Agriculture) and Fugitive categories decreased by 60, 78 and 35 percent, respectively, during the same period.

Total GHG emissions from the Energy sector were highest in 2001 reaching 17,678.71Gg CO_2eq and lowest in 2008 at 10,299.45 Gg CO_2eq, closely reflecting the general performance of the economy. In 2010 the total GHG emissions were 10,785.51 Gg CO_2eq.

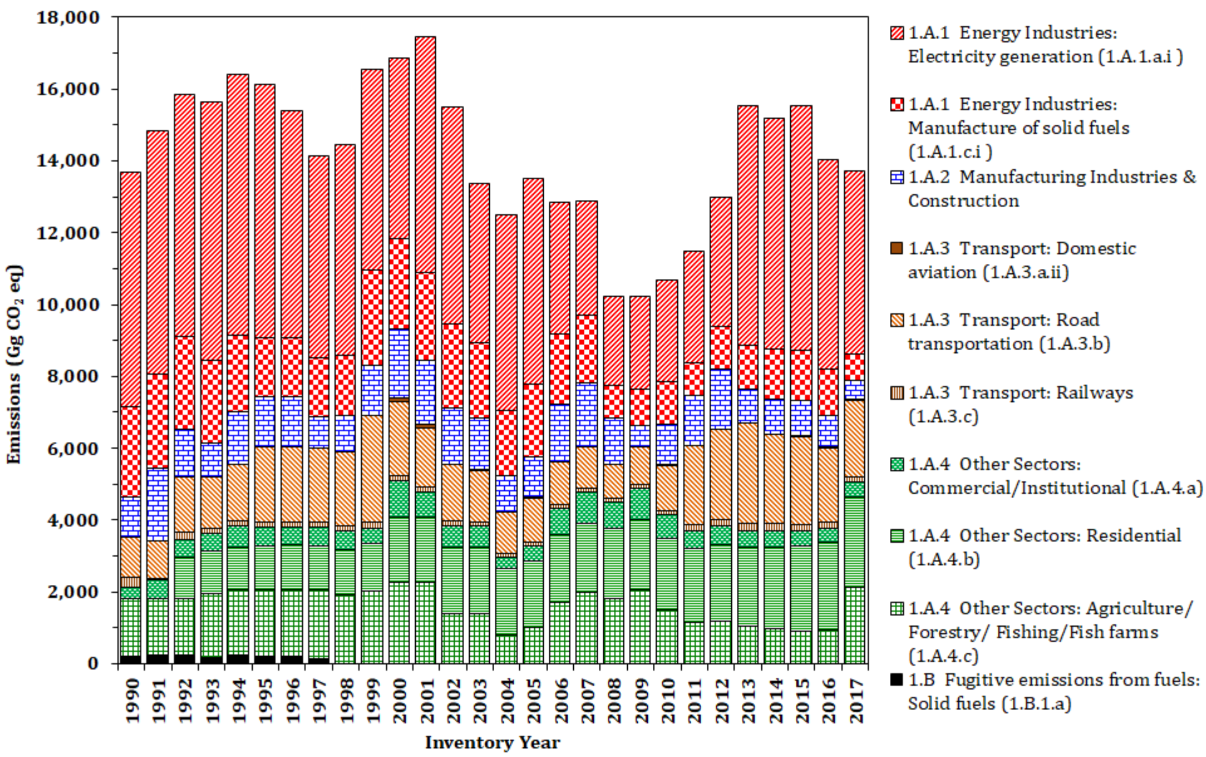


Figure 2.5: Emissions Trends by Category

2.5.1.2 Comparison between the Sectoral & Reference Approach

The sectoral emissions for the years 2000=2017 were compared with those of the reference approach as a QC measure.

2.5.1.3 Category Specific Recalculations

TNC data was obtained from the IEA. In the NC4, data was obtained from the MoEPD. Moreover, the 2006 IPCC Guidelines were used to estimate GHG emissions from the energy sector. The 2006 IPCC guidelines were also used in the TNC. The TNC used the Forth Assessment Report for the Global Warming Potential of CO_2, CH_4 and N_2O, while the BUR1 has used the GWP from the Second Assessment Report. Therefore, recalculations were performed for the reporting years 2000 (SNC) and 2006 (TNC) as shown in Table 2.7

Table 2.7: Energy Recalculated GHG emissions

Year	*Reported*	*Recalculated*	*Change (%)*
1994 (INC)	-	16,407.03	-
2000 (SNC)	13,240.00	17,094.3	29
2006 (TNC)	10,664.00	13,025.48	22
2010 (NC4)	10,785.51	10,785.51	-

2.5.1.4 Category Specific QA/QC Activities

Comparison was made between data obtained from the MoEPD and international sources (IEA and UNSD) for QC and verification. The uncertainties were calculated using the IPCC inventory software. However, the quality of the output was low since most data was supplied without specifying the uncertainties.

2.5.1.5 Proposed Future Improvements

The following key challenges were identified during the compilation of Energy Sector GHG inventory:

- Inadequate data on charcoal and firewood.
- Lack of disaggregated data on energy consumed in industry
- Weak institutional arrangements to regularly provide relevant data on energy minerals and fuels.
- Weak institutional arrangements to capture aviation data covering fuel and landings and take-offs (LTOS).
- Lack of disaggregated data on fuel sales or use by major consumers

In light of the listed challenges the following future improvements are planned for the Energy Sector inventory compilation:

- Capacitate the Forestry Commission and ZIMSTAT to be able to collect data on all charcoal and firewood produced in the country
- Capacitate the data providers (MoEPD, Zimbabwe Energy Regulation Authority (ZERA) and ZIMSTAT) to be able to collect and record energy consumed in industry by fuel and by year, disaggregating by industry category using standardised classifications.
- Strengthen the institutional arrangements in the Energy Minerals and Value Addition departments in the Ministry of Mines to regularly provide relevant data on energy minerals and fuels.
- Build capacity for Civil Aviation Authority of Zimbabwe (CAAZ), ZERA and MoTID and ZIMSTAT to capture aviation data covering fuel and LTOS by each aeroplane for both public and private run airlines.
- Capacitate ZERA to collect and avail data on fuel sales or use by major consumers.

2.5.2 Industrial Processes and Product Use (IPPU)

2.5.2.1 IPPU Overview

The IPPU Sector covers non-energy GHG emissions arising from manufacturing processes such as chemical and metal production and also the use of products, such as use of HFCs as replacement refrigerants for ozone-depleting substances (ODSs). In this inventory, GHG emissions from the IPPU sector were estimated from five source categories: Mineral (2A), Chemical (2B), Metal (2C) industries, non-energy products from fuels and solvent use (2D) .and Product Uses as Substitutes of ODS (2F). Other activities within the IPPU sector were excluded from the inventory due to unavailability of activity data.

2.5.2.2 Emissions by Sector

In 2010 the IPPU sector contributed 1,077.39 Gg CO_2 eq. which is 3.38 % of the national GHG emissions (31,908.11 Gg CO_2 eq.). The mineral industry (2A.) contributed 314.50 Gg CO_2 eq. (29.18 %) to the total IPPU sector GHG emissions. The chemical industry (2B.) contributed 200.91 Gg CO_2 eq. (18.64 %), the metal industry (2C.) contributed 202.12 Gg CO_2 eq. (18.75 %), Non-Energy Products from Fuels and Solvent Use contributed about 11.90 Gg CO_2 eq. (1.10 %) and Product uses as Substitutes for ODS contributed 348.40 Gg CO_2 eq. (32.32 %) to the total IPPU sector emissions (Table 2.8).

Table 2.8: IPPU Sector GHG Emissions by Source Category Gg CO_2 eq

Source category	***2000***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***
2A. Mineral industry	449.52	312.66	283.18	291.45	292.64	301.90	314.07	384.05	407.28	403.32	408.08	430.42	184.19	380.05
2B. Chemical industry	464.57	264.55	257.90	254.93	141.29	103.87	200.91	181.70	132.11	142.39	167.22	151.71	9.94	79.80
2C. Metal industry	742.36	556.69	338.80	322.62	196.23	97.07	202.12	212.10	181.42	170.62	218.85	151.43	194.18	428.00
2D. Non-energy products from fuel and solvent use	3.90	10.41	9.10	7.81	5.30	10.14	11.90	13.02	13.58	12.96	11.99	13.77	11.81	11.78
2F. Product uses as substitutes for ODS	86.22	187.10	209.82	233.31	272.88	311.14	348.40	378.94	407.39	434.07	461.60	489.42	517.92	546.54
Total	**1,746.57**	**1,331.42**	**1,098.80**	**1,110.12**	**908.33**	**824.11**	**1,077.39**	**1,169.81**	**1,141.77**	**1,163..37**	**1,267.74**	**1,236.75**	**918.05**	**1,446.18**
Numbers may not sum exactly due to rounding off														
** Values too small and when rounded off become 0*														

Figure 2.6 shows a steady decrease in GHG emissions from year 2000 to 2009 followed by a slight increase in emissions in the year 2010 and 2011. However, between 2012 and 2017 an inconsistent trend in emissions was experienced. The GHG emissions were largely mainly influenced by economic performance. A significant dip decline in GHG emissions was experienced in 2016 when a major monetary policy shift occurred causing shocks in the economy. This resulted in depressed economic activity because of foreign currency challenges arising from the monetary policy change.

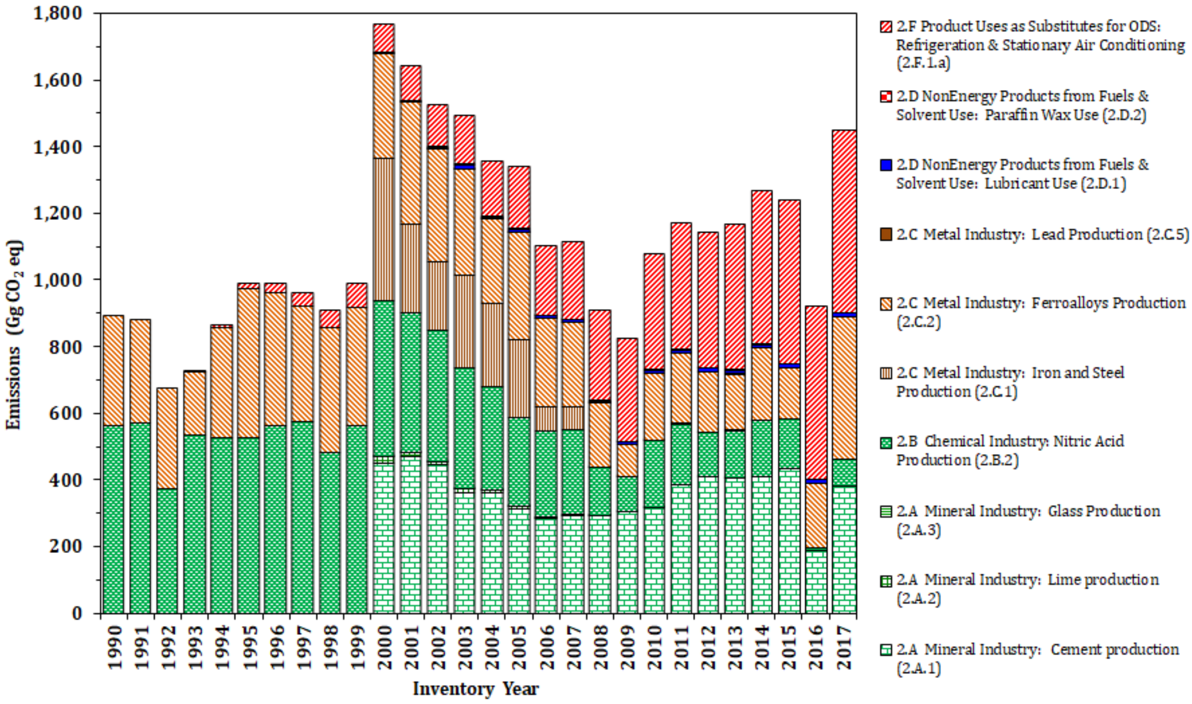


Figure 2.6: GHG Emissions in the IPPU-1990 to 2017

2.5.2.3 Emissions by Gas

Figure 2.7 shows the direct GHG emissions from the IPPU sector by gas from the period 2000 to 2017. With respect to N_2O, there was a decrease by 82.82% between 2000 and 2017. The decrease in emissions of both gases is mainly attributed to the reduction in industrial activities experienced by the country. Furthermore, the fertilizer industry has been experiencing stiff competition from cheap imports. The emissions of HFCs increased by 554.77% between 2000 and 2017 reflecting and increased use of the ODS refrigerants in the country. The emissions of Perfluorocarbons (PFCs), SF6 were not estimated due to unavailability of activity data.

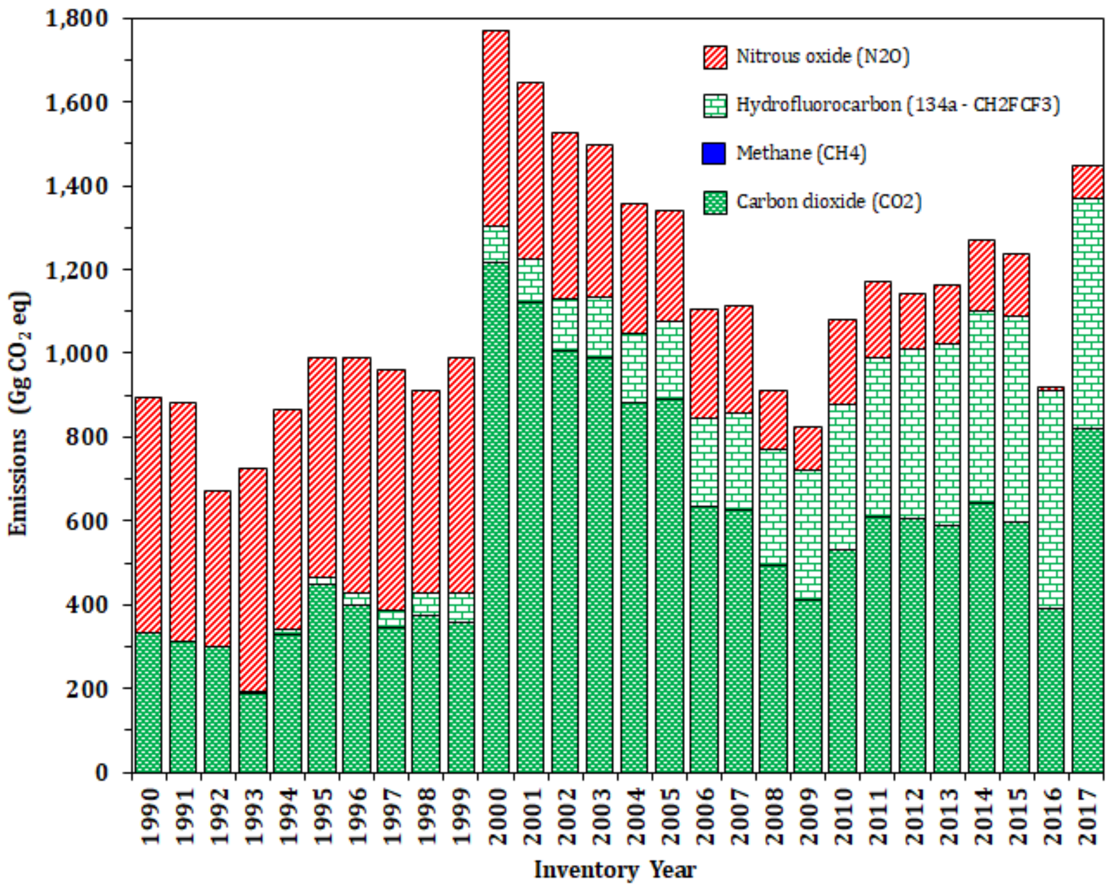


Figure 2.7: GHG Emissions from IPPU sector by gas from 1990-2017, Gg CO_2eq

2.5.2.4 Category Specific Recalculations

Recalculations were done in the cement sector due to use of a higher tier methodology. Recalculations were done for the source category other uses of soda ash (2.A.4.b) by subtracting the soda ash used in glass production from total soda ash used in the country. This was not considered in the TNC.

For nitric acid production, recalculations were done for the entire time series since the SAR GWP was used in this inventory compared to the 4AR GWP used in the TNC. Similar recalculations were done for CH_4 emissions in the iron and steel industry for the period 2000 to 2008. Recalculations were done for Non-energy products from fuels and product use (2D) since in the TNC, only imports were considered without accounting for exports. Recalculations were performed for the reporting years 2000 (SNC) and 2006 (TNC) as shown in Table 2.9: IPPU Recalculated GHG emissions (Gg CO2 eq).

Table 2.9: IPPU Recalculated GHG emissions (Gg CO_2 eq)

Year	Reported	Recalculated	Change (%)
1994 (INC)	-	863.90	-
2000 (SNC)	1,973.70	1,768.18	-10
2006 (TNC)	906.09	1,102.47	22
2010 (NC4)	1,077.82	1,077.82	-

2.5.2.5 Category Specific QA/QC Activities

General inventory QC procedures were conducted in accordance with the 2006 IPCC Guidelines Volume 1, Chapter 6. The general inventory QC involved checking the activity data, emission factors, analysis of emission trends and archiving of reference materials. Specific QC activities included checking with the energy sector to ensure that emissions were not double counted especially for coke production in the iron and steel industry and non-energy products and use. QA activities involved independent peer review with experts in the industry.

The IPPU sector benefited from international review of the TNC by experts from the UNFCCC/IPCC in February 2020. Recommendations from the review were used to improve on the quality of the inventory.

2.5.2.6 Proposed Future Improvements

The following key challenges were identified during the compilation of IPPU Sector GHG inventory:

- Emissions of PFCs and Sulphur Hexafluoride (SF_6) are currently not reported in NCs.
- Weak institutional arrangements and legislation to provide required data

In light of the listed challenges the following future improvements are planned for the IPPU Sector inventory compilation:

- Capacitate data providers to supply disaggregated activity data for estimating emissions of HFCs, PFCs and SF_6
- Set the institutional arrangements and legislation to ensure companies provide required data at scheduled times to meet the national inventory requirements.

2.5.3 Agriculture, Forestry and Other Land Use

2.5.3.1 AFOLU Overview

The GHG inventory in the AFOLU sector covers emissions and sinks from livestock farming, croplands, forests, grasslands, wetlands and settlements, under the following categories: Enteric fermentation (3.A.1), Manure Management (3.A.2), Forest land (3.B.1), Croplands (3.B.2), Grasslands (3.B.3), Wetlands (3.B.4), Settlements (3.B.5), Other lands (3.B.6), Emissions from Biomass Burning (3.C.1), Liming (3.C.2), Urea Application (3.C.3), Direct N_2O Emissions from Managed Soils (3.C.4), Indirect N_2O Emissions from Managed Soils (3.C.5), Indirect N_2O Emissions from Manure Management (3.C.6), Rice Cultivation (3.C.7) and Harvested Wood Products (3.D.1).

Net emissions from the AFOLU sector have been increasing in the past 30 years largely due to the shrinking carbon sinks (Figure 2.7) and (Figure 2.8). The major drivers of emissions and removals in this sector include deforestation due to agricultural expansion, fuelwood gathering, increased livestock, commercial logging, veld fires, harvesting construction timber, illegal settlements and mining, tobacco curing and charcoal making. Historically, the AFOLU sector was a net sink of GHG emissions up to 1994. Since then, the sector has now become a net emitter.

2.5.3.2 Emissions by Sub-Category

Over the period of 27 years the Forest land has between 310 and 55,087 Gg (mean: 30,210 ± 11,129 Gg) of CO_2 and the removal capacity has been decreasing rapidly to the lowest capacity in 2015. Concurrently, GHG emissions in the AFOLU sector have been increasing largely due to deforestation and biomass burning. Land Use Change has been a major contributor to GHG emissions in the AFOLU sector, particularly the conversion of Forest Land to Cropland and Grassland, and to a lesser extent, conversion of Forest Land to Settlement.

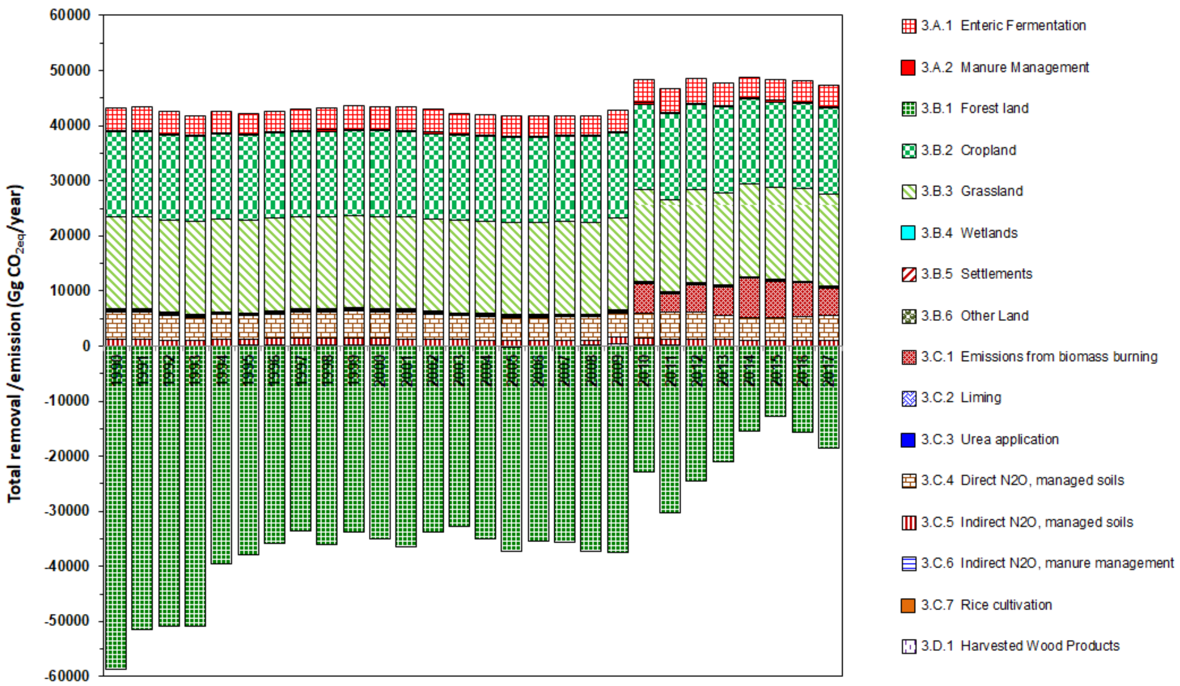


Figure 2.7: Total GHG Emissions and Removal in the AFOLU Sector (1990-2017)

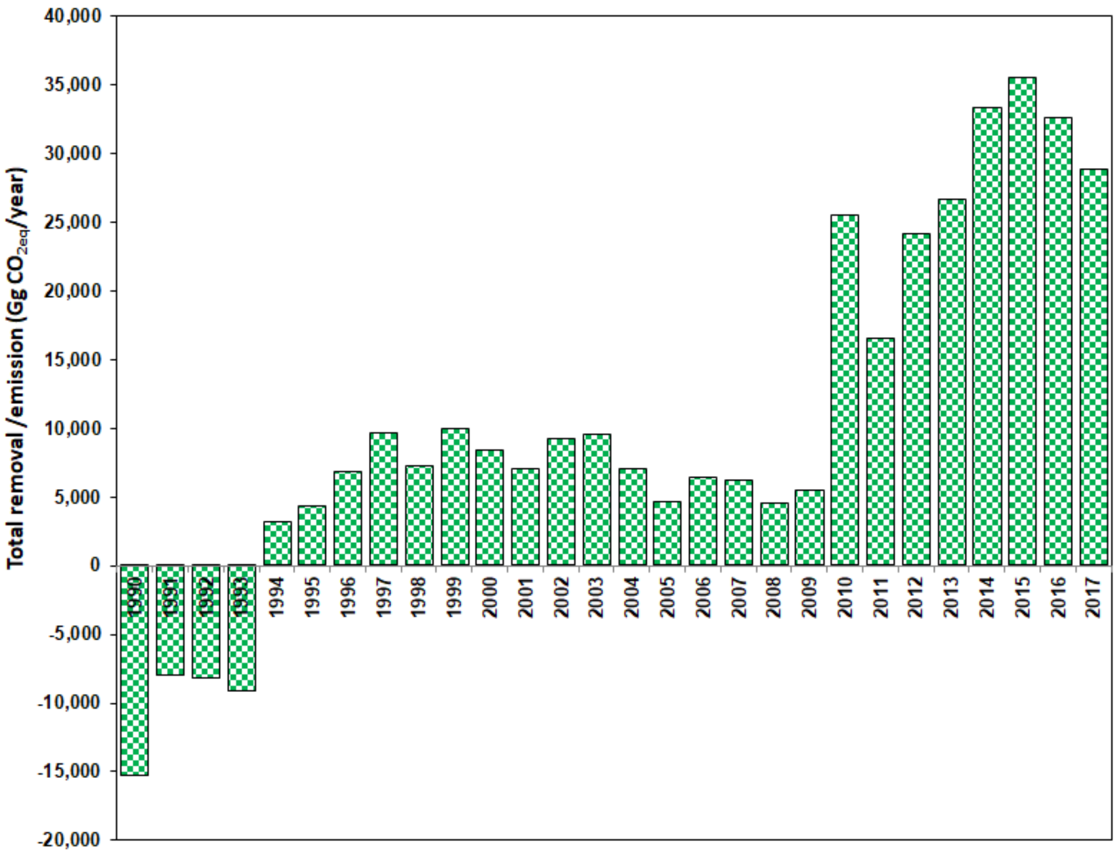


Figure 2.8: Net GHG Emissions and Removals in the AFOLU Sector (1990-2017)

In the year 2010 GHG emissions from the AFOLU sector were estimated at 42,989 Gg CO_2eq, while removals were estimated at 19,263 Gg CO_2, giving a net positive flux of 23,726 Gg CO_2eq (Figure 2.7, Figure 2.8 & Figure 2.9) Conversion of Forest Land to Grassland had the highest emission contribution of 17,342 Gg CO_2, that being 41% of the total emissions. This was followed by emissions from conversion of Forest Land to Cropland (18%), emissions from Biomass Burning (12%), Enteric Fermentation (10%), and Direct N_2O Emissions from Managed Soils (9%). The computation of emissions from Biomass Burning using local data was only possible from 2010 to 2017 due to lack of data in the earlier years. Despite the availability of international data on area burnt for the whole time series, its use was not possible because of incomparability with local datasets for the period 2010 to 2017.

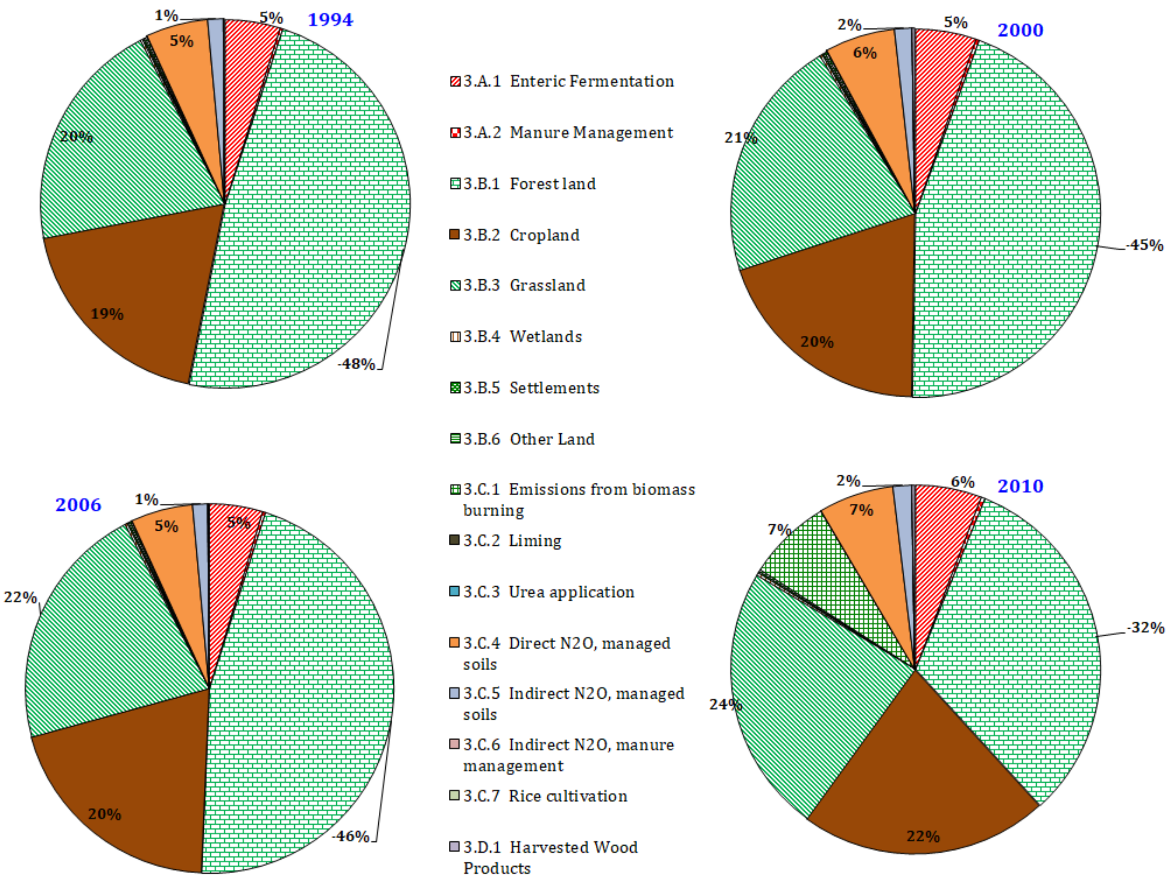


Figure 2.9: AFOLU Emissions by Categories in 2010

2.5.3.3 Emissions by Gas

Table 2.10 shows GHG emissions by gas from the AFOLU sector. Between the period 1994 to 2000 the emissions increased at a relatively gradual rate with CO_2 showing considerable increase in comparison with CH_4 and N_2O. Deforestation was the major driver of this change. Biomass burning was the major driver of GHG emissions responsible for the abrupt rise in emissions between 2000 and 2017.

Table 2.10: Emissions by Gas for the AFOLU Sector (1994-2017)

	Emissions (Gg/year)					*Change (%)*	
Gas	***1994***	***2000***	***2006***	***2010***	***2017***	***1994-2000***	***2000-2017***
CO_2	-6,768.75	-2,221.49	-2,756.94	10,008.44	14,117.09	-308.6	-735.5
CH_4	200.32	211.79	181.64	377.15	356.21	77.8	68.2
N_2O	18.38	19.79	17.11	24.39	23.06	25.5	16.5
NO_x	4.96	5.08	3.82	47.61	47.17	851.0	828.5
CO	182.68	186.90	184.67	2,751.63	2,625.68	1,337.3	1,304.9

2.5.3.4 Category Specific Recalculations

This, being the first time the AFOLU inventory was compiled using the 2006 IPCC Guidelines as well as the GWPs from the SAR, recalculations were done for all categories (Table 2.11). The previous inventories were conducted using the Revised 1996

IPCC Guidelines and by averaging activity data from multiple sources. In the current inventory the primary data providers were mainly ZIMSTAT, Environmental Management Agency (EMA), Forestry Commission and FAOSTAT.

Table 2.11: AFOLU Recalculated GHG emissions (Gg CO_2 eq)

Year	Reported	Recalculated	Change (%)
1994 (INC)	-	3,134.36	-
2000 (SNC)	21,959	8,361.53	-62
2006 (TNC)	9,686.38	6,362.24	-34
2010 (NC4)	25,489.79	25,489.79	-

2.5.3.5 Category Specific QA/QC Activities

The following procedures were followed to improve on the TACCC Principles:

- All procedures on selection of activity data and emission factors were peer reviewed and documented. The review ensured gap filling using recommended IPCC splicing methods and inclusion of justification for all methods selection
- While one primary source of activity data was selected, comparison of the computations with FAOSTAT computed emissions were done. In the case where the differences in emissions were considerable, explanation was given and documented.
- A capacity building workshop was undertaken involving participatory exchange of knowledge and information with data providers. The workshop provided background information to the activity data.
- Working workshops were held review the data and methods used in the AFOLU Sector.
- The AFOLU sector benefited from international review of the Third National Communication by experts from the UNFCCC/IPCC. Recommendations from the review were used to improve on the quality of the inventory.

2.5.3.6 Proposed Future Improvements

The following key challenges were identified during the compilation of AFOLU Sector GHG inventory:

- Absence of standardised templates and approaches for collecting livestock population.
- Inadequate financial resources to collect fire and land use data.
- Lack of disaggregated activity data and country-specific factors

In light of the listed challenges the following future improvements are planned for the AFOLU Sector inventory compilation:

- Standardisation of templates and approaches for collecting livestock population, fire and land use data
- Conduct a livestock census.

- Characterise feed and nutrition factors across the revised agro ecological regions.
- Survey for manure management systems across livestock sub-categories

2.5.4 Waste

2.5.4.1 Overview

In the Waste sector GHG emissions from source categories namely Solid Waste Disposal (4A), Biological Treatment of Solid Waste (4B), Incineration and Open Burning of Waste (4C) and Wastewater Treatment and Discharge (4D) are accounted for. The main source categories for the GHG emissions are solid waste disposal in landfill sites and wastewater treatment. Solid waste disposal is the key category within the waste sector, by level and trend analysis, contributing 87% of the total emissions in 2010, followed by Wastewater Treatment and Discharge at 11.5%. Open burning and Incineration of waste contributed the balance of 1.5%.

Table 2.12: GHG Emissions from the Waste Sector in 2010

Categories	Emissions [Gg]		
	CO_2	CH_4	N_2O
4 - Waste	0.680497075	25.96624074	0.144931494
4.A - Solid Waste Disposal	0	21.61376081	0
4.A.1 - Managed Waste Disposal Sites			
4.A.2 - Unmanaged Waste Disposal Sites			
4.A.3 - Uncategorised Waste Disposal Sites			
4.B - Biological Treatment of Solid Waste		NE	NE
4.C - Incineration and Open Burning of Waste	0.680497075	0.28507253	0.0037498
4.C.1 - Waste Incineration	NO	NO	NO
4.C.2 - Open Burning of Waste	0.680497075	0.28507253	0.0037498
4.D - Wastewater Treatment and Discharge	0	4.067407404	0.141181694
4.D.1 - Domestic Wastewaster Treatment and Discharge		4.067407404	0.141181694
4.D.2 - Industrial Wastewater Treatment and Discharge		NE	
4.E - Other (please specify)			

2.5.4.2 Emissions by Sub-sector

Since 1990, emissions from the waste sector gradually increased until 2005. Emissions were lower for the period 2006 to 2010 as shown in. Figure 2.10. The emissions trends are related the performance of the economy which in turn affects waste generation and collection rates.

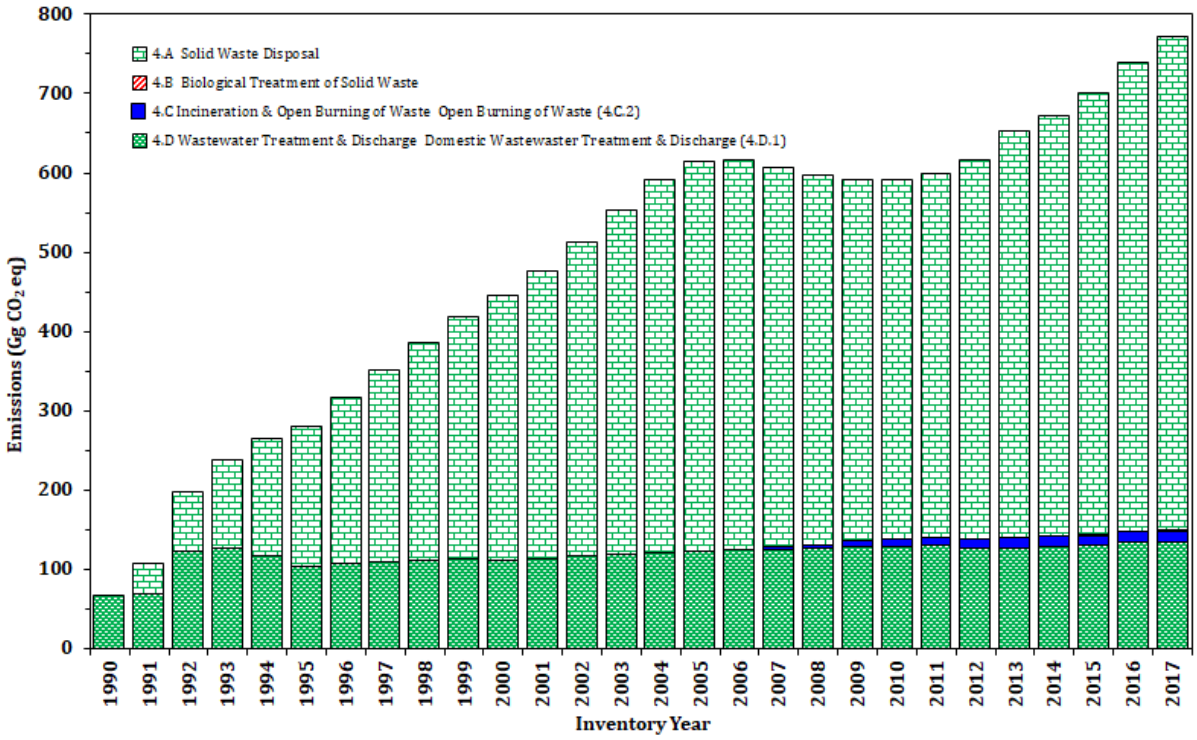


Figure 2.10: Waste sector emissions by sub-category 1990-2017

2.5.4.3 Solid Waste Disposal

The GHG emissions from solid waste landfills in Zimbabwe includes methane emissions from Municipal Solid Waste (MSW) disposal at disposal sites categorised as managed. These are found in the country`s major cities. In small towns and mining communities, MSW is disposed in shallow unmanaged dumpsites while in rural areas degradation of the waste proceeds mainly through aerobic means with few pockets of anaerobic digestion. Methane generation from these dump sites is very little and was not estimated. The methane that was generated at all the Solid Waste Disposal Sites (SWDS) in Zimbabwe was neither measured nor collected for flaring or use as an energy source. In 2010 the total waste generated was estimated at 1629.10 Gg based on an urban population of 4.363 million and waste generation rate of 373.39 kg/cap/yr. The amount of waste sent to SWDS was estimated at 651.64 Gg based on an average collection rate of 40% of the total generated waste. There were no methane emissions in 1990 due to the default assumption from the First Order Decay (FOD) method where methane production is assumed to start on the 1st of January in the year after deposition and have a residence time of 6 months. Methane emissions from SWD at landfills showed an increase from 6.7 Gg in 1995 to 22.04 Gg in 2015. The resulting annual CH_4 emissions and trend is presented in Figure 2.11.

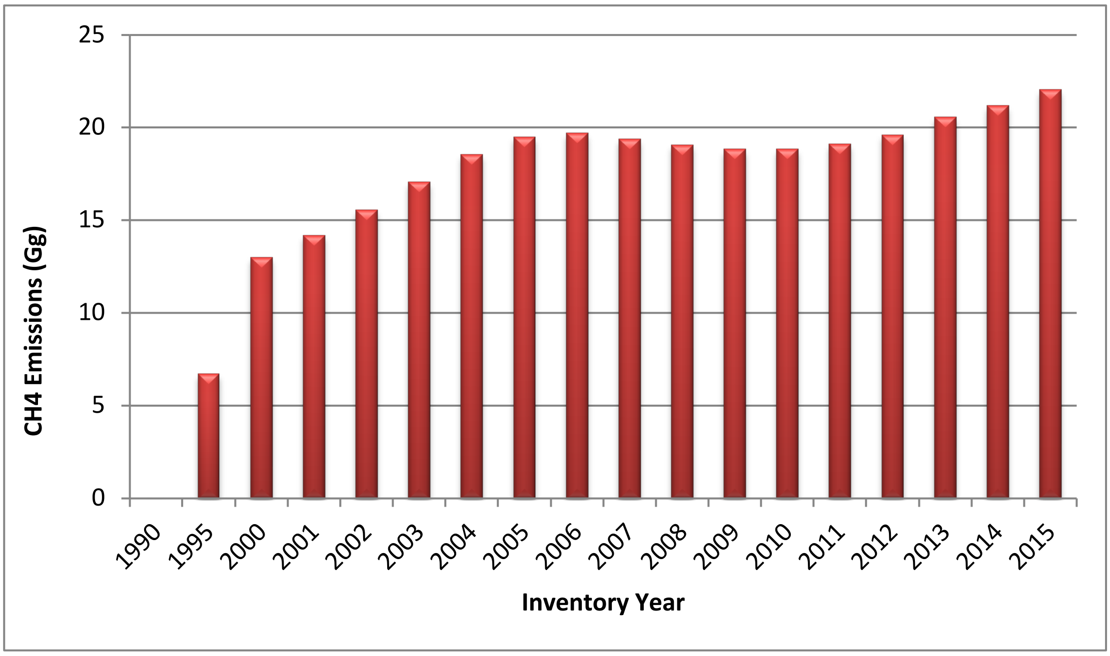


Figure 2.11: MSW Methane Emissions Trend 1990-2015

2.5.4.4 MSW Activity Data and Emission Factors

Estimation of CH_4 emissions from MSW landfills was performed in accordance with the 2006 IPCC Guidelines using a Tier 1 FOD using default parameters. All waste from small towns and mining settlements was assumed to constitute one large shallow unmanaged dumpsite. The aggregated waste composition from the Zimbabwe Statistical Agency (ZIMSTAT), UNEP survey and EMA survey were used to determine parameters used in the FOD model. Estimation of Methane Correction Factor (MCF) values was based on the weighted average taking into account the distribution of MSW flows into managed and shallow unmanaged landfills. The landfills in Zimbabwe are not covered with aerated material hence the default value for oxidation factor of zero.

2.5.4.5 Uncertainties and Time Series Consistency

In this inventory, the FOD method replaced the mass balance method used in inventories. Recalculations for previous year were done in order to restore time series consistency. Population data was used to estimate activity data for historical years where such data was not available and default factors used. Uncertainty estimates for municipal solid waste sub-sector were primarily due to the uncertainty arising from the FOD method, the activity data, default parameters and emission factors used. The combined uncertainty for CH_4 emissions from SWDS using the FOD method was estimated at 67%.

2.5.4.6 Category Specific QA/QC Activities

The following QA/QC procedures were performed;

- Comparison of activity data from primary and secondary sources
- Analysis of activity data trends along with emission trends along the time series

- Peer review of the activity data, emission factors and emission estimation results

2.5.4.7 Category Specific Planned Improvements

The emission estimates for solid waste were largely computed using default values. To improve accuracy, completeness and transparency of the emission estimates planned improvements include;

- Strengthening waste management data measurement.
- Improving on characterizing waste streams and the frequency of the surveys.
- Accurately determine the uncertainties of the data, thereby increasing accuracy in the reporting.
- Include waste streams from rural population for completeness of data.

2.5.4.8 Biological Treatment of Solid Waste

I. Category Description

Composting is the only method that is practiced for the biological treatment of solid waste in Zimbabwe. Data on composted household waste is not available, thus data from one compositing facility was considered. Incineration and Open Burning of Waste. Incineration and open burning of waste release CH_4, CO_2 and N_2O emissions and indirect (NOx, CO, Non Methane Volatile Organic Compounds (NMVOC) and SO_2) GHG emissions. There is insufficient activity data on incinerated medical waste to estimate emissions. Thus, emissions from waste incineration were not estimated in this inventory. Open burning of waste is prohibited by law in Zimbabwe. However, the practice is prevalent hence emissions from this category were estimated.

II. Indirect GHG Emissions

Tier 1 approach was used to estimate indirect GHG emissions (NOx, CO, NMVOC and SO_2) from open burning of MSW, based on the methodology available in the EMEP/EEA Air Pollutant Emission Inventory Guidebook (2016)

III. Category Specific Planned Improvements

It is planned to estimate emissions from waste incineration especially medical waste to improve on completeness of the sources of emissions. There is need to conduct a survey to determine the percentage of population practicing open burning of waste. Survey to include both rural and urban population.

2.5.4.9 Wastewater Treatment and Discharge

The wastewater emissions reported in this report refers to a combination of municipal, industrial and domestic wastewater. There is no methane recovery from the Waste Water Treatment Plant (WWTP), neither is there sludge burning or disposal to Municipal SWDS (MSWDS). The sludge is disposed off as manure after bed drying and sold to farmers. The calculation of methane emissions and nitrous oxide emissions was based on the 2006 IPCC guidelines using Tier 1 methodology and default emission factors. Indirect N_2O emissions from domestic wastewater treatment were estimated using the 2006 IPCC spreadsheets.

I. Uncertainties and time series consistency

The combined uncertainty estimate in the CH4 emissions for domestic wastewater treatment was ±63.24%.

II. The combined uncertainty estimate for N2O emissions was calculated at ±33.4%. Category specific QA/QC activities

The following QA/QC procedures were applied;

- Comparison of activity data from primary and secondary sources
- Analysis of activity data trends along with emission trends along the time series
- Peer review of the activity data, emission factors and emission estimation results

III. Category Specific Planned Improvements

The following activities have been identified as key to improve the accuracy of the estimated emissions from the sub category:

- Disaggregation of industrial and domestic wastewater flow at treatment plants
- Build capacity to consistently measure wastewater parameters

IV. Category Specific QA/QC Activities

The following QA/QC procedures used;

- Comparison of activity data from primary and secondary sources
- Analysis of activity data trends
- Peer review of the activity data, emission factors and emission estimation results
- The Waste sector benefited from international review of the TNC by experts from the UNFCCC/IPCC. Recommendations from the review were used to improve on the quality of the inventory.

V. Category Specific Recalculations

Recalculations were carried out for the SNC and TNC. The recalculations were due to methodological change from the Revised 1996 IPCC Guidelines to the 2006 IPCC Guidelines with accompanying changes in emissions factors and related parameters, as well as improvement in the liquid waste parameters. The recalculated 2006 emissions are shown in Table 2.135.

Table 2.13: Recalculations for waste

Year	Reported	Recalculated	Change (%)
1994 (inc)	-	264.17	-
2000 (SNC)	1,430.00	438.44	-69
2006 (TNC)	752.00	599.93	-20
2010 (NC4)	570.54	570.54	-

VI. Proposed Future Improvements

The following key challenges were identified during the compilation of the Waste Sector GHG inventory:

- Lack of disaggregated data on waste streams and a systematic data collection system
- Inadequate capacity to conduct uncertainty analysis
- Lack of data on medical waste incineration

In light of the listed challenges the following future improvements are planned for the Waste Sector inventory compilation:

- Capacitate local authorities to characterise waste streams and develop a systematic data collection system.
- Capacitate on uncertainty estimation associated with activity data and, emission factors
- Capacitate data providers to supply activity data for estimating emissions from medical waste incineration
- Implement the Integrated Solid Waste Management plan

CHAPTER 3.0 Vulnerability and Adaptation Assessment

3.1 Introduction

Zimbabwe is vulnerable to extreme weather events such as drought, floods, heavy rainfall events and heat waves. These events threaten water supplies, food and nutrition security, health, hydroelectric power generation, human settlements and biodiversity thereby impeding the country's social and economic development goals. The vulnerability of the communities is worsened by over-reliance on natural resources, limited technology, high levels of poverty, inadequate infrastructural and institutional capacity and poor health service and delivery.

There is differential vulnerability to climate change among livelihood groups and sectors such as agriculture, infrastructure and water due to differences in exposure, sensitive and adaptive capacity. For instance, previous studies show that women are more vulnerable to the impacts of climate change due to the central role they play in society. Women constitute 72% of the agricultural labour force. High levels of poverty in different provinces increase vulnerability of rural communities to climate change. For example, Matabeleland North Province has the highest poverty level (48.5%), followed by Mashonaland Central Province at 41.2%. In addition, infrastructure such as roads, schools, dams, power and communication lines are adversely affected annually by the impacts of reoccurring floods and droughts countrywide. Therefore, localised assessments are important to understand communities' vulnerability to climate change and to assist development of national adaptation plans.

The Government of Zimbabwe has adopted an approach in which, for each NC, detailed vulnerability assessment will focus on one vulnerable district. The vulnerability hotspots were identified in the SNC. The SNC assessed climate change vulnerability across the country and identified vulnerability hotspots in Zimbabwe while the TNC focussed on Chiredzi District in southern Zimbabwe. It was found out that water availability in Runde and Save catchments, where Chiredzi District is located will decrease with climate change based on the Commonwealth Scientific and Industrial Research Organisation Mark (CSIRO MK3) GCM. A strong correlation between malaria and rainfall was also noticed, hence a holistic approach targeted at mitigation measures around water and sanitation.

In this Fourth National Communication, the vulnerability of five sectors i.e., Agriculture, Ecosystems and Wildlife, Public Health, Water and Infrastructure were assessed focusing on Muzarabani District which is in Northern Zimbabwe is another hot spot area susceptible to extreme climate events.

3.2 Methodology

3.2.1 Climate Data

To understand climate change vulnerability and adaptation in Zimbabwe, there is need to explore the current and future climate scenarios. The historical climate variability in temperature and precipitation in Zimbabwe were explored based on observations of the past climate (1986–2005) from the Climatic Research Unit (CRU-UK). The projected changes in climate were carried out for the periods 2020-2040, based on the scenarios developed in the climate component of National Adaptation Plan (NAP) in Zimbabwe. Future climate data were obtained from the Coordinated Downscaling Experiment (CORDEX-Africa-domain) archive of GCMs and Regional Climate Models (RCMs). The future climate was projected under the Coupled Model Intercomparison Project Phase 5 (CMIP5) used in the Fifth Assessment Report of the IPCC. The data from CORDEX-Africa domain consisted of 10 different ensemble members (10 GCMs) and seven RCMs in various combinations). Two RCPs reflecting different scenarios of greenhouse gas emissions were considered. These are RCP4.5 representing lower emission reductions scenario that stabilise the CO_2 concentration at about 540 ppm by 2100, and RCP8.5 which assumes increases in emissions leading to a CO_2 concentration of about 940 ppm by 2100. These two RCPs were adopted for modelling vulnerability in the focal sectors. However, the CSIRO-Mk3.6.0 model with a high spatial resolution was used for modelling vulnerability of ecosystems to climate change.

3.2.2 Climate Trends and Projections in Zimbabwe

Observed historical records show that Zimbabwe has warmed by about 0.9°C between 1900 and 2018. In general, the number of hotter days has increased while the number of colder days has decreased. The period from 1980 to 2018 is regarded as the warmest period in the history of the country. Rainfall trends show mixed results with available evidence suggesting a general moderate decrease (about 5% from 1901 to 2018) over Zimbabwe. Although the rainfall trend is inconclusive, there is clear evidence of change in inter-annual rainfall variability. In particular, inter-annual rainfall variability has increased since the late 1960s. The year-to-year rainfall variability of rainfall anomalies is high across the country. In addition, the intra-seasonal pattern of the rainfall season is characterised by high frequency and intensity of dry spells, contraction of the rainfall season, late onset and early cessation of the rainfall season and the number of rainy days has decreased significantly.

Results of projected temperature pattern in the country show a general agreement across all 10 GCM. The RCM simulations show that future mean annual temperature will rise significantly under both RCP4.5 and RCP8.5 scenarios. The mean annual temperature is projected to increase by 1 to 1.5°C (2020-2040 under RCP4.5 scenario (Figure 3.1). For the RCP8.5 scenario, future warming is projected at 1 to 1.5°C (2020-2040). The south western parts of the country which are generally warmer, indicate the largest temperature changes

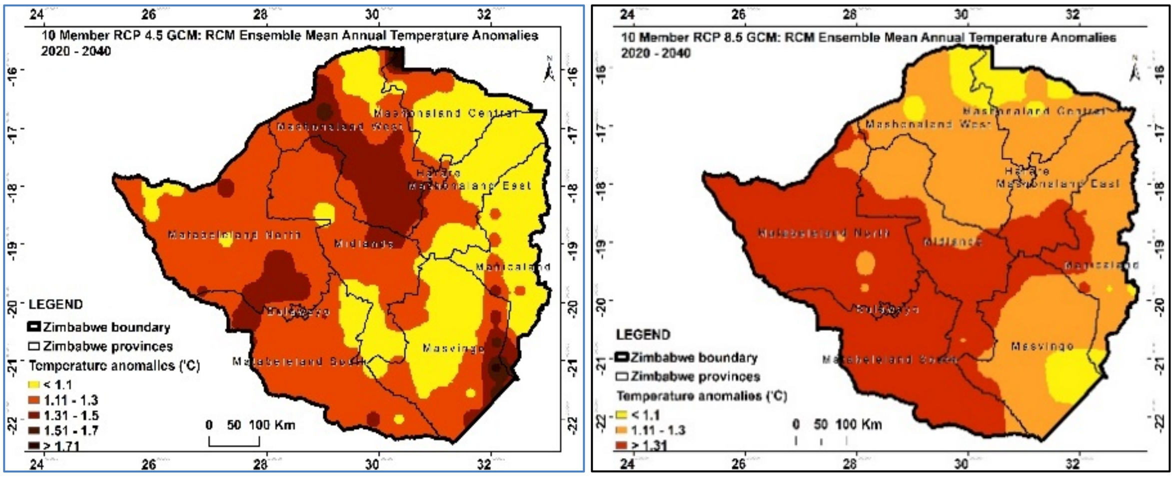


Figure 3.1: 10 Member GCM: RCM Ensemble change in mean annual temperature over Zimbabwe for 2020-2040

(Left panel RCP4.5 and right panel: RCP8.5)

The future mean annual precipitation is projected to decrease for both RCP4.5 and RCP8.5 for the period 2020-2040. In fact, the projected mean national annual precipitation is 10% lower than the 1986-2005 baseline. The spatial distribution of the annual precipitation anomalies shows Matabeleland South, Masvingo and Manicaland Provinces will experience the greatest decrease in precipitation (up to 10%) for all the three future periods (Figure 3.2).

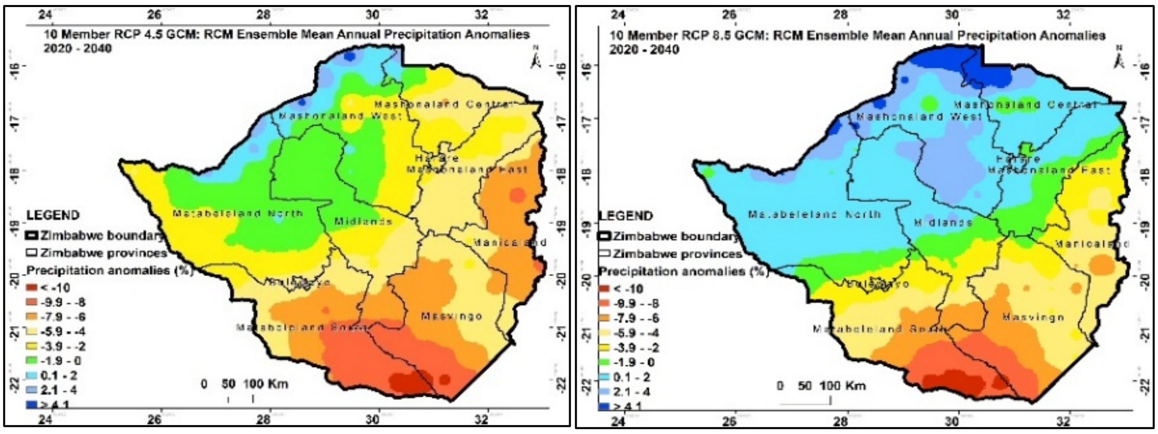


Figure 3.2: Future Change in Mean Annual Precipitation 2020- 2040

(Left panel: RCP4.5, Right panel RCP8.5)

Key Messages

- Zimbabwe is characterized by a highly variable seasonal climate. The number and frequency of dry spells interspersed with severe droughts has increased since the 1980s. The length and frequency of dry spells has increased. There is also late onset and early cessation of the rainfall season.
- Evidence suggest that the mean annual surface temperature has increased by about 0.1°C every ten years translating into 0.9°C warming between 1901 and

2018. Intra-seasonal rainfall characteristics such as onset/cessation dates, frequency of droughts/floods and mid-season dry spells have significantly changed across the country.

- Future projections show that temperatures will continue to increase both in the near to long-term future irrespective of the greenhouse gas emission scenario. The mean annual temperature is projected to warm by about 1 to 3.5°C above the 1986-2005 reference period from 2020 to 2080, with the warming trend being higher under the RCP8.5 than the RCP4.5 scenario. Warming will be highest in the southern, western and south-eastern parts of the country.
- Zimbabwe expects a 10% decline in mean annual rainfall when compared with the 1986-2005 baseline. The southern and south-eastern parts of the country will likely experience the greatest decline under all the three future periods. The projected temperature increase may shift crop suitability leading to reduced crop productivity. The projected higher temperatures may increase soil moisture deficit thereby increasing water stress.

3.2.3 Vulnerability Assessment Framework for Muzarabani

For detailed analyses of climate change impact, the study focused on Muzarabani district located in Mashonaland Central Province, about 250 km from Harare (

Figure 3.3). The total area covered by the district is 4,266km^2. The IPCC Vulnerability framework (IPCC, 2007) was adopted in modelling the vulnerability of the following sectors i.e., Agriculture, Ecosystems and Wildlife, Health, Water and Infrastructure. Specifically, the vulnerability of these sectors was modelled as:

$$Vulnerability = \int (Exposure + Sensitivity - Adaptive\ Capacity) \quad (1)$$

where:

Vulnerability is the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including variability and extremes Exposure is the nature and degree to which a system is subjected to significant climate variations

Sensitivity is the degree to which a system is affected either adversely or beneficially, a climate related stimuli

Adaptive capacity is the ability of a system to adjust to climate change (including variability to moderate potential damages, to take advantage of opportunities, or cope with consequences

To determine the vulnerability index for each sector, several quantitative variables representing exposure, sensitivity, and adaptive capacity of the respective sector to climate change were collected during a field survey carried out in 2021. These were later differentially weighted and integrated within a GIS environment. These variables were developed based on review of literature and validated through stakeholder consultations. The Vulnerability Framework was applied across the sectors with some adjustment to cater for the inherent differences in data requirements. For instance, the vulnerability assessment in the agricultural sector was based on exposure to drought, one of the major hazards in the district.

The vulnerability assessment in the water sector integrated the United Nations Environment Programme (UNEP)'s Driver, Pressure, State, Impact and Response (DPSIR) framework within the IPCC Vulnerability Framework. In addition the water sector used a modified Water Vulnerability Index (WVI) to include Sensitivity (rainfall, seasonality), Adaptive capacity (literacy level, agricultural dependence, population density), and Exposure (damages and injury due to extreme events). The data was obtained from previous analysis (RCP4.5 and RCP8.5) and questionnaires administered in the district.

Similarly, the vulnerability of the health sector in Muzarabani was based on three climate related diseases i.e., malaria, schistosomiasis and diarrhoea were implemented within the sustainable livelihood approach. The data on the three diseases were used to understand the socio-economic health impacts resulting from climate change using the Modelling framework for the Health Impact Assessment of Man Induced Atmospheric changes (MIASMA) Model Version 2.0. The model predicts socio-economic impacts resulting from a given climate related vector-borne disease. Prior to integration, the data indicative of the sensitivity, exposure and adaptive capacity of each sector were normalised using the linear minimum maximum scaling method. After the normalisation, all the indicators of exposure and sensitivity were summed up before subtracting the adaptive capacity component (Equation 2).

$$VI = \sum_{i=1}^{n}\left[\left(\sum_{j=1}^{m_i} x_{ij} \times w_{ij}\right) \times W_{ij}\right] \quad (2)$$

Where VI is the Vulnerability Index; n is the number of vulnerability components; m_i is the number of parameters in the ith component; x_{ij} is the jth parameter in the ith component; w_{ij} is the weight to the jth parameter in the ith component; and W_i is the weight given to the ith component.

The resultant Vulnerability maps for each sector were then classified into five classes: very low (0-0.2); low (0.2-0.4); moderate (0.4-0.6); high (0.6-0.8) and very high (>0.8). These were reported at ward level to ensure relevance to the NAP process.

3.3 Muzarabani District Profile

Muzarabani District has 29 wards. Based on the 2012 census the district had 26,928 households with an average household size of 4.6 and a total population of 122,791. Approximately, 61,160 (49.8%) are males with 50.2% (61,631) being females. A significant proportion (97.1%) of this population resides in a rural set-up while ~ 2.9% resides in an urban environment. The district has a huge demographic dividend with 45.3% of the population below the age of 15 years.

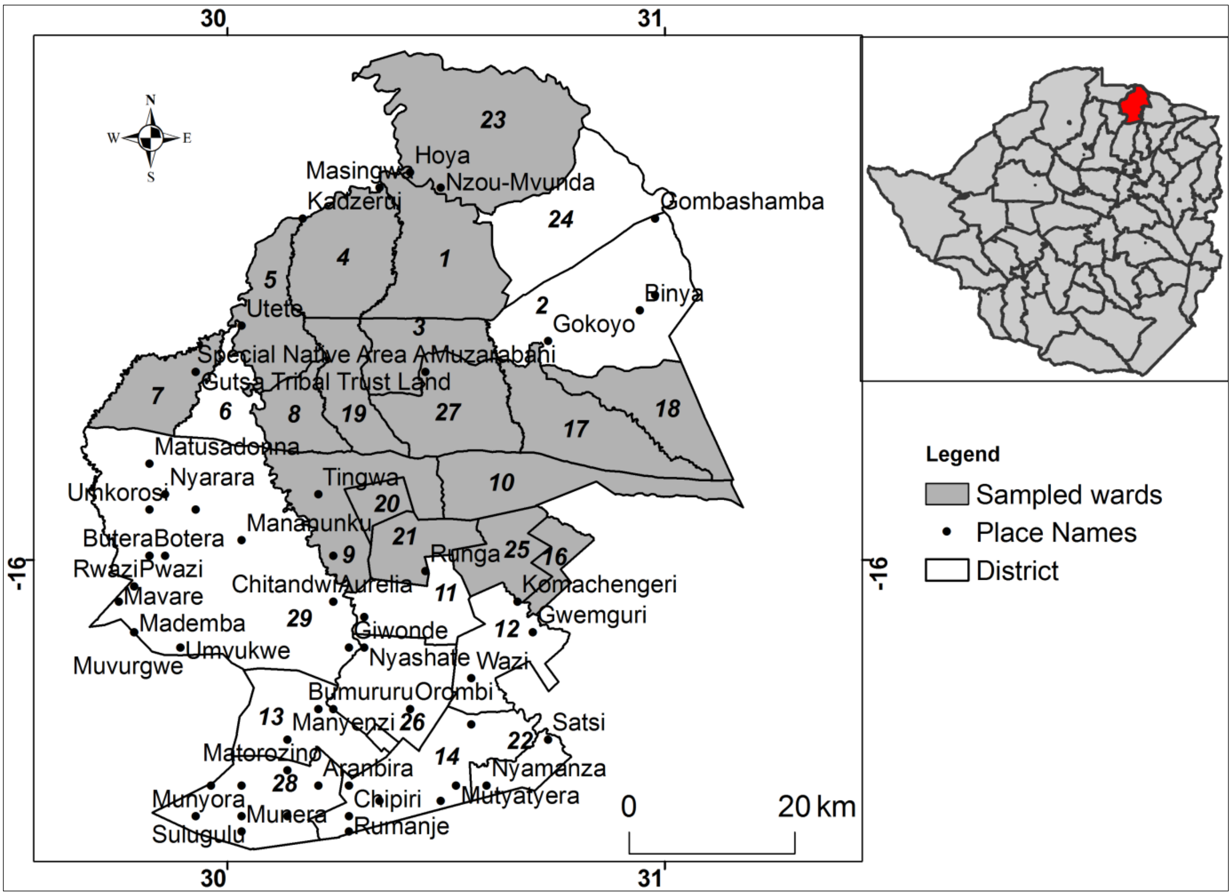


Figure 3.3: Location of Study Area

The majority of the population depend on rain-fed agriculture. The district is characterised by a semi-arid to arid climate and is in agro-ecological regions III and V, which is characterised by low rainfall of 450–650 mm per year interspaced by seasonal droughts and intra-season dry spells. Temperature ranges from 28^{0}C-31^{0}C during the winter season and 35^{0}C-40^{0}C during the hot season. The Mavuradonha range divides the district into two distinct zones namely the Upper Muzarabani and Lower Muzarabani. The upper part of the district falls in agroecological region 3 while the lower part is in agroecological region 5a. The upper part of the district falls in agroecological region 3, which is relatively cooler and receives higher rainfall than Lower Muzarabani. The lower part of the district is characterised by high temperatures, low elevation and flat, low and erratic rainfall, hence is more vulnerable to climate change. Sodic soils dominate the district with rich alluvial soils along flood plains in lower Muzarabani.

Most of the people settle along riverbanks to take advantage of water availability and fertile soils brought about by the back-flow effect of Cahora Bassa Dam in Mozambique. This, however, exposes them to flooding which is worsened by poor catchment management. The major hazards in the district are flooding (low-lying areas), severe droughts, fires, land degradation (particularly soil erosion), deforestation, storms, lightning, crop and animal pests and diseases such as malaria and gastro-intestinal tract infections. Forest fires are more prevalent in the northern parts of the district. The lower part of the district is generally inaccessible during flooding, a phenomenon that occurs almost annually.

The common wild animals found in the area are warthog, duiker, kudu, hyena, baboon, monkey, elephant, rabbits, impala and bushbuck. The climate-induced contraction of suitable habitats has resulted in a declining trend in the wildlife species. The affected wildlife species includes antelopes, lions, kudu, buffalos and cheetahs. The decrease in the habitat is compounded by human population pressure resulting in increased human-wildlife conflicts.

The main crops are maize, tobacco, groundnuts, cotton, sesame seed and small grains (pearl millet and finger millet). Tobacco is grown in upper Muzarabani. Sesame is an ideal crop for the district given its drought tolerance, adaptability to diverse soil types and low fertilizer requirements. The crop whose market is mainly the export confectionary industry, is generally grown in the northern wards of Lower Muzarabani. Livestock production systems are dominated by cattle, goats and poultry at subsistence level. The district is characterised by sparse road network, which is predominantly gravel, save for the main tarred road that links the upper part of the district to the beginning of the lower part.

3.4 Vulnerability to Climate Change in Muzarabani District

This section provides an overview of vulnerability in the Agriculture, Ecosystems and Wildlife, Health, Water, and Infrastructure of Muzarabani district under the current and future climate (2040s). These sectors were selected based on the critical role they play in national development as well as their dependence on the climate system.

3.4.1 Agriculture

Results in Table 3.1 and Figure 3.4 are based on equations 1 and 2. The mean agricultural sensitivity index is 0.54 ± 0.06 standard deviation implying a moderate sensitivity of the agricultural sector to climate change. Out of the sampled wards, ~80% are moderately sensitive while 20% are highly sensitivity (0.6-0.8). This is mainly attributed to a) large area planted to maize, which is highly sensitive to drought; b) land degradation; c) use of retained seeds, which have low water, nutrient and pesticide use efficiencies owing to low seed vigour.

Table 3.1: Mean Sensitivity, Adaptive Capacity, Exposure, and Vulnerability in Lower Muzarabani

Ward	Sensitivity	Adaptive Capacity	Exposure	Vulnerability
1	0.450	0.240	0.580	0.790
3	0.440	0.280	0.542	0.702
4	0.530	0.280	0.533	0.783
5	0.610	0.220	0.467	0.857
7	0.520	0.320	0.700	0.900
8	0.630	0.250	0.514	0.894
17	0.540	0.260	0.690	0.970
18	0.560	0.270	0.690	0.980
19	0.560	0.290	0.513	0.783
23	0.510	0.260	0.738	0.988
Mean	0.540	0.270	0.597	0.865
Sdev	0.060	0.030	0.093	0.093

Meanwhile, in addition to the moderate sensitivity of the agricultural sector, Table 3.1 shows that the adaptive capacity is low (mean 0.27±0.03). Figure 3.4 shows the spatial variation in adaptive capacity in Lower Muzarabani.

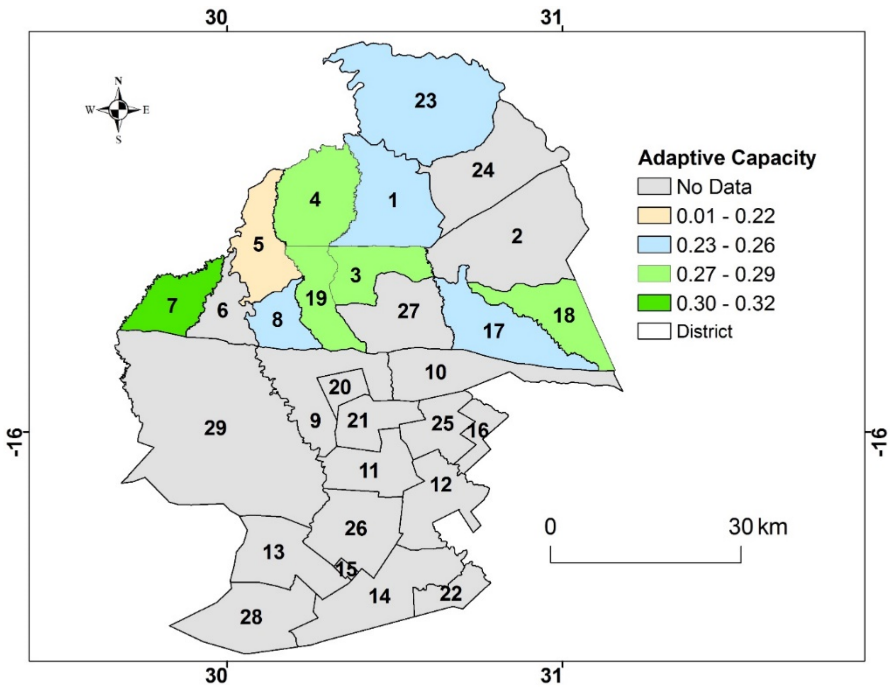


Figure 3.4: Spatial Variation in Agriculture Adaptive Capacity

Pertaining to natural climate variability and change, Table 3.1 shows that the agricultural sector is moderately exposed to droughts with a mean of 0.597± 0.09. However, despite the moderate exposure, the overall vulnerability of the agriculture sector is generally high with a mean of 0.865± 0.09. The high overall vulnerability might be attributed to low adaptive capacity. This shows that much of the vulnerability to climate change in Lower Muzarabani does not necessarily emanate from exposure to drought but other factors on the ground. Thus, policy interventions that result in use of improved agricultural technologies are critical to build resilience in a variable climate. Currently, lack of irrigation infrastructure and limited adoption of climate smart technologies such as conservation agriculture make significant contribution to the low adaptive capacity. Limited irrigation infrastructure in an area with high climate variability leads to persistently low food security in the lower Muzarabani. Irrigation development is key to build adaptive capacity in smallholder farming systems in Lower Muzarabani since drought is the major agricultural risk. In this regard, government through Zimbabwe National Water Authority (ZINWA) has prioritized the construction of Silverstroom Dam, which is envisaged to support about 2000 ha of irrigable land and additionally serve the Agricultural and Rural Development Authority (ARDA) scheme in the district.

Apart from the above, there is need support the production and export of sesame leveraging on programmes such as the Climate-proofed Presidential Input Scheme, which is embedded on the *Pfumvudza/Intwasa* concept. The concept has three pillars: minimum soil disturbances; crop rotation and diversification and; mulching. Besides, farmer training on good agronomic practices and benefits of the crop are crucial to increase the viability of the crop. In addition, more support is required on crop value addition and exploring the dynamics of high valued markets. Increased product quality and productivity is however crucial in all this.

In the 2020/2021 farming season, the yield for sesame was 0.38 tonnes/ha in Mashonaland Central, compared to a national average of 0.51 tonnes/ha for the same season. For a crop of such vast potential for income diversification (fetches US$1.00 per kg compared to maize (0.39US$ per kg)) and foreign currency generation for the nation, increasing productivity will guarantee a fair share of the global export market, expected to grow to US$17.77 billion by 2025.

The results do not explicitly capture the future vulnerability given the uncertainties in key socioeconomic projections; hence, the information could not be applied for projection of future agriculture vulnerability scenarios in Muzarabani. Nevertheless, policies and strategies that are planned are envisaged to improve adaptive capacity of the agricultural sector to a variable future climate.

3.4.2 Water Resources

A larger part of Muzarabani lies within the Musengezi sub catchments of Manyame catchment while Lower Manyame and Upper Ruya sub catchments (Mazowe catchment) form the remainder of the district. The flow of rivers follows the rainfall pattern that decreases from the upper to the lower part of the district. The base flow index in the district ranges between 0.21- 0.3 which is in the medium range, supporting groundwater development in the district. Ground water depth ranges from 2-20m while water recharge rates vary from 50-300mm/year.

Surface water resources available in the district are still underdeveloped. The current surface water utilisation index ranges from almost zero in the lower valley to 0.9 in the upper reaches suggesting underutilisation. The main water uses are agriculture, wildlife and water supply for communities and services centres. There is a proposal to develop a significantly large dam, Silverstroom Dam, in the Musengezi sub catchment with a capacity of 160 million cubic metres. Most of the impounded water will be used to open up 2,000ha of irrigable land as well as augment water supplies for service centres and rural communities.

The water sources in Muzarabani District comprise dams, wells, springs and boreholes adding up to 474 sources servicing more than 28,000 households (Figure 3.5). About 47% of the water sources are operational with the rest either abandoned or have broken down. Approximately 71% of the water is classified as being of good quality with only 4% treated at source. Groundwater is the main source of water in the district with 62% of the households obtaining their water from boreholes. There are also some water pans in the Lower Muzarabani which are annually replenished from the rains. They are currently used for livestock rearing. However, major settlements such as Centenary do not have enough water treatment capacity with water intermittently supplied to residents and other users. Some of the water sources have also been drying up of late with water yields decreasing. The decreases are attributed to climate change with the district already experiencing reduced rainfall and increased temperatures. Development of additional dams, borehole drilling and water harvesting techniques could therefore enable communities to readily access water for irrigation and livestock thereby increasing their food security.

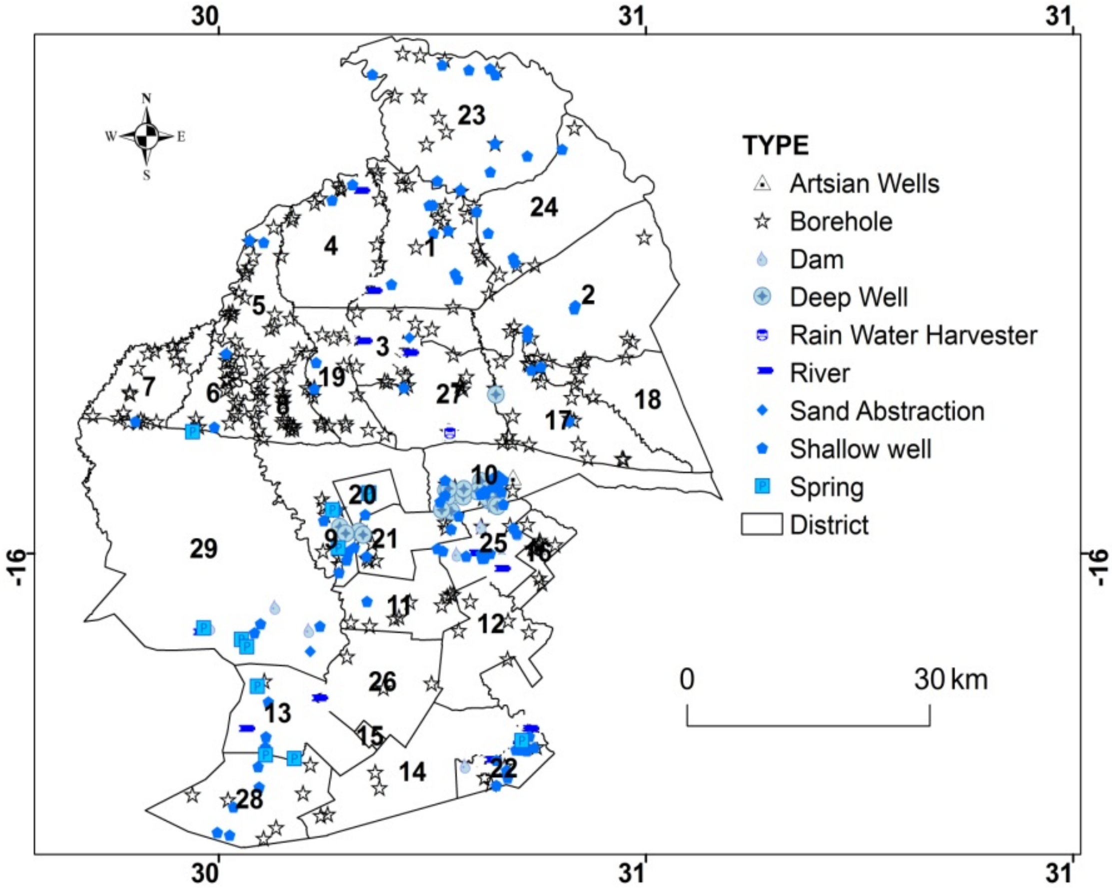


Figure 3.5: Map of Muzarabani District Water Resources

(Rural WASH Information & Services Management System (RWIMMS), latest update 23/7/2020)

There are four hydrological stations in the district with near-real time data transmission capabilities. Currently there are no groundwater monitoring points in the area. There is no official weather station in the district, as a result records from Mt Darwin, the adjacent district to the east are usually used. Water pollution in the district is mainly from agricultural activities.

In terms of the normalised water vulnerability index, generally wards in the Lower Muzarabani which are also prone to flood and droughts, are more vulnerable to climate change than those in the upper part. The Lower part of the district has a WVI more than twice that of the upper district for all projections. Ward 1 (Chadereka) in Lower Muzarabani, is the most vulnerable under all the 3 scenarios. There is a marginal increase of water vulnerability in some of the upper parts of the district for 2030 and 2040 projections which generally supports the reduction of rainfall pattern predicted from the downscaled CORDEX models (Figure 3.6).

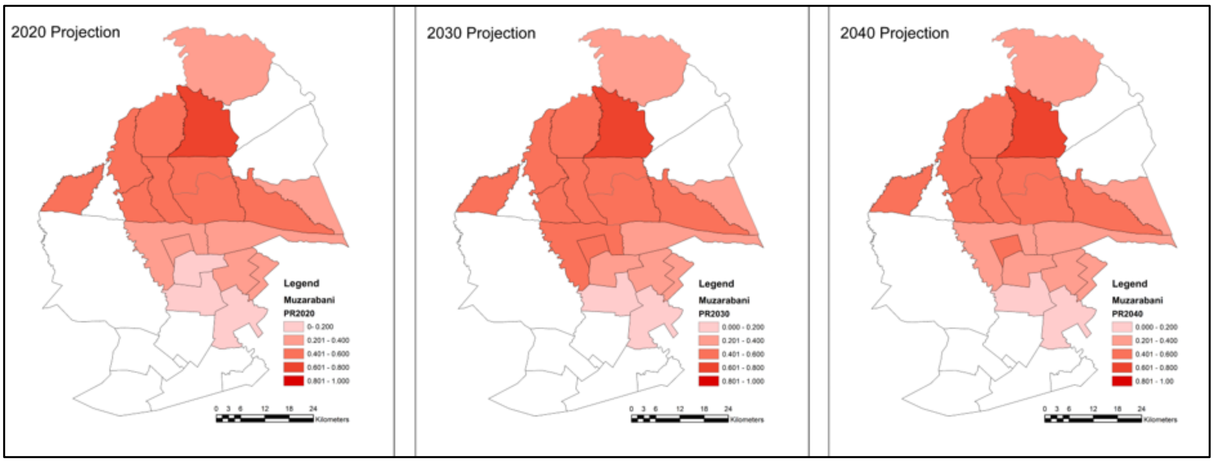


Figure 3.6: Water Vulnerability Index 2020 to 2040 Projections based on RCP8.5 MOHC

The general increase in vulnerability in the district especially the Lower part supports the need to develop more water resources in the district. More boreholes and other water harvesting techniques can be developed in the lower part of the district where the terrain is very flat, making it impossible to develop medium to large dams.

Table 3.2: Water Vulnerability Index in Muzarabani at Ward Level

Region	**Ward**		**Scenarios**		
	Number	**Name**	**2020**	**2030**	**2040**
Lower Muzarabani	1	Chadereka	0.615	0.615	0.615
	3	Machaya	0.521	0.527	0.523
	4	Dambakurima	0.522	0.525	0.522
	5	Kapembere	0.449	0.455	0.449
	7	Hwata	0.418	0.426	0.418
	8	Muringazuva	0.583	0.592	0.585
	17	Hoya	0.422	0.427	0.422
	18	Mutemakungu	0.285	0.290	0.286
	19	Utete	0.569	0.577	0.571
	23	Kairezi	0.360	0.367	0.363
	27	Mutuwa	0.584	0.592	0.586
	WVI_{Lower}		**0.484**	**0.490**	**0.485**
Upper Muzarabani	9	Chiwashira	0.317	0.403	0.400
	10	Chiweshe	0.305	0.312	0.308
	11	Chinyani	0.153	0.149	0.148
	12	Botambudzi	0.145	0.139	0.139
	16	Mukwengure	0.206	0.202	0.200
	20	Chawarura	0.365	0.470	0.467
	21	Runga	0.168	0.282	0.280
	25	Museredza	0.235	0.341	0.339
	WVI_{Upper}		**0.237**	**0.287**	**0.285**

Water Resources Adaptation Interventions

- Interventions must prioritise the Lower Muzarabani which is more vulnerable.
- There is need to prioritise the construction of Silverstroom Dam. The large dam will open up 2,000ha of irrigable land. However new design parameters incorporating effects of reduced inflows due to reduced rainfall activities are required before construction. The dam will enable resuscitation of irrigation schemes in the districts, serve the commercial ARDA Muzarabani Estates as well as create additional schemes. The dam whose site is on the Upper part of the district, will service most of the schemes through gravity, thereby reducing operational costs which is challenge for most communal irrigation schemes in Zimbabwe.
- Borehole drilling programme must continue especially on the eastern part of the district which will not be served by the proposed Silverstroom Dam.
- Most of the runoff in the district is generated from the upper part of the district and Mazowe District, upstream of Muzarabani. Adverse activities such as deforestation and alluvial mining activities which cause siltation and decrease carrying capacity of rivers and dams need to be controlled.
- A programme to monitor effluent especially from Centenary, the only urban centre in the district must be initiated. Surface water monitoring in the district is adequate in terms of the World Meteorological Organisation standards. The

two water quality monitoring sites in the area are not enough. The extent of groundwater recharge in the district must be investigated through selected monitoring sites. Meteorological stations are also required, preferably in the lower part of the district owing to the terrain cannot be adequately represented from the nearest station in Mt Darwin.

3.4.3 Public Health

Climate change is likely to have diverse and wide-ranging impacts on human and livestock health in Muzarabani. In times of flooding water-borne diseases such as cholera, typhoid and dysentery are prevalent in the area. Cholera is made worse by the contamination of water by collapse and flooded pit latrines. Figure 3.7 shows that malaria cases are higher in lower Muzarabani District because of high temperatures while bilharzia is more common on the upper part of the district due to relatively abundant water resources.

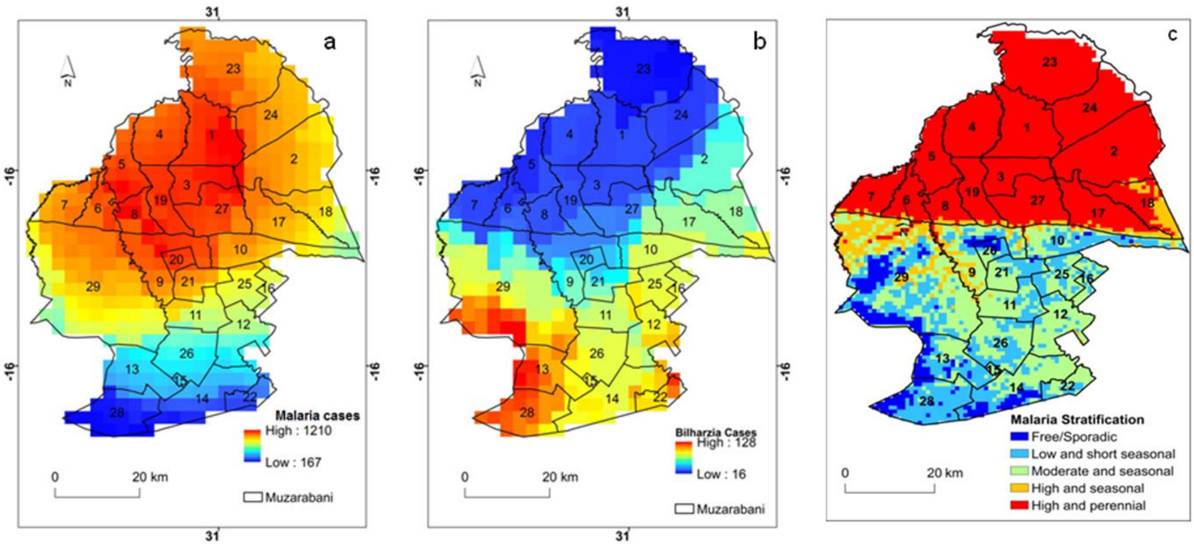


Figure 3.7: Spatial distribution of Malaria and Bilharzia in Muzarabani

a) Malaria, b) Bilharzia Cases in 2019 and c) Malaria stratification in the district

Climate change is expected to result in changes in transmission of vector-borne diseases. Temperature and precipitation changes are likely to influence the behaviour and geographical distribution of vectors, and thus change the incidence of vector borne diseases, which are major causes of mortality and morbidity in most tropical countries. Figure 3.7(c) shows malaria stratification in the district. It can be observed that the upper part of the district is characterised by free to low or sporadic malaria pattern while the lower part is classified as having high and perennial malaria cases. Results of health impacts show that most people do not seek treatment at health centres because of the long distances they have to travel to access the services. As a result they end up using alternative medicines to treat common diseases such as malaria.

Health Interventions

The main gaps identified were lack of education on the effects of climate change on health due to lack of awareness. As a result of the several threats posed by climate change to health in the area, several recommendations are made:

- There is need to provide climate information to health officials to improve early warning systems;
- There is need to scale up indoor residual spraying and provision of insecticide targeting highly vulnerable wards;
- Strengthen integration of climate change adaptation into the health sector by increasing public awareness and social mobilisation on climate change impacts on health;
- Design appropriate measures for surveillance and monitoring of climate change related diseases to enhance early warning systems;
- Improve the road infrastructure;
- Develop the capacity of research institutes to conduct multidisciplinary collaborative research on climate and health issues

3.4.4 Ecosystems & Wildlife

3.4.4.1 Current Species Composition

The major ecosystems covering Muzarabani district are the typical miombo vegetation characterised by extensive grasslands, savannas and shrub-lands (
Figure 3.8). More than 47 families and 55 genera of plants have been observed in the district. However, there could be more undocumented species that might not be in the National Herbarium database and might also have been missed during the field work. From these datasets, it was observed that the woody vegetation is dominated by the following species: *Brachystegia boehmii, Brachystegia allenii, Brachystegia spiciformis, Colophospermum mopane, Cobretum apiculatum, Commiphira Diospyros quiloensis,* species (
Figure 3.8). Combined, woody vegetation is distributed within 30% of the district with most of the woodlands concentrated in Wilderness Safari area. Herbaceous layer in the district is mostly composed of a sparse but continuous layer of grasses, forbs and sedges characterised by predominance of *Andropogon* and *Hyparrhenia* species. Grasslands occupy ~20% of the district land area. In contrast, croplands cover the greater proportion of the area in the district with ~50% under cultivation thereby constituting one of the greatest threats to biodiversity in the district.

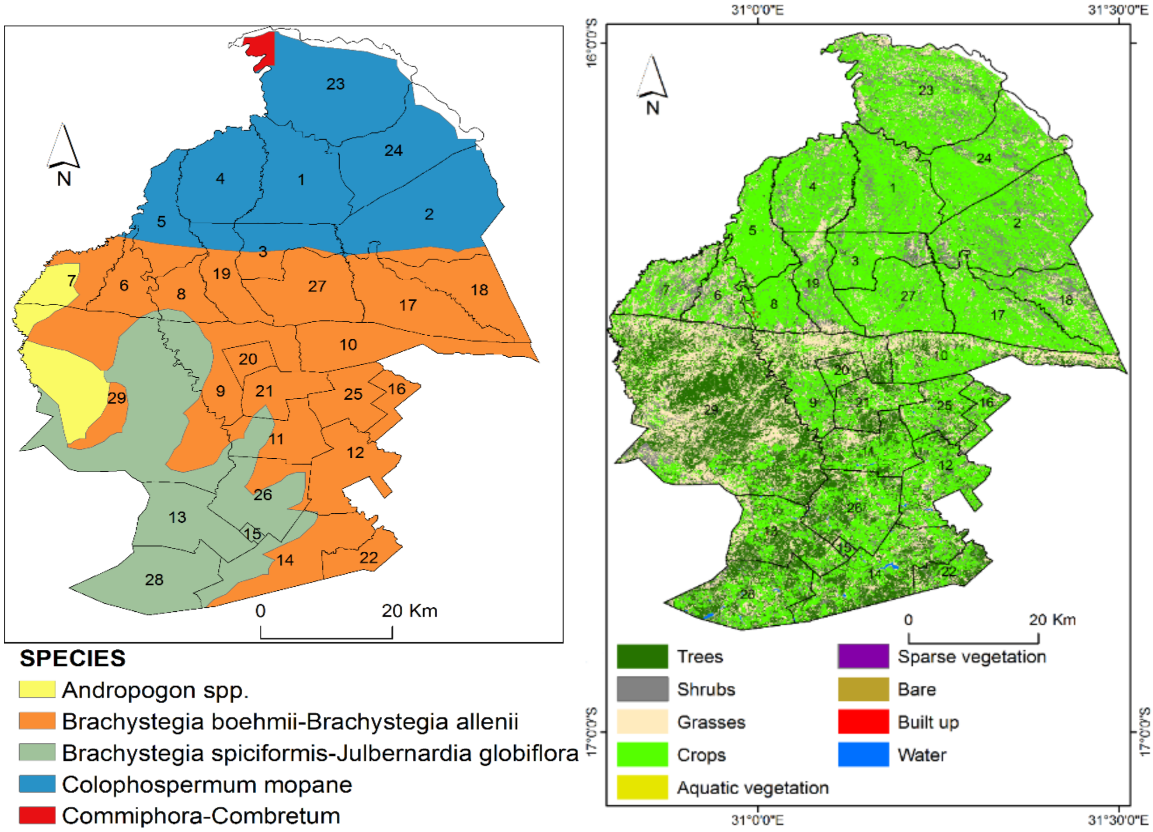


Figure 3.8: The key ecosystems found in Muzarabani District

Table 3.3: Area of each ecosystem across Muzarabani district

Cover	Area (km²)	Percentage
Cropland	2119.1	49.7
Grassland	845.3	19.8
Tree cover area	752.0	17.6
Shrub cover areas	538.0	12.6
Open water	6.3	0.1
Sparse vegetation	4.3	0.1
Others	2.3	0.1
Total area	**4267.2**	**100.0**

3.4.4.2 Current Natural and Anthropogenic Threats (exposure) to Ecosystems in Muzarabani District

Muzarabani District is exposed to several natural and human induced drivers that threaten the integrity of ecosystems. In terms of fire, ecosystems within the southern parts of the districts are more exposed to fires than those in the northern parts of the district. For example, 486 fire incidences were detected from the year 2000 and 2020 in the district which translates to 24 fire incidence per year (Figure 3.9). The areas that are prone to fires are the grass-dominated ecosystems especially the *Hyperrhenia* grasses, predominantly found in the upper part of the district, whose abundant biomass provides fuel for fire ignition and sustenance. The situation is further worsened by the fact that ~60% of farmers in the district do not construct fireguards resulting in the fires affecting large areas as there are no breaks to stop them. This significantly impacts the ecosystems and in worst cases loss of human lives and property.

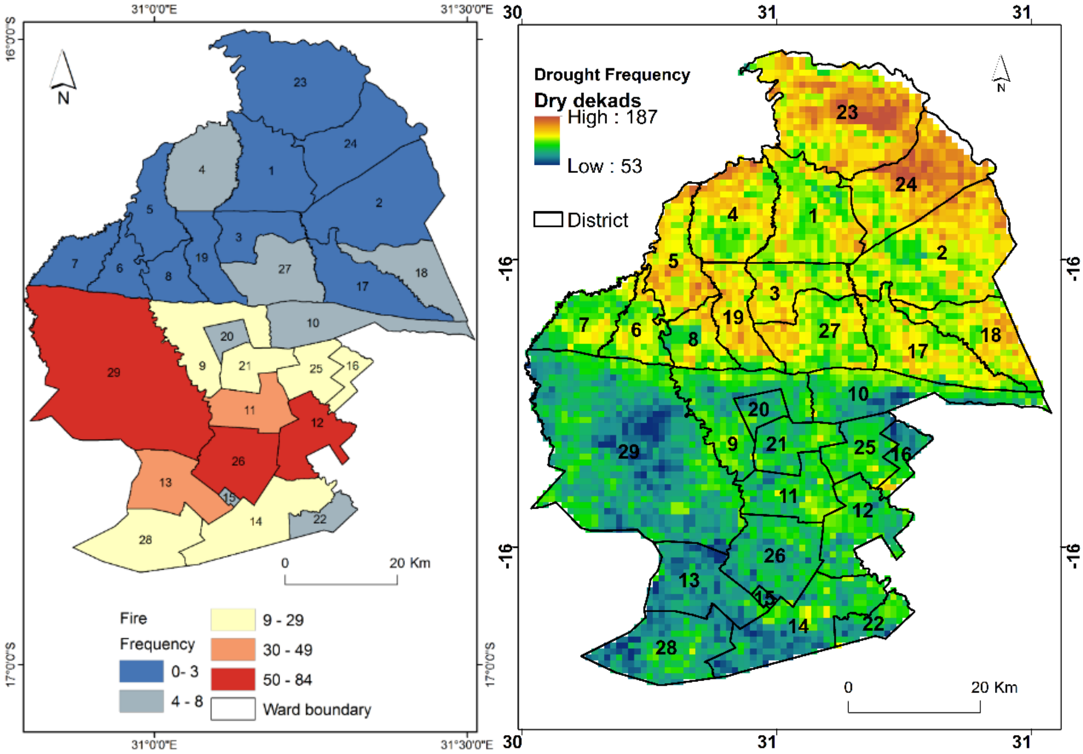


Figure 3.9: The Exposure of Ecosystems in Muzarabani to Wildfires and Droughts

Droughts occur more frequently than any other hazards in the district (Figure 3.9) Since the greater part of the district is semi-arid to arid, frequent and prolonged dry spells not only affect natural ecosystems but agro ecosystems as well. Results of drought frequency analysis illustrate that the whole district is susceptible to droughts although the severity and intensity is higher in the lower than in the upper part. Droughts affect both terrestrial ecosystem and aquatic ecosystems. For instance, droughts usually trigger massive tree and shrub mortality which results in expansion of grasslands at the expense of woody species thereby altering ecosystem structure and functioning. Similarly, drought alters hydrological regimes and water availability in water bodies and wetlands thereby affecting plant and animal species found therein. Droughts have immediate negative effects such as death of fish and invertebrates in reservoirs whereas altered flow regimes significantly reduce stream flow resulting in reducing habitat quality and availability for freshwater organisms.

Apart from the above threats, land degradation is also becoming a key driver of biodiversity loss in freshwater and terrestrial ecosystems. Gully erosion has exposed most of the underlying soil thereby exposing roots of plants (resulting in plant death) and destroying habitat of terrestrial animal species. Almost three quarters of the wards

in the district exhibit serious gully erosion that threatens the ability of the ecosystems to provide goods and services to communities in the district (
Figure 3.10). Some of the gullies especially in the northern wards can stretch for about a kilometre and having depths of up to 5m. Most of the gullies occur in sodic soils that dominate the district which poses challenges in rehabilitating the gullies /soils. Eroded soil from these gullies is ultimately deposited into rivers causing siltation. Siltation in turn reduces freshwater availability and negatively affects riverine ecosystems. Droughts alongside desiccation of wetlands and water bodies such as rivers and ponds has negatively impacted these aquatic ecosystems. For example, in aquatic ecosystems, animal species such as fish and crocodiles among other species are disappearing in the district due to recurrent droughts and subsequent desiccation of water bodies.

Stream bank cultivation has also been identified as a major threat to ecosystems in the district. It is estimated that 47.5 km of rivers/streams has been severely affected by stream bank cultivation. The fragile Kalahari and sodic soils that are traversed by rivers such as Dande, Hoya, Kadzi, Msengezi and Nzou-mvunda has resulted in change of river course. In areas where rivers have changed courses, the local community utilise the fertile alluvial soils deposited by flooding. Moreover, alluvial gold panning is threatening ecosystems through siltation and use of cyanide. This practice is prevalent in the lower parts of the district and has been responsible for water pollution and fish kills. Thus, there is need to develop sustainable livelihood options.

The high rate of deforestation in Muzarabani is attributed to agricultural expansion, tobacco curing and domestic fuel wood. Approximately, 162,234 ha of woodlands were converted to arable land in Muzarabani District between 1992 and 2008. Forest clearance has resulted in contraction and fragmentation of habitats leading to emigration of some animal species (lions, hyenas, and elephants). However, the Mavuradonha Wilderness area still has large tracts of forest that have not experienced significant reduction though fires and drought threaten their survival.

Climate change is a threat to terrestrial and aquatic species. The problem is also exacerbated by the threat posed by proliferation of invasive alien species in the area (
Figure 3.10). One of the most widespread invasive plant species in the district is *Lantana camara*. It is estimated that close to 17ha in the district especially in the Upper parts is infested by *Lantana camara*. In this regard, there is need to strengthen measures to control invasive species especially in the context of climate change.

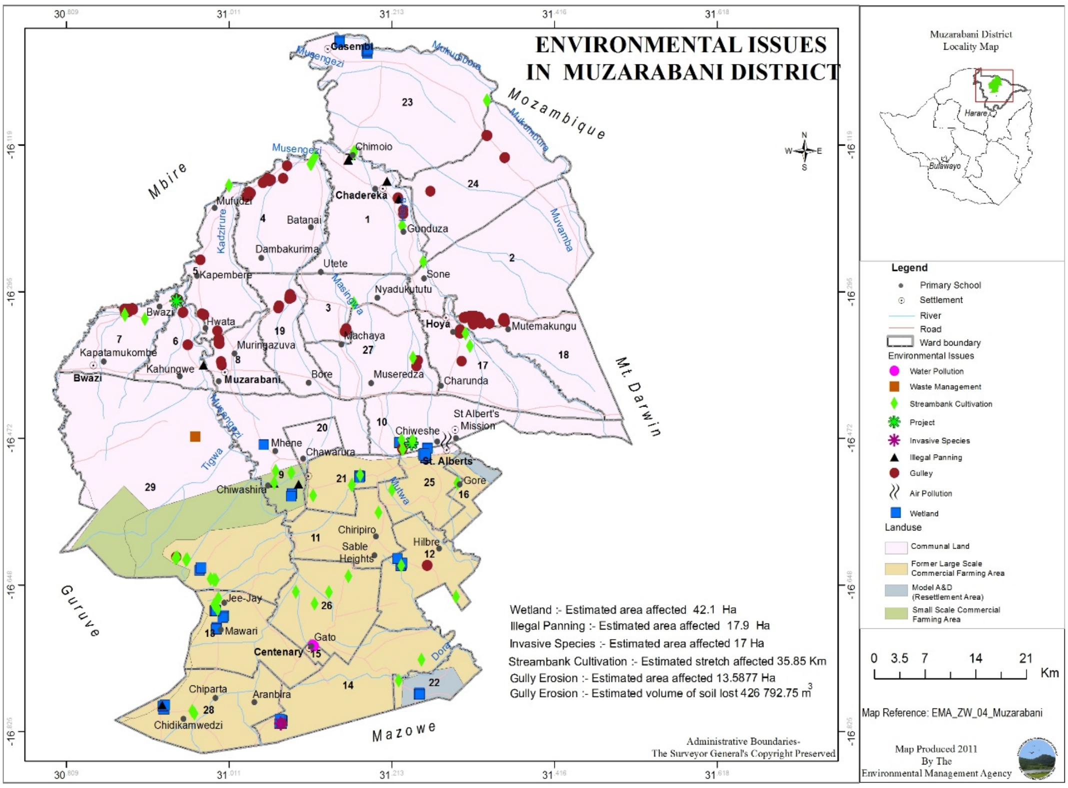


Figure 3.10: Summary of key threats to the structure and functioning of ecosystems (Source: Environmental Management Agency 2011)

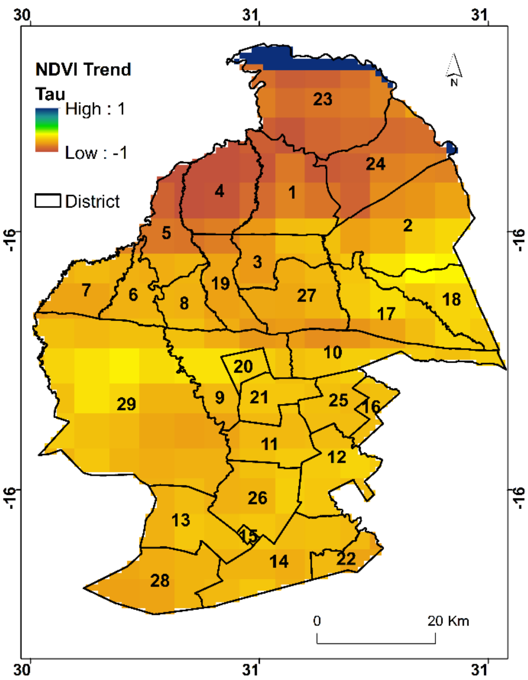


Figure 3.11: Changes in Vegetation Productivity
(Negative values illustrate decreasing trends in vegetation productivity while positive values indicate otherwise)

The district is highly suitable for *Combretum apiculatum* and *Brachystegia boehmii* with the former being highly suitable in the central and lower sections of the study area while the latter is suitable within the central and upper region (
Figure 3.12 and Table 3.4). In addition, *J globiflora*, *Lannea discolour* and *Uapaca kirkiana* dominate the central parts of the district. In contrast, *C. mopane* is only suitable in the relatively dry northern parts of the district. The current distribution of dominant species within the district illustrate that these species occupy specific areas although there are niche overlaps among these focal species.

Table 3.4: Current (2020) habitat suitability (%) of the dominant species in Muzarabani District

Suitability	*B. Boehmii*	*C.apiculatum*	*C.mopane*	*J.globiflora*	*L.discolor*	*U.kirkiana*
Marginal	5		62	57	59	82
Moderate	33		15	27	25	9
High	34	100	19	10	10	6
Very high	28		4	7	6	4
Total	100	100	100	100	100	100

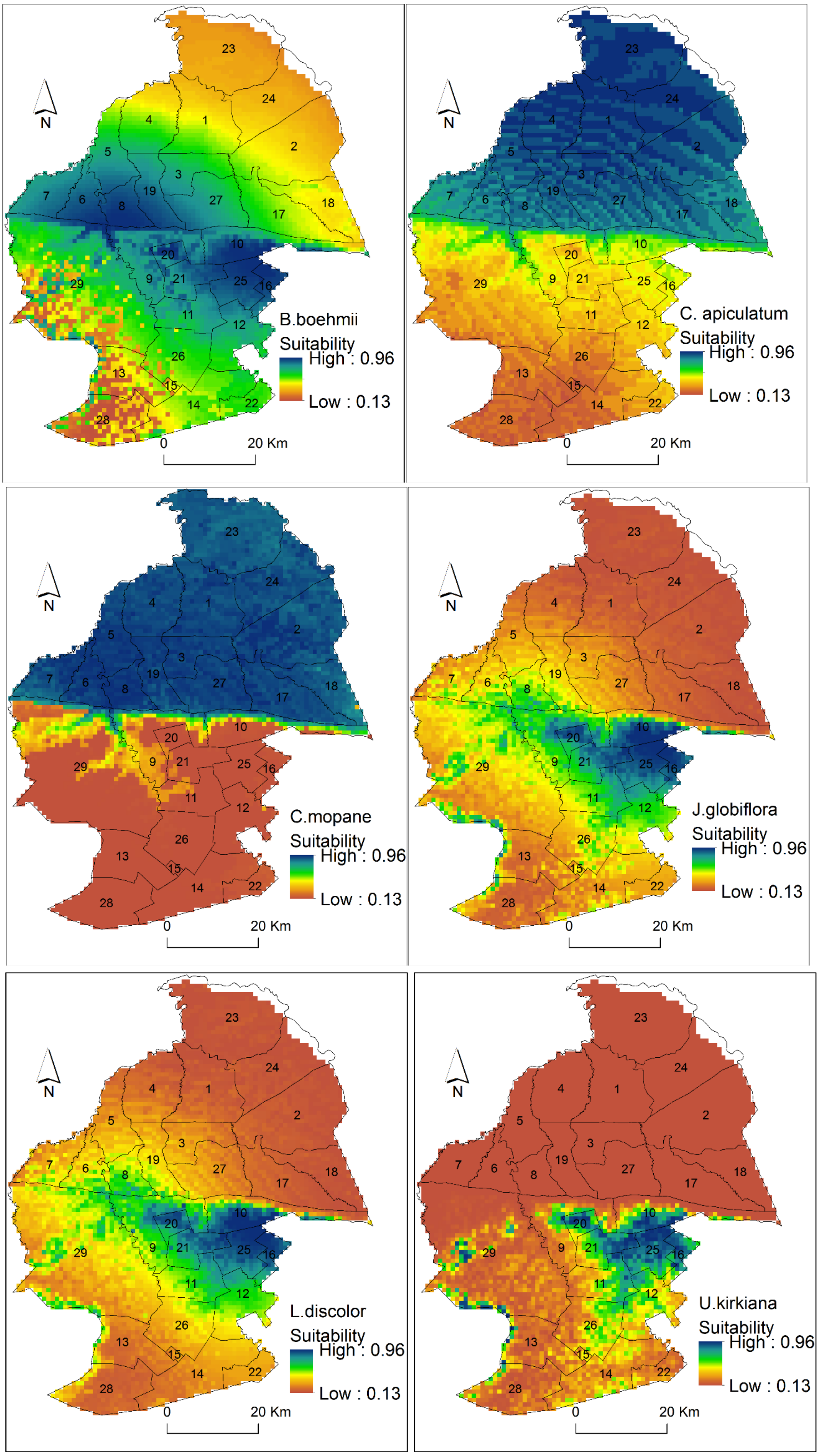


Figure 3.12: Current (2020) suitability of dominant woody species in the study area

Using future climate scenarios, the distribution of dominant woody species in Muzarabani district shows mixed results (Figure 3.13). For instance, under RCP 4.5

B.boehmii is projected to dominate the central and upper parts of the district while the range of *C.apiculatum* shows marginal changes. Under the same climate scenario, the suitable habitat for *C. mopane* is expected to decrease and will be mostly confined to the lower parts of the district.

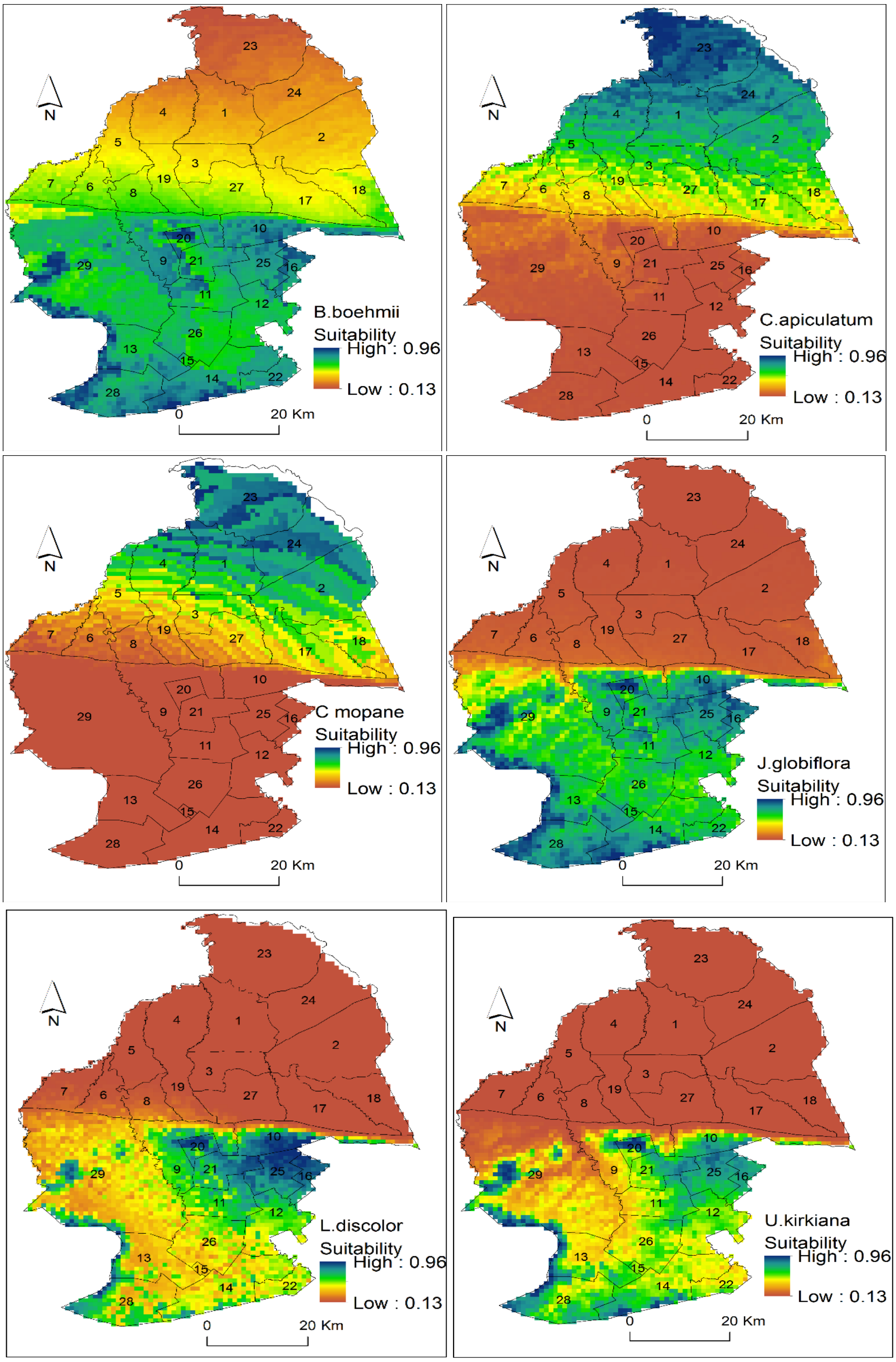


Figure 3.13: Future distribution of dominant woody species based on CSIRO MK3, RCP4.5

Table 3.5: Percentage of area modelled as suitable under RCP 4.5

RCP4.5	B. Boehmii	C apiculatum	C.mopane	J.globiflora	L.discolor	U.kirkiana
Marginal	0	51	43	54	59	63
Moderate	28	17	4	8	23	21
Highly suit	50	21	7	30	12	13
Very highly	22	11	46	9	7	4
Total	100	100	100	100	100	100

However, under RCP 8.5 the suitable habitat of *C. mopane* and *B. boehmii* is projected to increase figure 3.14.

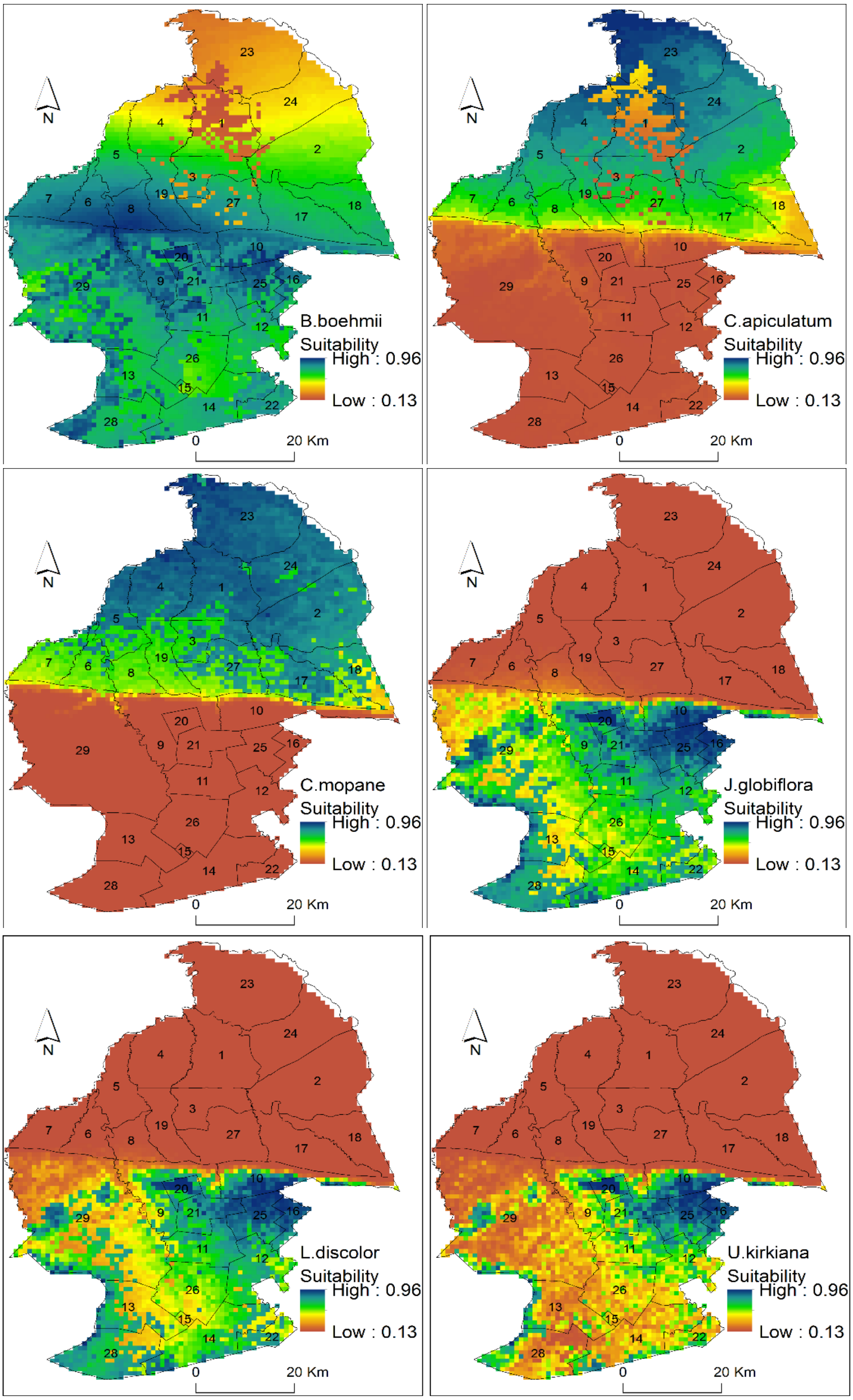


Figure 3.14: Future distribution of dominant woody species based on CSIRO MK3 RCP8.5

Table 3.6: Percentage of area modelled as suitable under the RCP 8.5

Current(2020)	B. boehmii	C apiculutum	C.mopane	J.globiflora	L.discolor	U.kirkiana
Marginal	10	54	49	53	59	71
Moderate	15	10	15	14	13	14
Highly suit	46	26	34	18	16	8
Very highly	30	10	2	15	12	6
	100	100	100	100	100	100

Table 3.7: Modelled changes in suitable habitat of key species because of climate change.

Current vs RCP4. 5	*B. boehmii*	*C apiculutum*	*C.mopane*	*J.globiflora*	*L.discolor*	*U.kirkiana*
Marginal	-5	51	-19	-3	0	-19
Moderate	-5	17	-12	-19	-3	12
Highly suit	16	-79	-12	20	2	7
Very highly	-6	11	42	2	1	0
Current vs 8.5	*B. boehmii*	*C apiculutum*	*C.mopane*	*J.globiflora*	*L.discolor*	*U.kirkiana*
Marginal	5	54	-13	-3	0	-10
Moderate	-18	10	-1	-13	-12	5
Highly suit	11	-74	15	8	6	3
Very highly	2	10	-1	8	5	2

Negative values denote a decrease in suitability while positive values denote otherwise. Zero illustrates areas that are unlikely to change under a future climate

On the wildlife sector climate change is likely to affect wildlife distribution and survival in semi-arid savannas. The potential effects of climate change include changes in the range of certain animal species, emigration of wildlife to suitable areas and even loss of ecosystem function because of changes in wildlife composition. From a wildlife perspective, it was noted that the main effects of climate change on wildlife includes contraction of monthly range due to low rainfall, animal deaths due to heat waves, decrease in water supply and forage, destruction of forests and extinction of certain species. The negative effects of climate change are also being exacerbated by habitat fragmentation and increase in human wildlife conflicts. Due to the climate change related impacts on wildlife, the abundance of the existing species is now low such that some species may become extinct. Out of the dominant species in the area, baboons, bucks, hyenas, monkeys, elephants and warthogs were identified as responsible for destroying people's crops leading to human-wildlife conflicts. The shortage of food for the animals is also made worse by the frequent fires which destroy forage for the animals with 57% of the respondents indicating that fires occur every year.

Results from this study as well as from previous studies show the sensitivity of ecosystems to climate change. For instance, results show that climate change will likely result in:

- changes in tree-grass ratios which in turn influence the ability of these ecosystems to provide goods and services to communities that reside therein,
- contraction in suitable species habitat that may lead to changes in structure and composition of these ecosystems including its associated faunal diversity,
- alteration of thermal cycles of aquatic systems such as rivers and wetland with consequences on the structure and function of these ecosystems especially volume of water in freshwater bodies and wetlands
- phenological changes with subsequent alterations in key ecological processes as well as timing of ecological events.
- increase pressure on biodiversity that is already suffering from anthropogenic pressures such as overexploitation, habitat fragmentation, land-use change and pollution. Already several animal species including mammals, birds, and reptiles have disappeared from the district and climate change will likely increase extinction rates.
- increase in the spread of invasive species due to their ability to establish in new areas and adapt to disturbances.

Interventions

Some of the measures that can be introduced to enhance resilience of ecosystems and livelihoods of communities include:

- strengthening enforcement of biodiversity management laws and by-laws in protected and unprotected areas;
- establishing biodiversity monitoring network to track changes in plant and animal species composition. This is critical in assessing impacts as well as determine the sensitivity of biodiversity to climate change
- promoting land-use practices that reduce fragmentation of habitats thereby providing corridors for species to seek alternative habitats;
- mainstreaming and integrating current and projected biodiversity information into land-use planning especially outside of protected areas
- rehabilitation of degraded ecosystems including wetlands to increase ecosystem goods and services;
- facilitating dispersal and colonisation of endangered or threatened species through intentionally moving species to regions where it has not occurred in the recent past, but could thrive under a future climate
- ex-situ conservation for species seriously threatened by climate change and related anthropogenic pressures
- promoting and enhancing carbon market-based instruments and payment for ecosystem services schemes.

3.4.5 Infrastructure

Extreme weather events such as violent storms and cyclones pose risks of flooding and damage to infrastructure such as roads, schools, human settlements, health facilities, bridges, and communication and electricity lines. Figure 3.15. illustrates the main infrastructure found in Muzarabani District. The main infrastructure facilities such as roads, bridges and housing in the district are not climate proofed. A significant number of settlements are located close to rivers as such they are frequently flooded. For example schools and structures located close to the confluence of Hoya, Musengezi, Dande, and Manyame rivers are affected by backflow from Cahora Bassa Dam.

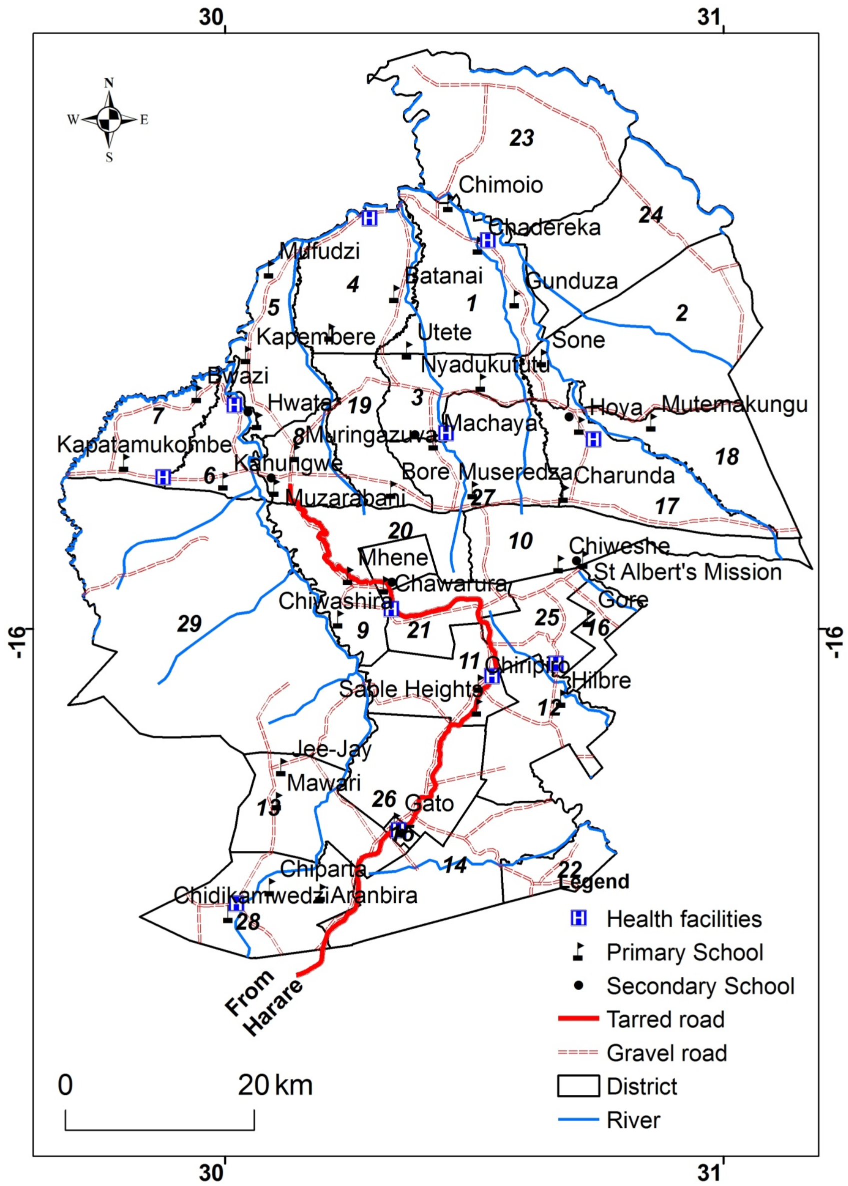


Figure 3.15: Main Infrastructure in the district

The destruction of road infrastructure during floods hampers rescue efforts during disasters and distribution of relief aid in addition to retarding economic growth. Most of the roads are gravel (Figure 19) which make them highly susceptible to destruction. Once there is excessive rainfall, the roads become impassable (see Figure 3.16).

Figure 3.16: Muddy and slippery road after excessive rain in Muzarabani District (Picture courtesy of (Ruswa 2017)

The frequent flooding resulting from excessive rains also damage bridges which link the different wards in the district making the communities even more vulnerable as access to some places is cut-off. The destruction of critical infrastructure such as houses, roads, schools, boreholes and clinics weakens the community's social, economic and human systems. The disruption of water and sanitation services results in frequent illness, malnutrition and overall discomfort that lower earning potential among adults.

Infrastructure Adaptation Interventions

To reduce the negative effects of climate related hazards on infrastructure several recommendations were made:

- Development and implementation of climate proofed building codes and standards
- Mobilise resources for infrastructure development through private-public-partnerships in addition to government funds.

3.4.6 Possible Adaptation Measures in the District

In line with the adaptation measures outlined in the revised NDCs, the following are suggested adaptation measures that can be implemented in Muzarabani district:

i) Develop, implement and scale-up climate smart agriculture solutions and strengthen agricultural value chains and markets;
ii) Enhance early warning and climate-related disaster risk reduction systems (including information management systems);
iii) Ensure climate resilient infrastructure designs and development; and
iv) Develop and promote resilient and sustainable water resources management,

3.5 Climate Change Adaptation Projects in Zimbabwe

Several climate change adaptation projects have been implemented in Zimbabwe. These projects have predominantly focused on the agricultural sector, although other sectors such as disaster risk management are also covered.

Table 3.8: Climate Change Adaptation Projects in Zimbabwe

Sector	Name of Project	Implementing Partners
Energy	Institutional and Domestic Biogas digesters	REA
Housing	Community based Disaster Risk Management in Gokwe district	Ministry of Local Government
	Mapping of safe havens at District levels Manicaland Province, Chimanimani area	Ministry of Local Government
	Relocation of Illegal settlements in Wetlands/River basins and e.g. Budiriro area, Harare	Ministry of Local Government, Local authorities
	Enforcement of building codes	Ministry of Local Government, Local authorities
Forestry & Tourism	Nationwide afforestation and Reforestation	Forestry Commission Sustainable Afforestation Association
	Restoring degraded forest areas e.g. Hurungwe, Mbire and Muzarabani districts	Forestry Commission Rural District Councils
	Lower Zambezi Biodiversity Project, Forest Restoration and Woodland Management, Hurungwe, Mbire and Muzarabani Districts	Ministry of Environment, Tourism, Climate and Hospitality Industry, Rural District Councils
	Drilling solar powered boreholes in National Parks,	Parks and Wildlife Management Authority
Health	Improved toilet facilities in Gwanda District and Tsholotsho District	Ministry of Health and Child Care
	Improved child nutrition by carrying out some feeding schemes at the clinics e.g. Mabvuku Tafara Clinic in	Ministry of Health and Child Care

Sector	Name of Project	Implementing Partners
	Harare, Daramombe Clinic in Chikomba district	
Agricultur e	Climate-proofed Presidential Input Support Scheme	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development
	Green Climate Fund (GCF)-financed 'Building Climate Resilience of Vulnerable Agricultural Livelihoods in Southern Zimbabwe project	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, Climate Change Department and UNDP Zimbabwe
	Building Climate Resilience of Vulnerable Agricultural Livelihoods in Southern Zimbabwe	Ministry of Environment, Climate, Tourism and Hospitality Industry
	Scaling Up Adaptation in Zimbabwe, with focus on Rural Livelihood	Oxfam-Zimbabwe
	Scaling up Adaptation in Zimbabwe, through Strengthening Integrated Planning Systems	
	Adaptation Fund	EMA
	Coping with Drought and Climate Change in Zimbabwe	EMA in MECTHI and supported by UNDP-Global Environment Facility (GEF)
	Lack of Resilience in African Smallholder Farming: Exploring Measures to Enhance the Adaptive Capacity of Local Communities to Pressures of Climate Change,	University of Zimbabwe and the Soil Fertility Consortium for Southern Africa, and funded by the International Development Research Centre (IDRC)
	Building Capacity to Adapt to Climate Change in Zambia and Zimbabwe, implemented by the Midlands State University and supported by IDRC	Midlands State University and ICRISAT
	Community Based Adaptation to Climate Change in Africa, implemented by the African Centre for Technology Studies and funded by IDRC	CIRAD

Sector	**Name of Project**	**Implementing Partners**
	Integrated Climate Risk Management for Food Security and Livelihoods in Zimbabwe focusing on Masvingo and Rushinga districts.	
	Government Pfumvudza programme for improving yields for communal farmers	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development
Cross-sectoral	Zimbabwe Resilience Building Fund (ZRBF)	Enhancing Community Resilience and Sustainability (ECRAS)
		Enhancing Community Resilience and Inclusive Market Systems (ECRIMS)
		Matabeleland Enhanced Livelihoods, Agricultural and Nutrition Adaptation (MELANA);
		Zambezi Valley Alliance for Building Community Resilience (ZVA);
		Building Resilience through improving the Absorptive and Adaptive Capacity for Transformation (BRACT);
		Sizimele Action for Building Resilience in Zimbabwe (SIZIMELE);
		Programme for Growth and Resilience (PROGRESS)
	Presidential Horticulture recovery Scheme	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, ZINWA, Rural District Councils
	Agricultural Information Management Scheme	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, ZINWA, Rural District Councils

Sector	Name of Project	Implementing Partners
	Supporting Enhanced Climate Action for Low Carbon and Climate Resilient Development Pathway	Ministry of Environment, Climate, Tourism and Hospitality Industry
Water	Borehole drilling	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, ZINWA, Rural District Councils
	Dam construction	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, ZINWA
	Zimbabwe Water Master Plan	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, WB
	Enhancement of Data Collection and Sharing for Effective Water Related Disaster Management	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, AfDB, GWPSA, UZ, UMSCC, ZMS, DCP
	Wetland rehabilitation, restoring the biological characteristics of wetlands Nyamhara in UMP, Marongere in Masvingo as well as Matambo in Midlands	EMA
	Rehabilitation of degraded river systems Shamva and Mazowe river systems	EMA
	Construction of dams and dam weirs to cushion farmers during drought season Msenampongo community weir in Matabeleland North Province.	EMA
	UNOPs through the African Development Bank (AfDB) is rehabilitating 9 stations affected by cyclone Idai flooding in 2022	Meteorological Services department (MSD), ZINWA
	The Global Environmental Facility is funding the installation of 6 stations in Save, Buzi and Pungwe Basin during the period 2021 – 2025	ZINWA

CHAPTER 4.0 Climate Change Mitigation

4.1 Introduction

The Government of Zimbabwe (GoZ) is committed to taking urgent action to mitigate the causes and drivers of climate change. Zimbabwe supports the objectives of Article 4 of the Paris Agreement to limit average global temperature increase to well below 2°C above pre-industrial level whilst pursuing economic development efforts towards upper middle-income economy by 2030. The GoZ submitted its INDCs to the UNFCCC in 2015 and this was approved and advanced to NDCs following the ratification of the PA in 2017. The INDC emission reduction target was a 33% reduction in energy-related emissions per capita compared to Business As Usual (BAU) scenario by 2030, conditional on international support. Zimbabwe followed the INDC with the development of the LEDS in 2020, The LEDS sets the course for Zimbabwe to reduce GHG emissions, while ensuring sustainable economic development for the country through 2050. The LEDS is economy-wide, covering GHG mitigation in the Energy, IPPU, AFOLU and Waste sectors. The GoZ submitted its Revised NDC to the UNFCCC in 2021 with a revised NDC target of 40% reduction in GHG emissions per capita compared to Business as Usual (BAU) by 2030, conditional on international support.

Since 2015, Zimbabwe has adopted several important national and sectoral policies and strategies that are central to achieving GHG emission reduction for the country. The overarching national policies and strategies in addition to those outlined earlier in this section include:

- National Climate Policy (2017):
- National Climate Change Response Strategy (NCCRS, 2015):

4.2 Mitigation Assessment Methodology

Zimbabwe has improved its method for assessing mitigation policies and measures. In previous (first, second and third) national communications, mitigation assessment was done at sectoral level only. However, since the development of the LEDS (2020) and the revised NDC (2021), Zimbabwe conducted an economy wide assessment of technical and economic mitigation potential of policies and measures through a consultative approach. Table 4.1 shows the methods employed in the development of the National Communications, INDC, LEDS and revised NDC.

Zimbabwe used a multi-criteria analysis to prioritise the mitigation policies and measures eligible for use in the mitigation assessment for the Revised NDC based on the following:

i) Existence of a local implementing agent
ii) Clear emission reduction/sink enhancement target/ mitigation potential
iii) Definite and current medium to long-term timeline
iv) Alignment with national development goals and targets
v) Responsiveness to available MRV methods/frameworks

Table 4.1: Methodology Used for Mitigation Assessment in National Documents

	Sectoral Coverage	Reference year of target, Base year and historical data	BAU (Baseline) Scenario - Variables used for baseline projections	Mitigation Scenario (Number of Mitigation Actions Selected for Assessment)	Remarks
INC and SNC	Energy, Industrial Processes, Agriculture, LULUCF, Waste	-	-	-	Mitigation assessment not conducted due to lack of complete historical and BAU emission projections. Proposed sectorial mitigation measures mentioned
TNC	Energy, IPPU, Agriculture, LULUCF, Waste	2030 2000-2013	GDP, GDP growth rate, Population, population growth rate, industrial growth rate, average deforestation rate,	Assessment done just for individual measures in each sector	Sectoral mitigation assessment done.
INDC	Energy	2030 2000-2015	Electricity consumption per capita, Population, GDP growth rate	5	
LEDS	Energy, IPPU, AFOLU, Waste	2050 2000-2015	GDP growth rate, Population, industrial growth rate,	38	Assessment includes technical and economic assessment of mitigation potential of actions
Revised NDC	Energy, IPPU, AFOLU, Waste	2030 2010-2017	GDP growth rates, GDP per capita growth rates, Manufacturing value added, Population, Population growth rate	17	Assessment includes technical and economic assessment of mitigation potential of actions

Comparison between LEDS and Revised NDC.

In the LEDS (2020-2050), Zimbabwe identified 38 economy wide mitigation measures. These mitigation measures were projected to significantly reduce Zimbabwe's GHG emissions below the BAU scenario despite strong forecast economic growth. Figure 4.1 illustrates the abatement potential to be 33.2 $MtCO_2e$ by 2050, which corresponds to around 50% of BAU GHG emissions in that year. The largest abatement potential is expected from the AFOLU sector (46.9% of the total abatement potential), followed by the energy sector (44.4%), waste (6.1%), and the IPPU (2.7%).

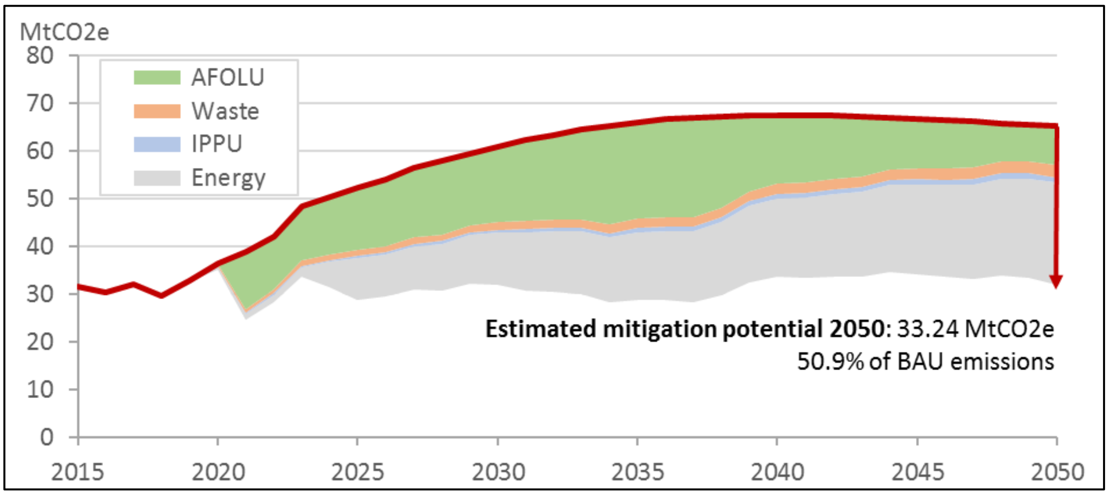


Figure 4.1: Economy wide mitigation scenario in the LEDS (2020-2050)

The updated mitigation contribution of the revised NDC draws on an economy wide GHG mitigation assessment. A total of 17 mitigation measures were selected for inclusion in the revised NDC. Table 4.2 shows that the biggest reduction in emissions from the BAU in 2030 comes from the AFOLU sector (25.35 $MtCO_2eq$), followed by the energy sector (4.2 $MtCO_2eq$), with smaller reductions from waste (0.65 $MtCO_2eq$) and IPPU (0.45 $MtCO_2eq$) sectors. The economy wide GHG abatement potential is 30.65 $MtCO_2eq$ which corresponds to around 40% of BAU GHG emissions in the same year.

Table 4.2: Sectoral reductions in GHGs in 2030 compared to a baseline scenario

Sector	2030 baseline GHG Emissions (million tonnes CO_2-eq)	2030 GHG emissions (million tonnes CO_2-eq)- with mitigation actions	Absolute Reduction (million tonnes CO_2-eq)	Perecentage Reduction (%)
Energy	26.62	22.42	4.2	14
IPPU	4.20	3.75	0.45	2
Agriculture, Forestry and Other Land Use	41.57	16.22	24.35	82
Waste	3.00	2.35	0.65	2
Overall	**75.39**	**44.74**	**29.65**	**100**

4.3 Sectorial Policies and Measures to Mitigate Climate Change

4.3.1 Energy Sector

4.3.1.1 Overview

Zimbabwe's energy portfolio is dominated by biofuels. Energy consumption increased by 15% but the energy consumption per capita decreased by 4% between 2000 and 2017. The contribution in the energy mix of the renewables and waste rose from 65% to 80% while coal contribution dropped from 14% to 3%, and oil remained at 11% (Figure 4.2).

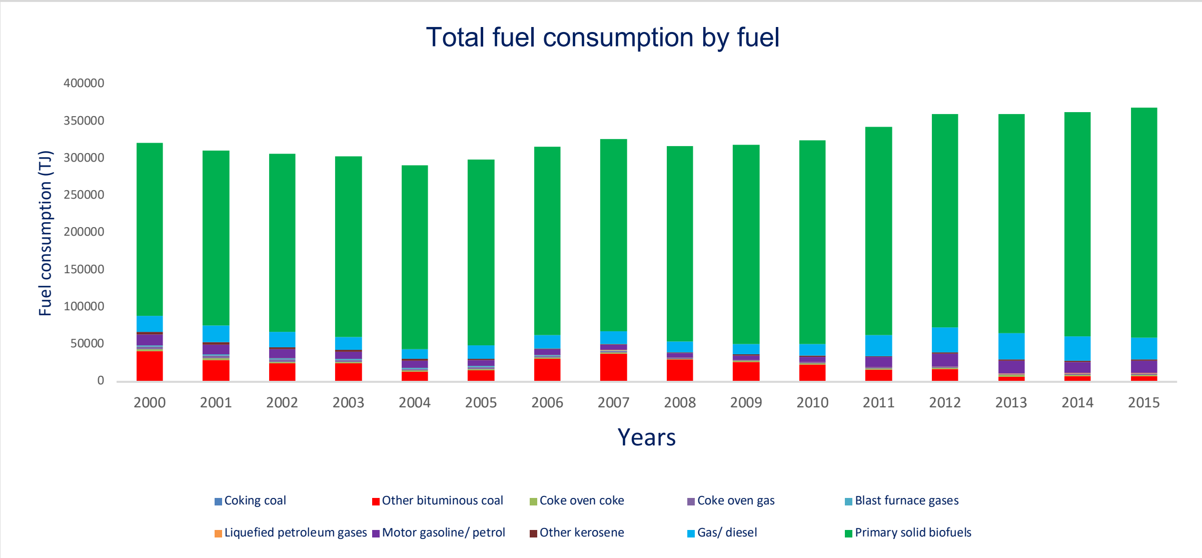


Figure 4.2: Zimbabwe's Total Final Energy Consumption (TJ) for the period 2000-2017

Zimbabwe has been experiencing very serious energy shortages as indicated by the low energy consumption per capita for both total energy and commercial energy. The residential category is by far the largest consumer of energy, followed by transport and commercial sectors (Figure 4.2).

Zimbabwe's power mix is dominated by thermal and hydro. Kariba Power Station, the major hydro plant, and Hwange Power Station, the major coal power plant, are the two main suppliers of electricity. In 2017 they contributed 52% and 43% respectively, of the local electricity generation (Figure 4.3). The remaining 5% came from small hydro power plants (1.6%), small coal plants (2.2%), biomass power plants (0.2%) and diesel power plants (0.7%). The power mix for 2018 would include solar after the construction and commissioning of a 2.5MW Riverside solar plant, 2.25MW Nottingham Estates, 0.33MW Nyanyana North Solar Plant, 2.5MW Centragrid Power Station, 0.45MW Econet Willowvale Solar Plant, among others.

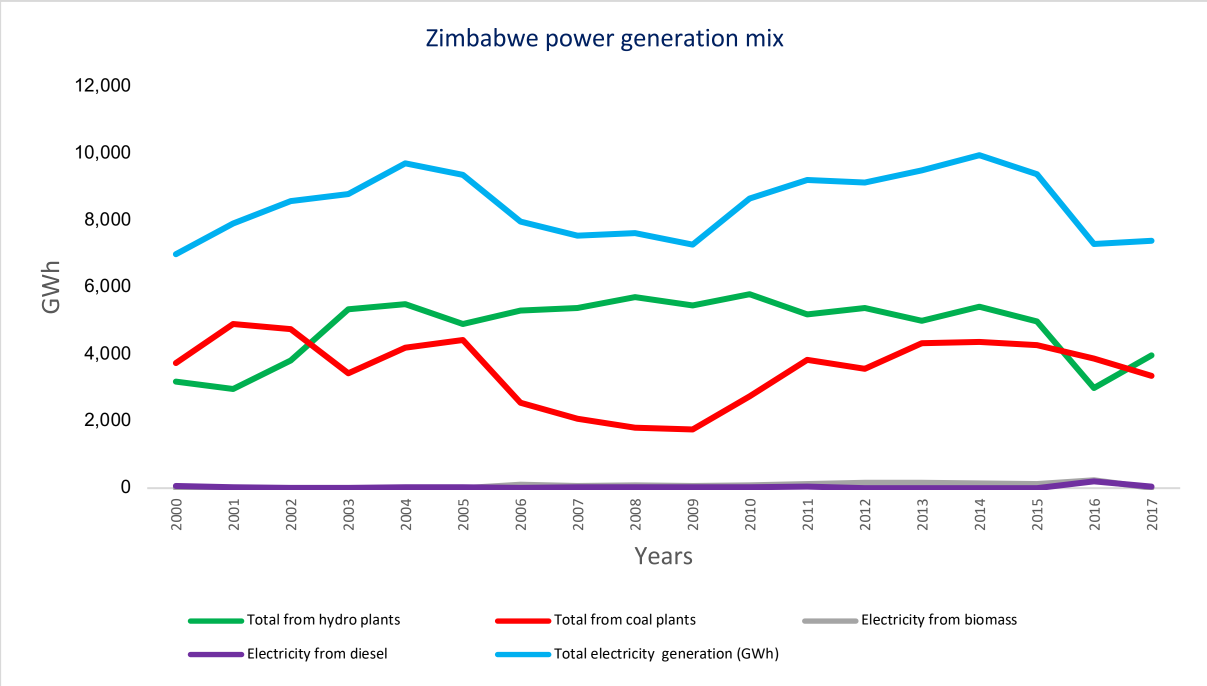


Figure 4.3: Electricity generation by energy source

In order to provide its people with clean and affordable energy and power, the GoZ increased generation capacity at Kariba Power Station from 666MW to 750MW in 2003, and from 750MW to 1,050MW in 2018. Shortages of water in 2015 and the subsequent years were responsible for the reduced generation at the hydropower plants. The Kariba Power Station Load Factor (LF) dropped from 88% in 2014 to 44% in 2017 (Figure 4.4).

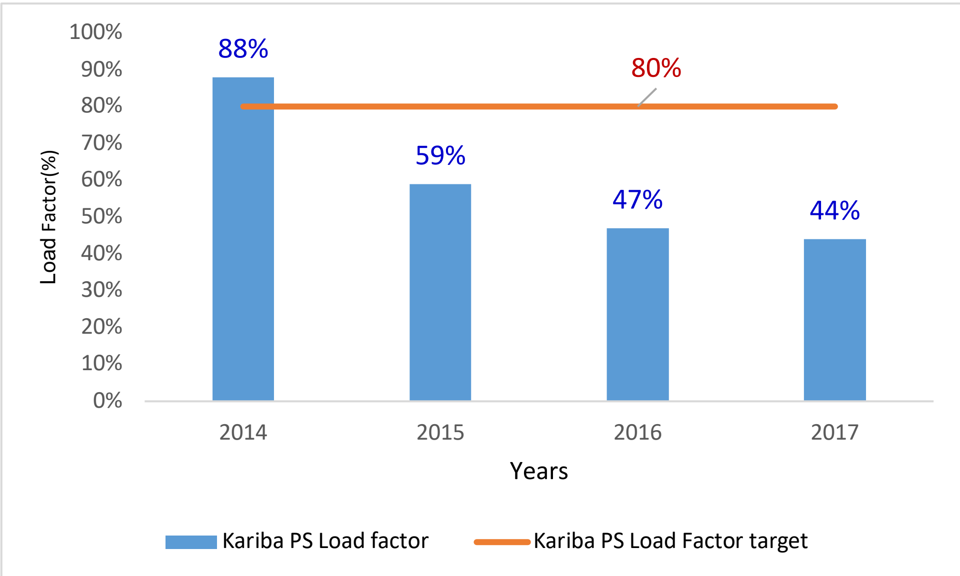


Figure 4.4: Load Factor (LF) trends for Kariba Power Station, 2014-2017

The formation of ZERA in 2011 and the launch of the National Energy Policy in 2012 triggered the sharp rise in mini hydro power development during the period 2012-2017

(Figure 4.5). The rise in installed capacity was steeper during the period 2016-2017, the period Zimbabwe was crafting the National Renewable Energy Policy which was finally launched, together with the Biofuels Policy, in March 2020. However, these mini hydro plants are not spared by the droughts experienced in the country as most of them fail to achieve the ZERA-set capacity utilisation targets of 40%.

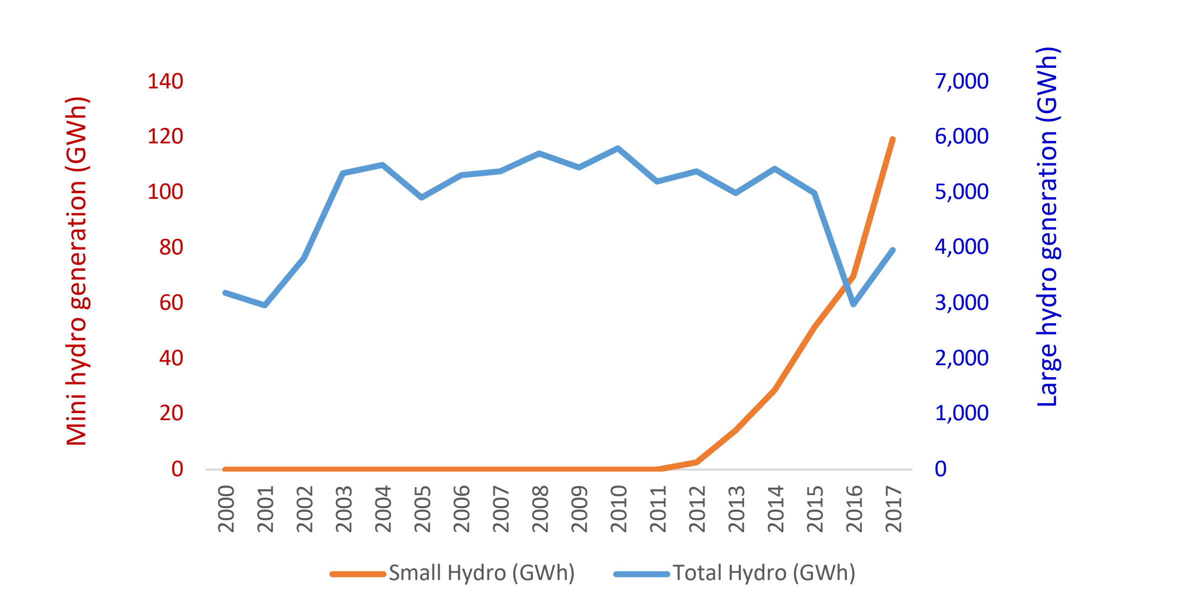


Figure 4.5: Penetration of mini-hydro power in Zimbabwe

Electricity generation at coal plants after the 2008-9 was highest in 2014, but the plant LF of Hwange Power Station was 53% against a target of 80%. The LF has been declining since 2014 due to coal shortages and low plant availability. From 2009 Zimbabwe ramped up power generation at the three small coal plants whose percentage contribution on coal power generation rose from 1% in 2009 to 15% in 2014 but dropped to 5% in 2017 (Figure 4.6). Giving priority to Hwange Power Station over the small and old power stations when it comes to coal deliveries saves energy and money and reduces emissions. These four coal plants are responsible for most of the emissions in the Energy Industries category.

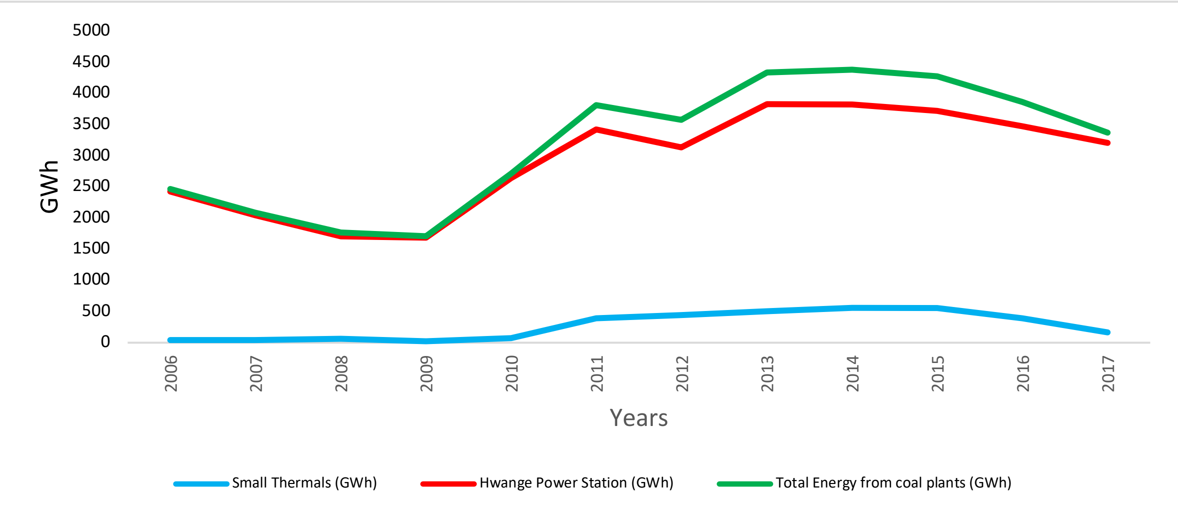


Figure 4.6: Trends of electricity generated at coal plants (2006-2017)

The Government of Zimbabwe has been working on improving the efficiencies of the power plants and reducing technical losses of the transmission and distribution network. Although the plant efficiency of Kariba Power Station has been fairly constant and ranged from 94 to 95% during the period 2014-2018, all four coal plants showed small improvements in plant efficiency, following the refurbishments and re-tooling carried out in the power stations. Hwange Power Station plant efficiency improved from 28% in 2014 to 29% in 2018, but failed to achieve its target of 30%. Bulawayo Power Station improved its plant efficiency from 15 to 18% during the 2014-2018 period, but failed to achieve its target of 20%. Harare Power Station plant efficiency was 22% in 2014 and 23% in 2018, but failed to achieve its target of 25%. Munyati Power Station, which had the lowest plant efficiencies, improved its efficiency from 14% in 2014 to 18% in 2018. The plant which has a target of 20% had a 10% plant efficiency in 2017.

The technical losses, especially the distribution component, have been rising since 2014, from 16.3% in 2014 to 17.71% in 2017 (Figure 4.7). These losses are higher than the national approved target of 12% used to calculate allowable losses in tariff determination. Achieving the target technical losses of 12% will result in significant energy savings and emissions reductions by the utility. In addition, ZERA developed Transmission and Distribution Codes to set progressive agreed targets for the losses which will be linked to tariff reviews.

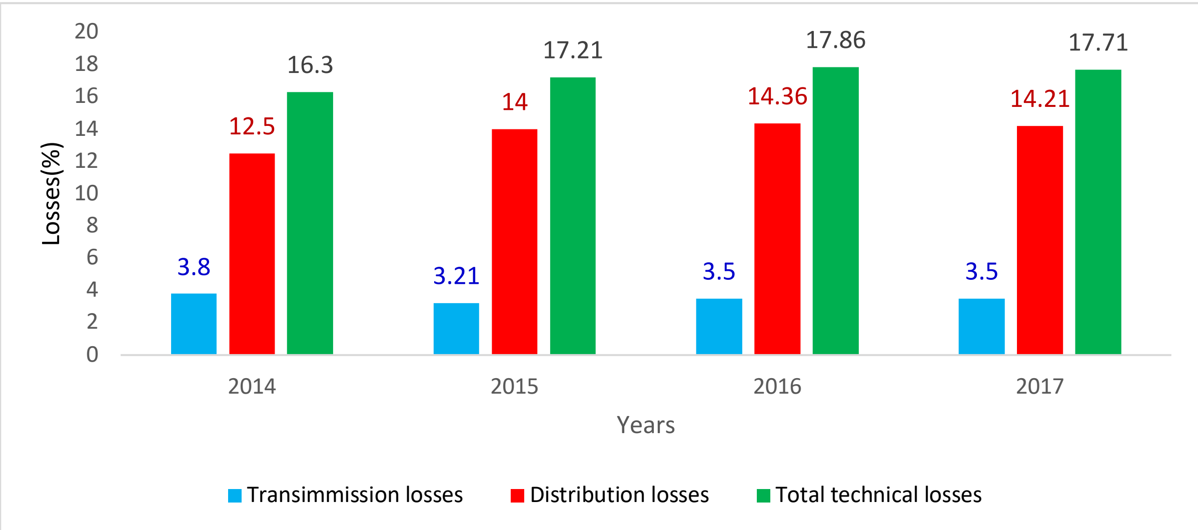


Figure 4.7: Transmission and Distribution losses, 2014-2017

4.3.1.2 Current Energy Sector Mitigation Policies

Zimbabwe developed several policies at national and sectoral levels. These policies form the basis for the development of climate change mitigation actions in the sector. The energy sector policies that are at various stages of development and implementation are shown in Table 4-3.

Table 4.3: National Energy sector-specific policies and strategies

Instrument	Goals, targets and actions	Gender Considerations	Status
National Energy Policy (2012)	Provides a framework for the exploitation, distribution and utilisation of energy resources; The policy aims at: increasing access to affordable energy services; stimulating sustainable economic growth by promoting efficiency; promoting research and development in the energy sector and using of other renewable sources of energy.	The policy acknowledges the need to mainstream gender. The policy also provides for goals and strategies relating to energy and gender.	Under implementation
National Renewable Energy Policy (2020-2030)	The goal of the policy is to increase access to clean and affordable energy. Specifically, the policy aims at: establishing an institutional and regulatory framework for promoting up-take of Renewable Energy (RE); setting a robust procurement mechanism framework for purchase of RE; improving electrification levels in a sustainable and establishing a robust financing mechanism for funding capital intensive RE projects.	• The policy goes to a larger extent in promoting gender equity and recommends certain key initiatives to address gender issues: • Involving Women Entrepreneurs; • Access to Technical Education; • Training Programs: • Assessments and Audits; universities and other educational institutions for	Under implementation

Instrument	Goals, targets and actions	Gender Considerations	Status
		youth and children. In the renewable energy policy, key results and indicators for gender equity involves looking at the Involvement of women in income-generating activities and RE projects and the percentage of women using renewable energy.	
National Energy Efficiency Policy	Targets to address energy intensity across all the primary energy balance mix of the country including a mix of efficient electricity, biofuels and renewable energy solutions to achieve universal energy efficiency in the country.	The policy identifies the need for gender sensitive leadership, governance, mainstreaming and participation in Energy Efficiency Programmes	Draft
Biofuels Policy (2020)	2% target in the production and use of liquid bio-fuels in the transport sector up to year 2030. To improve the viability and long term growth and sustainability of the bio-fuels sector; ensure the maintenance of bio-fuel product quality and standards; improve the productivity and economic viability of bio-fuel feedstock production; implement development	A significant number of issues on gender considered at programme and project level.	Under implementation

Instrument	Goals, targets and actions	Gender Considerations	Status
	trajectories that balance bio-fuel investments with biodiversity maintenance and water and air pollution; and, implement production models that increase community benefits from bio-fuel investments and foster institutional cooperation and coordination.		
National Transport Master Plan (2018)	Medium growth would result in traffic flows increasing by a factor of three. Coal will be the anchor traffic, with ongoing growth from the chrome, sugar, and fuel industries.	The policy does not specify the gaps, barriers and opportunities or gender.	Under implementation
System development plan (ZETDC, 2017)	Hwange 7&8 and Hwange Rehabilitation to be implemented. Rehabilitation of all small thermals not recommended. Developments of Solar capacity at supply side should be limited to protect system security and blended tariff impact. Demand side solar technology should be promoted as compared to supply side solutions Promoting growth in civil aviation	A number of opportunities for women exist especially at project and technology level. Expansion of clean technologies, namely solar PV and biogas can involve women and youths as key players.	Under implementation
Electricity Act (Chapter 13:19)	The law aims to create, promote, and preserve efficient industry and market structures for the provision of electricity services, and to ensure the	This act is silent about gender, women and youth participation and or involvement. Identifying the role	Under implementation

Instrument	Goals, targets and actions	Gender Considerations	Status
	optimal utilisation of resources for the provision of such services; ensure safety, security, reliability, and quality of service in the production and delivery of electricity to consumers and establish appropriate consumer rights and obligations regarding the provision and use of electricity services; consumer connections to distribution systems in both rural and urban areas; c) ensure that an adequate supply of electricity is available to consumers.	of women, and youths, as equals to men counterparts, in electricity generation and efficient usage should be considered in the NDC.	
The Zimbabwe Energy Regulatory Authority Act (Chapter 13:23)	Regulate the procurement, production, transportation, transmission, distribution, importation and exportation of energy derived from any energy source; create, promote and preserve an efficient energy industry market for the provision of sufficient energy	Some efforts were made in the policy and organizational structure. The regulator is strategically positioned to promote the increase in participation of women and youths through consideration of gender promotive licensing requirements and indicators.	Under implementation
Rural Electrification Fund Act (Chapter 13:20)	Act for rural Electrification, collection of the levy to provide for the allocation and disbursement of money from the Rural Electrification Fund.	The Act is silent on gender considerations in appointments for the Board, Chief Executive, as well as disbursement of funds.	Under implementation

Instrument	Goals, targets and actions	Gender Considerations	Status
Sustainable Energy 4 All	Improve access to adequate, reliable, least-cost, environmentally sustainable energy services. The aim is to halve the proportion of people without access within 10 years for each end use and halve again in successive 5 year periods until there is universal access for all end uses	Identifies the need to increase energy access sets energy efficiency targets, clean cooking and renewable energy mix in the power supply for women and children	Under Implementation

Gender issues in the energy sector can be identified at both the supply and demand sides. Women and youths dominate energy use in the communal areas where fuelwood is the main source of energy. Any interventions like fuel switching or technology improvements for addressing GHG emissions from fuelwood need to consider women and youth. Solar Renewable energy technologies present an opportunity for up-scaling the involvement of women and youths. On the demand side, the energy efficiency technology and renewable energy technologies especially standalone systems of solar energy such as: solar micro grids; solar lanterns; solar home lighting systems; and cook stoves, can provide communities with affordable energy, promote productivity and help in creating employment by empowering enterprises for both the rural and urban poor present opportunities for equal participation in gender terms. While biogas technologies are another opportunity for up-scaling the involvement of women and youths, it has its drawbacks considering that women have limited access to livestock dung, much needed for biogas technologies, and the demand for large quantities of water where access is already a strain.

4.3.1.3 Mitigation Analysis for the Energy Sector Actions

Zimbabwe's latest mitigation analysis was done for the Revised NDC. The Revised GHG mitigation assessment evaluated the GHG emission reduction potential of key plans and policies that have been put in place since 2015. In the preparation of the Revised NDC, the historical GHG emissions were updated, the most up-to-date basis for projecting emissions into the future were provided, and an economy-wide GHG mitigation assessment was conducted. The GHG mitigation assessment also evaluated emission reductions of short-lived climate pollutants (SLCPs), such as black carbon, and health-damaging air pollutants that are emitted alongside GHGs. The mitigation measures were analysed using the Low Emissions Analysis Platform (LEAP) model. Three scenarios were developed, that is, a) historical emissions between 2010 and 2017, b) baseline projections of emissions from 2018 and 2030, and c) emission estimates in 2030 estimated to simulate the implementation of policies and measures that aim to reduce emissions in key source subsectors. Specific national activity data was used, whilst emission factors and methodologies were mainly obtained from the 2006 IPCC emission inventory guidelines. All the three direct GHG gases from the energy sector were covered, namely; Carbon dioxide (CO_2), Methane (CH_4) and Nitrous oxide (N_2O).

4.3.1.4 Energy Sector Historical and Baseline Emissions

The main drivers for the emissions in the sector are electricity consumption in both industry and residential sectors, as well as consumption of diesel and gasoline in the transport sector. Total GHG emissions from the Energy sector were highest in 2000 reaching 17,366.07Gg CO_2eq and lowest in 2008 at 8,973.45 Gg CO_2eq, closely reflecting the general performance of the economy. In 2010 the total GHG emissions were 9,500 Gg CO_2eq (Figure 4.8). The Energy Industries is the key category in the energy sector, contributing 52% of the emissions in 2010, followed by Other Sectors at 19% and Transport at 14%. The manufacturing Industries and Construction, Transport and Fugitive categories contributed 11%, 2.4% and 2.0% respectively. The fact that the emissions of the top three emitting categories increased during the period means that the categories deserve close attention when it comes to mitigation prioritisation.

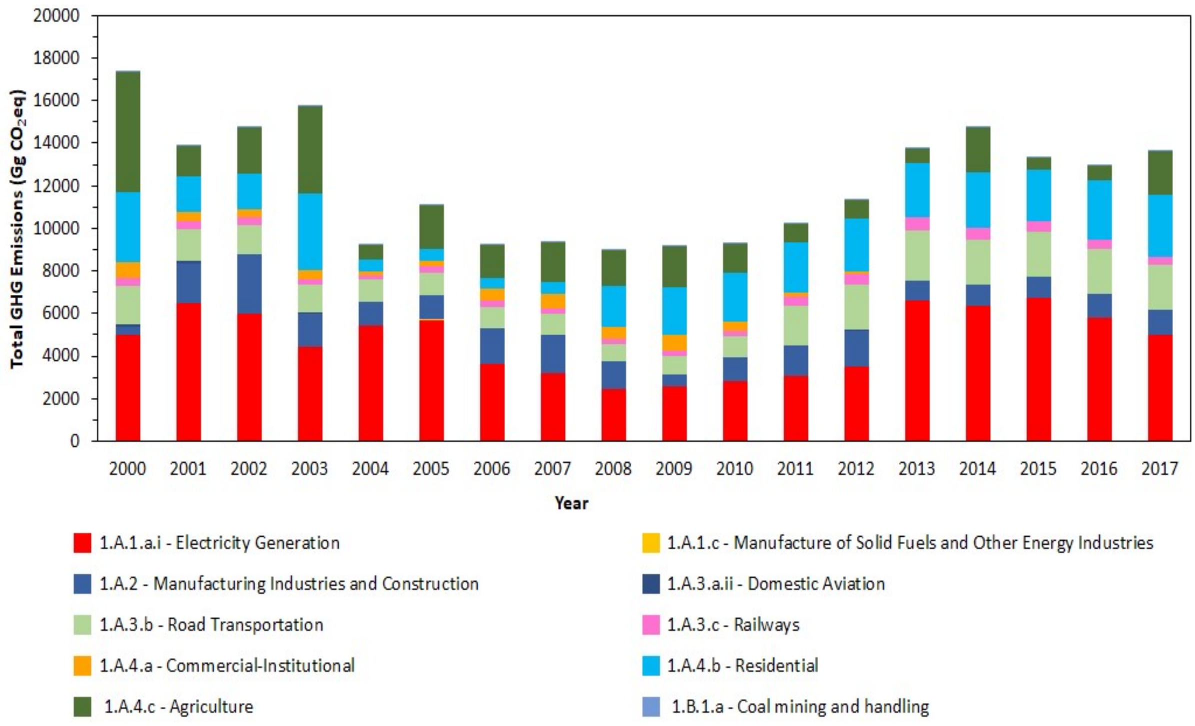


Figure 4.8: Emissions trends by category

The main source of GHG emissions from the energy sector in 2017 was thermal power generation (37.71%), followed by energy consumption in residential (19.08%), road transportation (15.48%) and agriculture (13.84%), as shown in Figure 4.9.

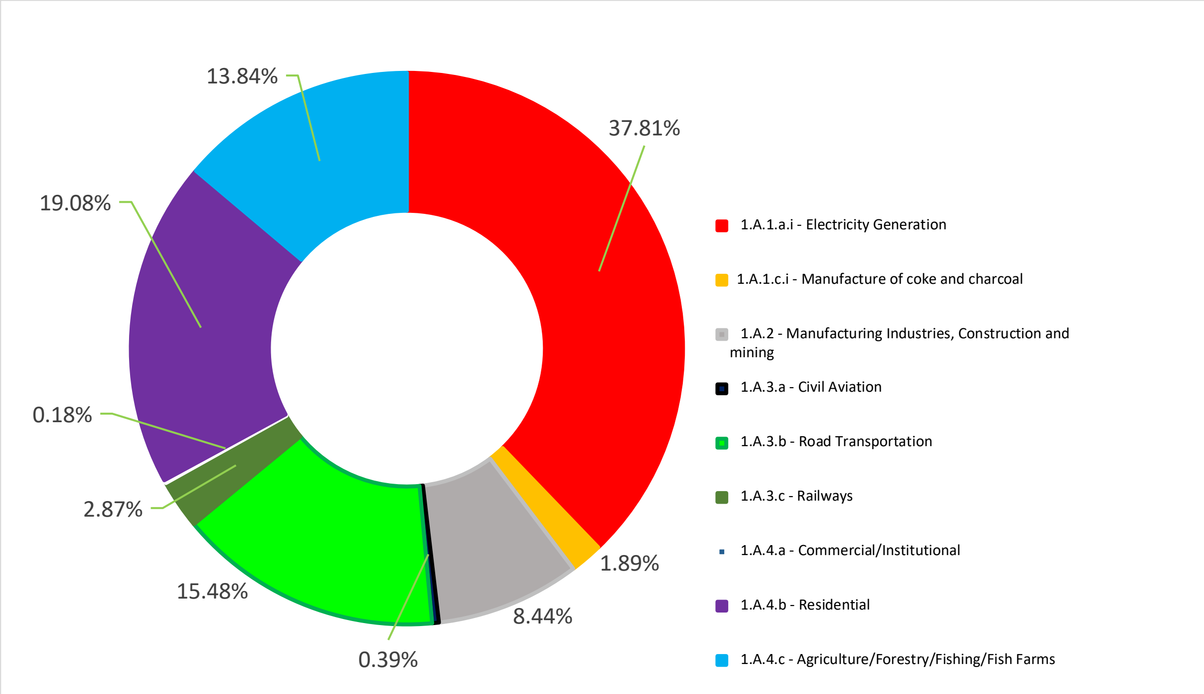


Figure 4.9: Energy sector GHG emission sources in 2017

The baseline for the energy sector is illustrated in Figure 4.10. The introduction of Hwange 7 and 8 in the generation mix explains the jump in GHG emissions from electricity generation in 2020. The historical emissions from the LEAP analysis were lower owing to exclusion of other source categories, notably fugitive emissions from coal mining.

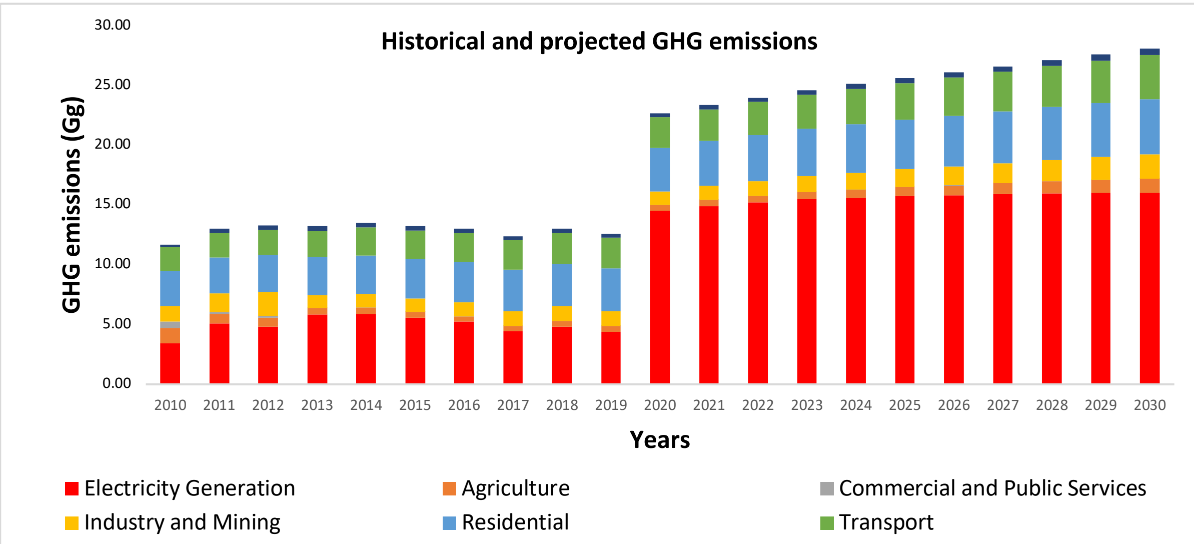


Figure 4.10: Energy sector historical (2010-2017) and BAU emissions

Table 4.4 shows the energy sector mitigation measures that are included in Zimbabwe's key documents namely, the National Climate Change Response Strategy (NCCRS), TNC, INDC, LEDS, Revised NDC and first BUR1

Table 4.4: Mitigation Measures in the Energy Sector

Description of mitigation action	Estimate GHG impact	Projected non-GHG effects	Status	NCCRS	TNC	INDC	LEDS	*Revised* NDC	BUR1	Comments
1. Planned large hydropower (including Batoka and Devil's Gorge).	8.1 $MtCO_2eq$	• SDG Goal 7: Affordable and clean energy	Planning stage	*	*		*		*	The mitigation action was left out of the revised NDC owing to the limited time left for its implementation against the 2030 deadline for the NDCs.
2. Planned solar PV micro-grids.	0.59 $MtCO_2eq$	• SDG Goal 7: Affordable and clean energy • Reduced reliance on climate sensitive energy sectors. • Economic advantages in the long run	Implementation	*			*	*		Planned to be implemented in 2028
3. Planned solar PV utility projects.		• SDG Goal 7: Affordable and clean energy • Reduced reliance on climate sensitive energy sources.	Planned				*			
4. Planned municipal biogas power projects.	9.31 $MtCO_2eq$	• SDG Goal 7: Affordable and clean energy • Employment creation	Planned				*	*	*	4.1 MW biogas capacity added in 2024 (RNDC).
5. Unplanned renewables 2032-2050 (solar PV, CSP, hydro).		• SDG Goal 7: Affordable and clean energy • Employment creation	Planned				*			
6. Reactive power compensation.			Planned				*			
7. Energy efficiency (EE) programme.	2.62 $MtCO_2eq$ by 2030	• Economic benefits	Ongoing	*	*		*	*		The Energy Efficiency Improvements are: Agriculture: 12% savings (2030 compared to baseline scenario); Commercial: 16% savings; Domestic: 22.08% savings; Manufacturing: 18.63% savings; Mining: 8% savings
8. Energy efficient electric motors in mining.		• Economically viable through reduced electricity bills	Ongoing				*			Partly included in energy efficiency in industry
9. Local biofuel production	0.82 $MtCO_2eq$ by 2030	• Employment creation	On-going	*	*		*	*		2% biodiesel in fuel by 2030 in line with the Renewable energy policy.
10. Fuel economy policy.	0.71 $MtCO_2eq$	• Economic benefits; reduced import bill	Planned				*	*		Fuel efficiency improvement 2025-2030: Motorcycles: 2.2% per year; LDVs: 2.9%/year; Buses: 2.6%/year; HGVs: 2.5%/year
11. Electric and Hydrogen vehicles.	0.16 $MtCO_2eq$	• Reduced air pollution • Reduced fuel imports	Under implementation[1]			*	*			

[1] Private sector initiatives

Description of mitigation action	Estimate GHG impact	Projected non-GHG effects	Status	NCCRS	TNC	INDC	LEDS	*Revised* NDC	BUR1	Comments
12. Public transport (modal shift).	176 $MtCO_2eq$	• Health benefits through improved local air quality will also be realized.	Under implementation	*			*	*		5% shift from private car to public transport in 2030
13. Rail refurbishment and electrification.		• Economically viable • Reduced risk	Planned		*	*	*			Not analysed in the revised NDC
14. CSA: Solar pumping for irrigation.	0.2	• SDG Goal 7: Affordable and clean energy • Economic benefits	Under implementation				*			Farm and home level individual initiatives being implemented
15. CSA: On-farm bio-digesters.	0.17	• Reduced electricity bills	Under implementation				*	*	*	Individual initiatives
16. Solar water heating programme.	0.1	• SDG Goal 7: Affordable and clean energy • Economic benefits	Under implementation		*	*	*		*	
17. Rooftop solar PV for SMEs.		• SDG Goal 7: Affordable and clean energy • Economic benefits	Under implementation				*			Include private sector and individual initiatives
18. Off-grid solar electrification.		• SDG Goal 7: Affordable and clean energy • Economic benefits	Under implementation	*	*	*	*	*		Include private sector and individual initiatives
19. Solar LED Street and traffic lighting.		• SDG Goal 7: Affordable and clean energy • Economic benefits	Under implementation				*			Local authority and private sector initiatives
20. Replacement of inefficient lighting devices.		• Economic benefits	Under implementation				*			Supported by Statutory Instrument 21 of 2017 on (Inefficient Lighting Ban and Labelling Regulations).
21. Minimum Energy Performance Standards.		• Economic benefits	Under implementation				*			
22. Reduced Transmission and Distribution losses from 18% in 2020 to 11% in 2025	0.97% GHG reduction vs 2030 baseline/760 $MtCO_2eq$	• Economic benefits	Planned	*				*		Including in the NDS1
23. Households with improved cookstoves: 60% (1,100,000) of rural population using improved cookstoves.	1.59 $MtCO_2eq$	• Economic benefits • Reduced air pollution •	Under implementation	*				*		A CDM project running in the country.
24. Households with improved cookstoves: 22% of rural population using LPG	0.85 $MtCO_2eq$	• Reduced air pollution	Planned					*		Only individual and private sector initiatives running
25. Sustainable Energy Alternatives of curing tobacco		• Reduced air pollution	Under implementation			*				
26. Changing thermal power station technologies, Coal-bed methane (CBM) power.		• Economic development	Planned			*				

Description of mitigation action	Estimate GHG impact	Projected non-GHG effects	Status	NCCRS	TNC	INDC	LEDS	*Revised* NDC	BUR1	Comments
27. ZFC Limited 5MW CDM solar PV project		• SDG Goal 7: Affordable and clean energy • Economic benefits	Under implementation						*	
28. Harava Solar Park 20MW Solar PV		• SDG Goal 7: Affordable and clean energy • Economic benefits • Reduced reliance on climate sensitive energy sources	Under implementation						*	

4.3.1.5 Other Implemented Measures

Industrial Energy and Water Efficiency Improvement

In 2017 Zimbabwe received Technical Assistance from the Climate Technology Centre & Network (CTCN) for piloting uptake of industrial energy efficiency and efficient water utilisation in the industrial sector in Zimbabwe. The project was coordinated by the Business Council for Sustainable Development Zimbabwe (BCSDZ) and UNIDO (June 2018 - Dec 2022). The country received a Technical Assistance from CTCN to the tune of USD260,000 which was used to pay the Consultants who trained 40 local experts on energy management over a 3-day period and carried out energy and water audits in ten companies.

The objective of the mitigation action was to: identify energy, water efficiency and management improvement potential in 10 selected pilot companies and; create capacities to replicate and implement such interventions in companies across Zimbabwe in the future. The following activities were performed:

- Development of implementation planning and communication documents
- Identification and prioritization of 10 units to undertake the preliminary industrial energy and water audits
- Assessment of the energy and water efficiency improvement potential of each company
- Selection of energy supply side options based on renewable energy resources assessed
- Training of company staff and external consultants on ISO 50001 and identification of energy & water efficiency improvement options
- Recommendations on how to best exploit opportunities of integrated water and energy efficiency improvements with renewable energy integration

Baseline energy and water production intensities were established and recorded. It is envisaged that the energy and water efficiency will be scaled up to cover the whole industry sector. In this scaled up project those companies that were audited will focus on implementation while the rest of the companies will be audited. Government will promote the development and growth of Energy Services Companies which will provide auditing and training services to companies. The Government will acquire auditing equipment kits which will be accessible to Audit Teams at a fee. The Secretariat, housed in the MECTHI, will form a Steering Committee which will comprise various ministries and institutions including the industry, mining, energy, finance, science and technology and climate ministries, the utility and business bodies. Auditing and implementation will be expected to run till 2026. Some of the recommendations are under implementation with two of the companies implementing solar projects.

Mandatory Petrol Blending

The target for 20% gasoline blending in Zimbabwe was achieved under Statutory Instrument 17 of 2013. Fuel blending was introduced for economic, social and environmental reasons, which include energy security. The blended fuel should meet fuel quality specifications in terms of Petroleum (Fuel Quality) Regulations, Statutory Instrument 23 of 2013 and Statutory Instrument 147A of 2013. The anhydrous ethanol used for blending shall have minimum purity of 99.3%. Blending of ethanol is only performed by licensed fuel importers.

Global Fuel Economy Initiative (GFEI)

ZERA commissioned the University of Zimbabwe (UZ) to study the vehicle inventory in Zimbabwe to establish its overall fuel economy and to recommend policy measures to reduce fuel consumption and hence emissions. The study was completed in 2018 and made some recommendations which are being discussed with key stakeholders. The main recommendations of the study were;

i) Introduction of new and used vehicle importation regulations to promote more fuel-efficient vehicles
ii) Development and implementation of vehicle fuel economy standards incorporating vehicle fuel efficiency labelling
iii) Promotion of local manufacture of fuel-efficient cars to reduce importation of same
iv) Development and introduction of policies and infrastructure that encourage mass transport systems, i.e. buses and trains and non-motorised transport systems, i.e. walking and cycling
v) Promotion of clean and renewable alternative automotive fuels and energy sources to ensure sustainable supply of vehicle fuels, and
vi) Development of guidelines for vehicle emission standards

Petroleum Standards Awareness

In 2017 and 2018, ZERA trained 420 and 488 service station operators and LPG fillers respectively, to promote LPG infrastructure standards, safe operations and environmental protection.

Private Sector Initiatives

Tongaat Hullet banned the use of firewood in the workers' compounds in favour of LPG which is now distributed in the estates for heating and cooking. The company requested comprehensive training of 10,000 employees in the safe use of LPG. This program will have quite a number of impactful benefits in the areas of health, energy and cost savings, emissions reduction and preservation of forests. The introduction of electric vehicles is being championed by some private companies. Energy audits are being conducted by a number of companies, although the adoption of the ISO 50001 energy management system standard is still low.

Introduction of Duty on Kerosene Imports

Figure 4.11 shows that the use of paraffin was rising faster than that of LPG. As a way of promoting use of LPG, a more efficient and cleaner energy source than paraffin, the GoZ decided to introduce duty on paraffin imports in 2018.

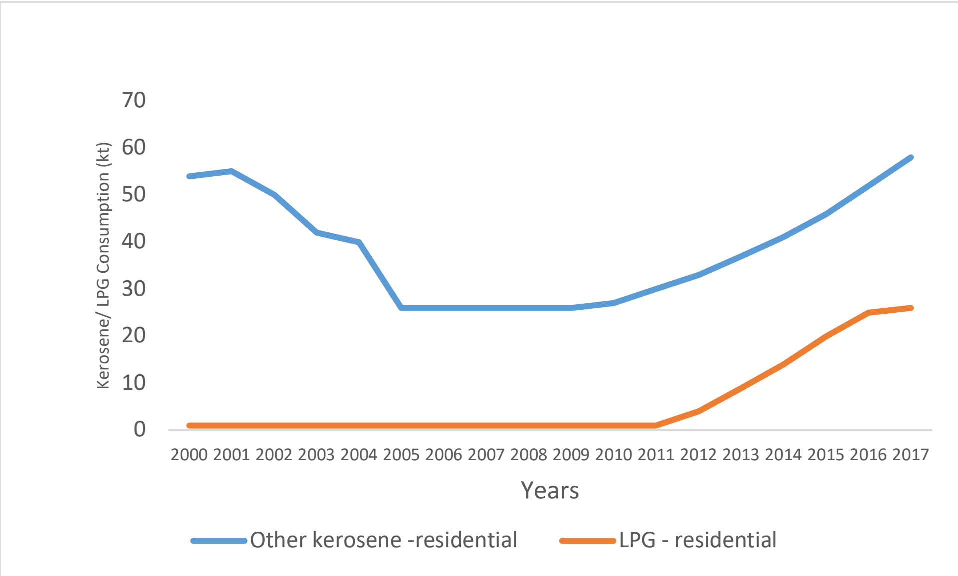


Figure 4.11: LPG and paraffin consumption trends

4.3.1.6 Challenges in GHG Emissions Reduction in the Energy Sector

Some barriers were identified that would affect the effectiveness of implementing the mitigation measures. These include;

- Lack of funding to support large renewable energy projects like the hydro and grid connected solar PV projects
- Low capacity of relevant institutions and persons responsible for tracking climate change mitigations actions. For example, REA does not have capacity to measure and report on the biogas mitigation projects.
- Poor infrastructure to support some projects (electricity grid, poor road network)
- Technology and technical skills not found locally (Efficient vehicles (Evs), Hydrogen Vehicles (HVs))
- Lack of national climate change mitigation MRV framework

4.3.2 Industrial Processes and Product Use (IPPU) Sector

4.3.2.1 Overview

Zimbabwe's industry comprises several sub-sectors which include, but are not limited to, non-metallic mineral products, chemicals, fertilizers, metals and metal products and, food and beverages. The industry sector has traditionally been a key sector in the economy in terms of contribution to GDP, formal employment, and foreign exchange earnings through exports. However, in recent years agriculture has been leading.

In the past two decades, the economy suffered de-industrialisation because of several challenges which negatively impacted all productive sectors. This resulted in the closure of many companies across various sub-sectors, job losses, declining manufacturing sector capacity utilisation and output as well as a decline in the sector's contribution to GDP and exports. As at 2017, the sector contributed US$2,314 million to GDP, i.e., 12.1% of GDP, hence fared well relative to other sectors. This was however below the average of 24% experienced when the country reached its peak of industrial development in the 1980s. The manufacturing sector capacity utilization declined to an all-time low of 10% in 2008 and picked up to 57% in 2011 following the introduction of the multicurrency system. Thereafter, capacity utilization fluctuated, dropping to 34.3% in 2015, then rising to 47.4% in 2016 before registering a slight drop to 45.1% in 2017. According to Zimbabwe's National Industrial Development Policy (2019-2023), potential exists for Zimbabwe to increase manufacturing sector capacity utilization to above 70% by 2023 if structural and economic challenges affecting the sector are addressed. In NDS 1 (2021-2025), the manufacturing real growth rate is expected to increase by 6.4% (2021), 6.5% (2022), 8.0% (2023), 6.0% (2024) and, 6.1% (2025).

4.3.2.2 Update of IPPU Sector Mitigation Policies

Zimbabwe has developed and implemented several policies and measures to support mitigation efforts that guard against environmental degradation. However, some of the legislative instruments for industry are broad and do not specifically focus on addressing climate change mitigation. Table 4.5 presents updated information on the relevant policies and measures in the IPPU sector that have been completed, adopted, under implementation and planned since the TNC. Although the period for some of the policies mentioned in Table 4.5 lapsed, some of the policy provisions were carried over into subsequent policies. There has not been an evaluation to determine the impact of any of the policies and measures whose period of implementation lapsed nor those that are under implementation. It is expected that such monitoring and evaluation will be done during implementation of the Revised NDC and the LEDS (2020-2050).

Table 4.5: Policies and measures relevant to the industry sector

Instrument	Focus areas on industry and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
National Climate Change Response Strategy (2015)	• Creation of a policy and regulatory framework that promotes resource use efficiency and cleaner production (RECP) in industry and commerce. • Developing an enabling policy and	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	Gender consideration during clean technologies development and deployment can help in mainstreaming	Under implementation	2015

Instrument	Focus areas on industry and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
	legal framework that encourages the setting up and operation of climate resilient industries. • Developing regulatory frameworks to encourage emission reduction and investment in resource efficient technologies. • Enforcement and monitoring the implementation of mandatory and voluntary environmental management systems. • Supporting research and development of technologies to mitigate climate change.		gender in the development and implementation of climate resilient industries.		
National Climate Policy (2017)	• Provide financial and economic incentives for use of cleaner technologies and practices • Promote adoption of resource efficient and cleaner production practices • Promote innovation and technology transfer in industry • Develop and implement a National Green Growth Strategy • Enhance monitoring systems based on appropriate methodologies to account for GHG emissions in the industrial sector	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	The policy provides the context for identifying the role that women and youths can play in the process of climate proofing in supply chains of IPPU.	Under implementation	2017

Instrument	Focus areas on industry and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
Zimbabwe Low Emission Development Strategy (2020-2050)	Clinker substitution in cement production using Blast Furnace Slag (BFS) and/ or Fly ash ,	CO_2	Gender mainstreaming can considered in the implementation of the strategy especially in supply chains of industries targeted for climate proofing.	Under implementation	2020
	N_2O abatement through use of a secondary catalyst in nitric acid production	N_2O		Adopted	2023
	Substitution of coke with sustainable biomass (biocoke) in iron and steel production	CO_2, CH_4		Planned	2024
	Substitution of coke with sustainable biomass (biocoke) in ferroalloy production	CO_2, CH_4		Planned	2024
Zimbabwe National Development Strategy 1 (2021-2025)	• Sectoral GDP growth rate from 2019 (-8.7%), 2020 (-9.6%), 2021 (6.5%), 2022 (6.5%), 2023 (7.7%), 2024 (6.1%) and 2025 (5.9%) • Manufacturing Real Growth from 2020 (-10.8%), 2021 (6.4%), 2022 (4.1%), 2023 (7.4%), 2024 (5.1%) and 2025 (5.2%) • Investment in new technologies in fertiliser manufacturing • Resuscitation of the iron and steel company and other SMEs • Increase in the number of ferrochrome processing plants	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	It is envisaged that implementation of the strategy will create jobs through the ramping up of steel production.	Under implementation	2021
Zimbabwe National Industrial Development Policy (2019-2023)	• The Green Industry initiative which seeks to re-orient industries to adopt cleaner and more efficient technologies in view of the emerging challenges of climate change and resource scarcity.	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	The ZNIDP commits to (i) integrate youth and gender issues into all industrial development initiatives at all levels and within all	Under implementation	2019

Instrument	Focus areas on industry and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
	• Targeted programmes under the Green Industry Initiative include, establishment of a Clean Technology Centre • Fiscal incentives for manufacturers such as exemption from import duty for certain machinery and equipment • Government will put in place strategies to ensure that the production of steel, cement, roofing material, timber; paints and glass among other inputs in the construction industry is enhanced		sectors, (ii) increase involvement and participation of women and youths in business and facilitate ownership of the means of production; (iii) prioritize and facilitate the growth of women and youth owned enterprises as well as facilitate exchange and mentorship programmes with large companies; and (iv) reserve a quota of funding for the empowerment of youth and women in industry		
Transitional Stabilisation Programme (2018-2020)	• Resuscitation and growth of the industry sector with resumption of operations at ZiscoSteel and increase in growth of the construction sector	CO_2, CH_4, N_2O		Period completed	2018
Zimbabwe Agenda for Sustainable Socio-Economic Transformation	• Resuscitation and growth of the industry sector with resumption of operations at ZiscoSteel and establishment of new iron and steel companies	CO_2, CH_4, N_2O		Period completed	2013

Instrument	Focus areas on industry and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
(ZimAsset) (2013 – 2018)					
National Environmental Policy and Strategies (2009)	• Promote the adoption of low carbon development pathways, greening industry regulations, voluntary greening initiatives, and environmentally sustainable lifestyles among other considerations	CO_2, CH_4, N_2O	The policy does not specifically cover gender issues in industry. This presents a gap that the NDCs can assess in order to improve the inclusion of women in climate proofing.	Under implementation	2009
Industrial Development Policy (2012-2018)	• Promote environmentally sustainable industrialisation • Increase in capacity utilization of industry from 57% in 2012 to around 80% by end of 2016	CO_2, CH_4, N_2O		Period completed	2012
Science, Technology and Innovation Policy (2012)	• Provide scientific solutions to global environmental challenges.			Under implementation	2012
Environmental Management Act (Chapter 20:27, 2003)	• Establishment of guidelines to minimize emission of greenhouse gases and identify suitable technologies to minimize air pollution	CO_2, CH_4, N_2O		Under implementation	2003
Environmental Management (Prohibition and Control of ODS,	• Prohibition and Control of Ozone Depleting Substances, Greenhouse Gases, Ozone Depleting Substance Dependent Equipment and	HFCs, PFCs		Under implementation	2016

Instrument	Focus areas on industry and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
GHGs, ODS and GHG Dependent Equipment) Regulations, 2016	Greenhouse Gases Dependent Equipment				
Zimbabwe Green Industry Initiative (GII)	• Programme for greening of existing industries through resource efficiency; pollution prevention and safe chemicals management through adoption of competitive technologies and production systems	CO_2, CH_4, N_2O		Under implementation	2018

Government launched the Zimbabwe National Industrial Development Policy (ZNIDP) which clearly commits to the inclusion of women and youth in the process of industrialisation. The Climate Change Policy also provides the context for identifying the role that women and youths can play in the process of climate proofing in the supply chains of IPPU. In the IPPU mitigation efforts focus on the Cement, nitrogenous fertiliser, and ozone depleting substitutes, as well as ferroalloys and ferrochrome. While these technologies are largely applicable at industrial level, their development and deployment as much as possible considers gender.

The Long-Term LEDS provides updates on key focus areas within the industrial sector, of which green industry investment is an important one, resource efficient machinery and equipment, cleaner energy as well as resource efficient production processes. IPPU is linked to a climate change measure in the energy sector and therefore mitigation measures in the energy sector are applicable to IPPU. e.g. solar application for productive purposes and energy efficiency, fuel switching, like the use of natural gas solar lighting and other forms of renewable energy such as mini hydro- electricity. It is therefore key to consider the gender dimensions of energy efficiency interventions.

4.3.2.3 Mitigation Analysis for the IPPU Sector Measures

The latest mitigation assessment was conducted in 2021 and aimed to estimate GHG emissions for three scenarios, namely, i) BAU (or Baseline) projections of emissions from 2018 to 2030, and ii) With Measures (WM) mitigation projections for the period up to 2030 and (iii) With Additional Measures (WAM) projections up to 2030 in the IPPU sector. The measures adopted were mostly from Zimbabwe's LEDS (2020-2050) and an additional one from phasing down of hydrofluorocarbons. The GHG mitigation assessment was developed using the LEAP. The LEAP model has capacity to account for emissions both in the BAU (Baseline) and mitigation scenarios. The baseline scenario projections were based on Zimbabwe's macroeconomic indicators as outlined in NDS 1 (2021-2025). Table 4.6 shows the macroeconomic indicators used and the assumed values. For all the subsectors (mineral, chemical, and metal), the manufacturing growth rate for the period 2021 to 2025 (adopted from the NDS1) and a constant growth rate from 2025 to 2030 was assumed. For the product uses as substitutes of ODS, the GDP growth rate was assumed as adopted from the NDS 1. For iron and steel production, an assumption to return to year 2000 production levels by 2024 was assumed.

Table 4.6: Assumptions on socioeconomic development in Zimbabwe

<table>
<tr><th>Source Sector</th><th>Variable used for baseline projections</th><th>Value</th><th>Source of Data</th></tr>
<tr><td>2A Mineral Industry</td><td>Clinker Production</td><td rowspan="4">Manufacturing Real Growth GDP growth rates
2020: -10.8%
2021: 6.4%
2022: 6.5%
2023: 8.0%
2024: 6.0%
2025-2030: 6.1%</td><td rowspan="4">National Development Strategy 2021-2025</td></tr>
<tr><td>2B Chemical Industry</td><td>Nitric Acid Production</td></tr>
<tr><td>2C Metal Industry</td><td>Pig Iron Production
Ferrochromium Production
Lead Smelting
Ferrosilicon Production
Sinter Production
Steel BOF/EAF Production</td></tr>
<tr><td>2D Non energy Products from Fuels and Product Use</td><td>Lubricant Use
Paraffin Wax Use</td></tr>
<tr><td>2F Product Uses as Substitutes of Ozone Depleting Substances</td><td>HFC Consumption in Refrigeration and Air Conditioning</td><td>GDP Growth</td><td>National Development Strategy 2021-2025</td></tr>
</table>

4.3.2.4 IPPU Sector Historical and Baseline Emissions

Emissions from the IPPU sector contributed 3.3 Million tonnes CO_2eq. (8.7%) to Zimbabwe's 2017 emissions, compared with 3.1 Million tonnes CO_2eq. (9.1%) in 2010, which is a decrease of approximately 0.2 Million tonnes CO_2eq. (7.5%) over the period. In 2017, the largest contributions to emissions in the sector originated from Ferrochrome Production (37%), followed by Cement Production (32%), the Consumption of HFCs (25%), Chemical Production (6%), and insignificant amounts from Non-Energy Fuel Use, lime production, lead and iron and steel production (Figure 4.12).

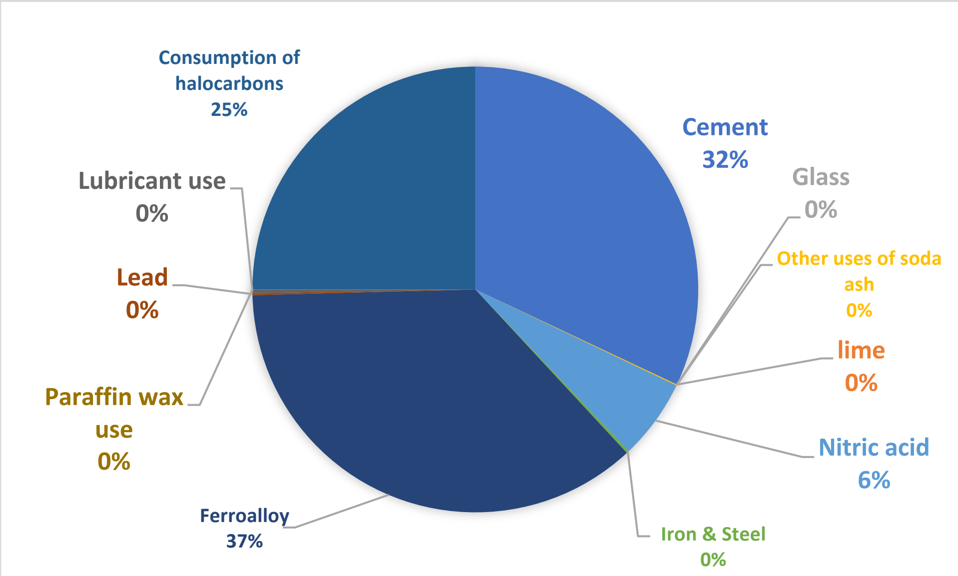


Figure 4.12: Total emissions of GHG in IPPU sector for 2017

Despite the reduction in emissions from 2010 to 2017 due to depressed economic activity and company closures, under the BAU scenario, GHG emissions from cement, fertilizer, iron and steel and ferrochrome industries are expected to increase with the envisaged growth in manufacturing industries (NDS1, 2021-2025). The same increase is expected from consumption of ODS substitutes. Figure 4.13 illustrates the historical and BAU emissions scenario for the IPPU sector for period 2010 to 2030.

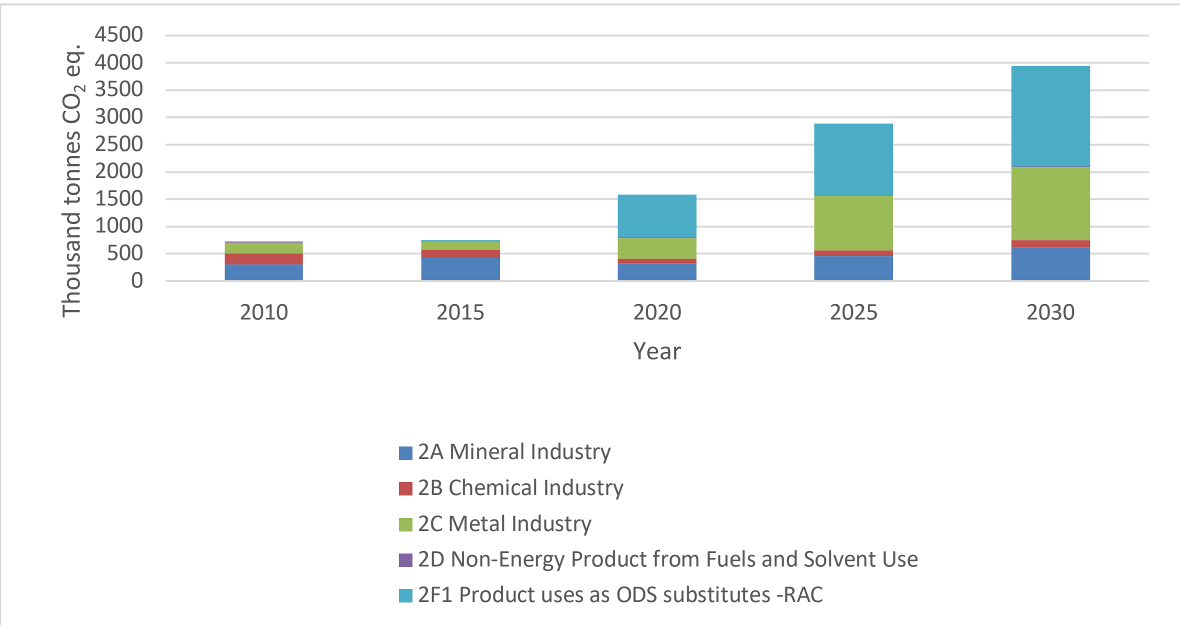


Figure 4.13: Historical and BAU emissions scenario for the IPPU sector

4.3.2.5 Mitigation Measures in the IPPU Sector

Table 4.7 shows the mitigation measures for the IPPU sector which were included in Zimbabwe's key policy and strategy documents namely, the NCCRS, TNC, INDC, LEDS, BUR1 and Revised NDC. Two mitigation measures for substitution of coke in iron & steel and ferrochrome production were excluded in the Revised NDC due to limited studies on the viability of coke substitution using biocoke and the acceptability of the technology with key stakeholders in addition to lack of a clear local implementing agency to advance the project.

Table 4.7: Mitigation Measures in the IPPU Sector

Description of mitigation action	Estimate GHG impact	Projected non-GHG effects	Status	NCCRS	TNC	INDC	LEDS	*Revised* NDC	BUR1	Comments
Increased clinker substitution with fly ash (up to 16% by 2030, 20% by 2050).	0.04 $MtCO_2eq$	• Enhanced competitiveness through cost reductions especially related to clinker substitution in cement production.	Under implementation		*		*			Also supported by the Cement Sustainability initiative (CSI).
Decomposition of N_2O emissions through use of a secondary catalyst.	0.12 $MtCO_2eq$ by 2030	• Local air quality and public health	Under implementation		*		*	*		
Phasedown of hydrofluorocarbon consumption (Freeze 2024, 10% reduction in 2029)	3.34 $MtCO_2eq$ by 2030	•	Under implementation					*		
Substitution of coke input to BF/BOF steel making with biomass (charcoal).	0.19 $MtCO_2eq$	• Local air quality and public health	Planned		*		*	*		
Substitution of coke input to FeCr-production with biomass (charcoal).	0.1 $MtCO_2eq$	• Local air quality and public health	Planned				*	*		
CO_2 emission reduction in metal industry		• Economically viable	Ongoing		*					Also includes process improvement and replacement of obsolete equipment.
NMVOCs emission reduction in food and beverages industry		• Economically viable	Ongoing		*					Also includes process improvement
CO_2 emission reduction		•	Planned		*					Industrial energy and process efficiency.

Figure 4.14 shows the With Measures and With Additional Measures scenarios. The WM scenario include the measures in the Revised NDC and WAM includes the planned measures in the LEDS i.e., substitution of coke by biocoke in the ferroalloy, iron and steel industries. The estimated mitigation potential for the different measures in shown in Table 4.7 above.

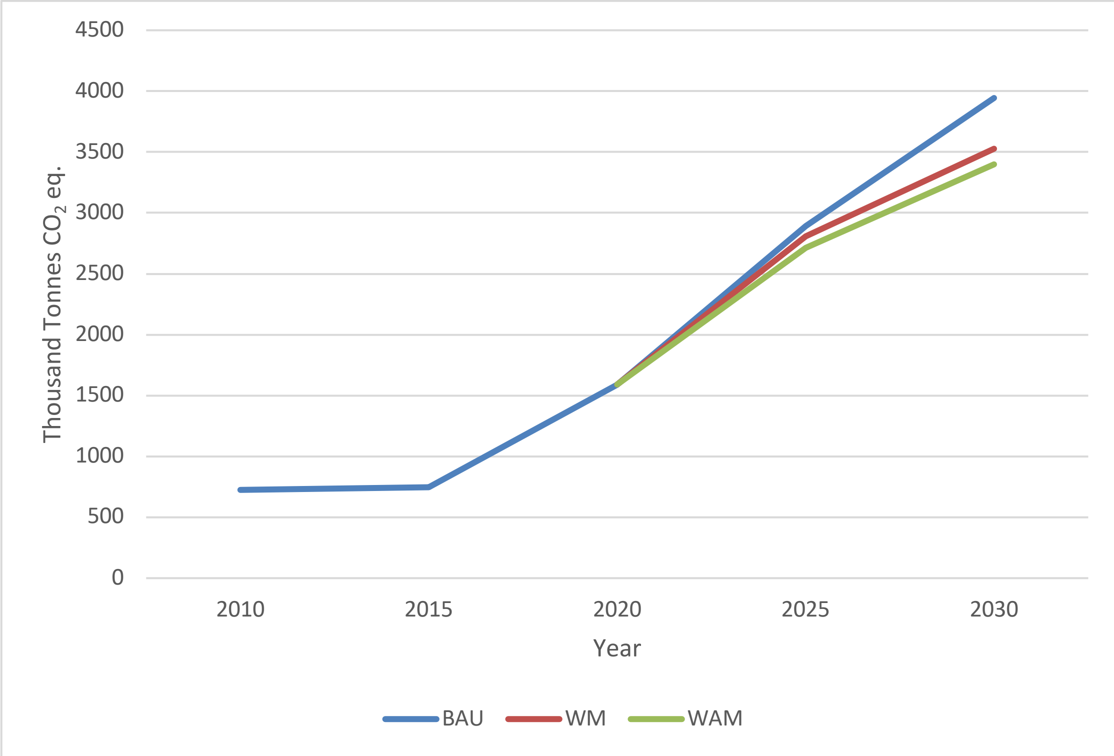


Figure 4.14: Avoided Emissions (BAU, WM, WAM Scenarios) in the IPPU sector

4.3.2.6 Challenges in emissions reduction in the IPPU Sector

Some of the barriers that are likely to impede the implementation of the IPPU mitigation measures include the following:

- Lack of finance to invest in clean technologies such as alternatives to HFCs. Financial support from multilateral funds is needed.
- Lack of institutional capacity of financial institutions to offer credit lines for investment in low carbon projects to private industries. There is need to support the development and piloting of specific financial instruments that could facilitate lending by local banks and financial institutions in mitigation activities.
- Inadequate human and technical capacity to implement and monitor mitigation measures. Capacity building is required to ensure sustainability of the adopted measures.
- The GHG emissions abatement within the metals industry is uncertain due to limited studies on the viability of coke substitution using biocoke and the acceptability of the technology with key stakeholders. More studies need to be conducted to assess both the technical and economic viability of the technology in Zimbabwe in view of other policies such as the Forest Policy.
- Absence of mitigation MRV system
- Inadequate trained mitigation experts and key stakeholders such as data providers and implementing entities
- Low stakeholder involvement in relevant inter-sectoral planning processes & implementation of mitigation measures due to limited understanding. There is need of capacity building and awareness raising workshops with relevant stakeholders.

4.3.3 Agriculture, Forestry and Other Land Use Sector

4.3.3.1 Overview

Consistent with regional policies such as the Comprehensive Africa Agricultural Programme and the Southern African Regional Agricultural Policy, agriculture is viewed as the key pathway for economic growth in Zimbabwe. Agriculture, forest and other land use (AFOLU) resources cover more than 60% of the total land and contributes up to 20% national growth domestic product (GDP) at peak production through providing 60% of raw materials as throughput into manufacturing. The resources support livelihoods of all rural people which represent 70 % of national population. Climate variability and change are linked with economic growth. Economic growth is positively correlated to rainfall and hence responds to water stress caused by high inter annual rainfall variability and frequency of droughts. As with other developing countries, the Zimbabwean agricultural and forestry systems are characterised by low resource-use efficiency and high greenhouse gas (GHG) emission intensities due to high deforestation and land degradation, huge yield-gaps, inadequate nutrition and health of crops and livestock and low productivity. According to the Zimbabwe BUR1, AFOLU-related activities contribute up to 80 % of national GHG emissions. The order of key source categories' contribution to AFOLU sector GHG emissions for the 2010 reporting year were: 33 and 13% corresponding to forest land conversion to grassland and cropland, 26% for land converted to forest land, 7% for enteric fermentation, 6% for direct N_2O emissions from managed soils, 9 % for emissions from biomass burning, 6% for forest land and remaining forest land. The huge share of agriculture and forestry related GHG emissions highlights the importance of AFOLU management activities as drivers of emissions and the need for identifying and prioritising implemented and planned options for GHG mitigation, and enhancing measurement, reporting and verification (MRV) systems for key source sub-sectors.

4.3.3.2 Current AFOLU Sector Mitigation Policies

Current national policy frameworks that deliberately seek to enhance agriculture sector contribution to economic development and food security are shown in Table 4.8:

Table 4.8: Policies and measures relevant to the AFOLU sector

Instrument	Focus areas on AFOLU and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
National Climate Change Response Strategy (2015)	• Develop national capacity to design carbon projects for accessing carbon financing	CO_2, CH_4, N_2O,	The policy reserved section 5 on gender mainstreaming as a cross cutting issue.	Under implementation	2015

Instrument	Focus areas on AFOLU and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
	• Maintain, account for, and expand carbon sinks • Promote appropriate climate smart land-use options • Promote climate smart land uses.				
National Climate Policy (2017)	• Promote good grazing management and feeding practices. • Reduce uncontrolled burning • Promote the growing of cover crops to prevent losses of residual soil nitrogen and reduce N_2O emissions • Strengthen national capacity to control veldt fires • Promote the establishment of woodlots and plantations and improve carbon sinks • Develop national capacity to design carbon projects for accessing carbon financing	CO_2, CH_4, N_2O		Under implementation	2017
Zimbabwe Low Emission	Clinker substitution in cement production using	CO_2		Under implementation	2020

Instrument	Focus areas on AFOLU and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
Development Strategy (2020-2050)	Blast Furnace Slag (BFS) and/ or Fly ash ,				
	N_2O abatement through use of a secondary catalyst in nitric acid production	N_2O		Adopted	2023
	Substitution of coke with sustainable biomass (biocoke) in iron and steel production	CO_2, CH_4		Planned	2024
	Substitution of coke with sustainable biomass (biocoke) in ferroalloy production	CO_2, CH_4		Planned	2024
Climate Smart Agriculture Framework (2018-2028)	• Improve access to, and sustainable use of CSA inputs, tools and technologies; • Increase the use of climate smart farm practices; • Strengthen coordination, Knowledge management and capacity for implementation; • Mainstream CSA into policy, regulatory and disaster risk management frameworks.	CH_4, N_2O		Under implementation	2018
Climate Smart Agriculture Investment Plan (2019)	• Package A: Enhanced agricultural knowledge and innovation system			Under Implementation	2019

Instrument	Focus areas on AFOLU and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
	• Package B: Sustainable Livelihoods through Diversified Livestock Systems • Package C: Water harvesting for resilient crop and livestock production • Package D: Women and youth-focused value chain development • Package E: Resilient commercial dairy farming				

4.3.3.3 Mitigation Analysis for the AFOLU Sector Measures

The GHG mitigation assessment for the Revised NDC aimed to estimate emissions of GHG for three scenarios: i) historical emissions between 2010 and 2017, ii) baseline projections of emissions from 2018 and 2030, and iii) emission estimates in 2030 estimated to simulate the implementation of policies and measures that aim to reduce emissions in key source sub-sectors.

Agriculture and forestry are strongly linked with the rest of the economy, with growth multipliers of 1.5 - 2.7%. The AFOLU sector is anticipated to grow by 7.5-13.5% between 2021 and 2025 (Table 4.8). Annual growth projections for livestock emissions were developed up to 2025 by multiplying the base year emissions by livestock population growth rates predicted in Livestock Growth Implementation plan. Emissions from aggregate sources and non-CO2 emission sources on agricultural land such as rice production, fertilisers application, biomass burning in grasslands, forestland, and croplands were projected using annual GDP forecast for agriculture and forestry (NDS, 2021-25). The LEAP model was used to derive the emission projections and to progressively adjust the projections up to 2030 using the agriculture and forest sector growth rates. Baseline GHG emission projections for FOLU subcategories were derived by continuing the historic trends from Fourth National Inventory data.

Table 4.8: Socioeconomic development assumptions used to develop the AFOLU baseline scenario

Source Sector	Variable used for baseline projections	Value	Source of Data
3A Livestock	Number of Animals	Dairy Cattle: 9.67% yr^{-1} increase Other Cattle: 1.83% yr^{-1} increase Sheep: 8.83% yr^{-1} increase Goats: 6.33% yr^{-1} increase Pigs: 4.17% yr^{-1} increase	Zimbabwe Livestock Growth Implementation Plan 2021-2025
3B Land	Land (forest, plantation, crop, grassland, wooded grassland, wetland, settlement) remaining land type Land converted to other land types	Continuation of historic GHG emission trends (2010-2017)	Fourth National Inventory Report 2021
3C Aggregate sources and non-CO2 emission sources on land	Rice Production Amount of fertilisers applied Area burnt in grasslands, forestland, croplands	Sectoral GDP Growth Rate 2019: -17.8% 2020: -0.2% 2021: 11.3% 2022: 8.9% 2023: 7.6% 2024: 9.5% 2025-2030: 10.4%	National Development Strategy 2021-2025

4.3.3.4 AFOLU Sector Historical and Baseline Emissions

In the year 2017, total GHG emissions and removals in the AFOLU sector were estimated at 56,142 Gg CO_2-eq, while removals were estimated at 15,734 Gg CO_2, giving a net positive flux of 42,029 Gg CO_2-eq. Conversion of Forest Land to Grassland had the highest emission contribution of 19,987 Gg CO_2, (35%) of the total key category emissions as shown in Figure 4.15. This was followed by emissions from conversion of Land to Forest land (28%), Forest Land to Cropland (18%), emissions from Biomass Burning (12%), Enteric fermentation (10%), and Direct N_2O emissions from managed Soils (9%). Emissions from the conversion of Forest Land to Cropland and Grassland have been increasing in the AFOLU sector largely due to deforestation and forest degradation, biomass burning caused by rural settlement agriculture expansion, and firewood extraction for tobacco curing and veld fires.

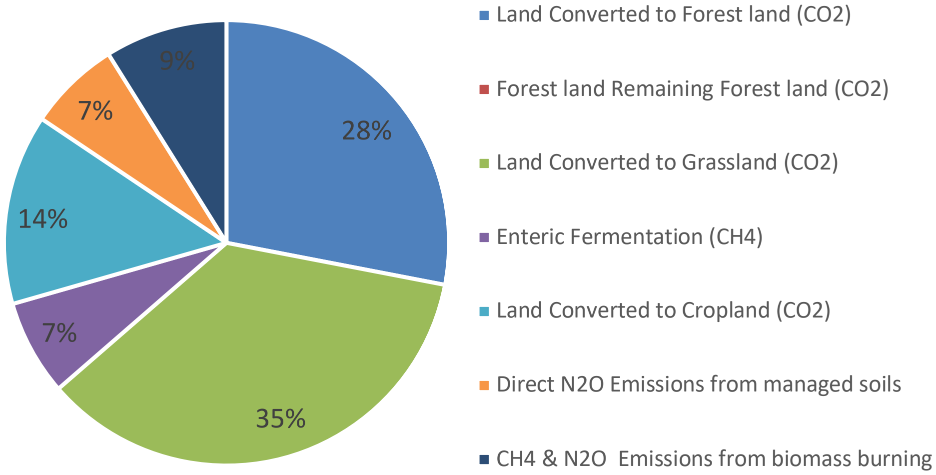


Figure 4.15: Key category analysis of GHG emissions from Zimbabwe's AFOLU sector in 2017.

The total GHG emissions between 2010 and 2017 are shown in Figure 4.16, and range between 15 million tonnes CO_2-equivalent emissions in 2011 and 30 million tonnes in 2015. On average, forestry and other land use is estimated to be the largest net GHG emitting sector, with a 2010-2017 average net emission of 13 million tonnes (42% of the 2010-2017 average total GHG emissions). However, there is substantial variability in the magnitude of emissions from the FOLU sector across the time series.

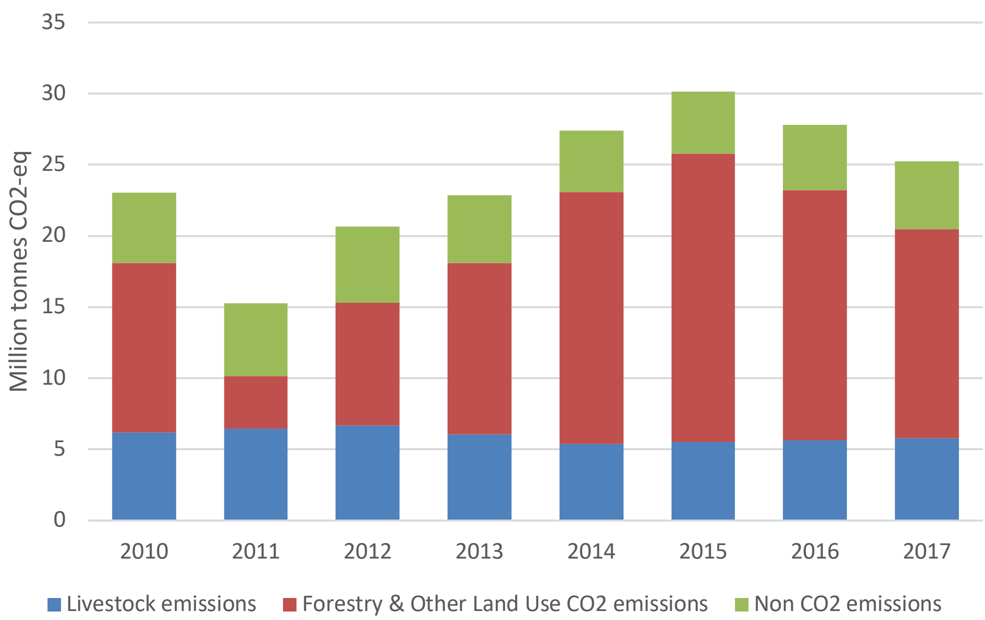


Figure 4.16: Contribution of sub-sectors to total AFOLU sector GHG emissions between 2010 and 2017.

Total sectoral GHG emissions were projected to increase by 86% to 50 million tonnes in 2030 for a baseline scenario, in which policies and measures to reduce GHGs are not implemented, but the AFOLU sector develops as outlined in NDS1 (Figure 4.17).

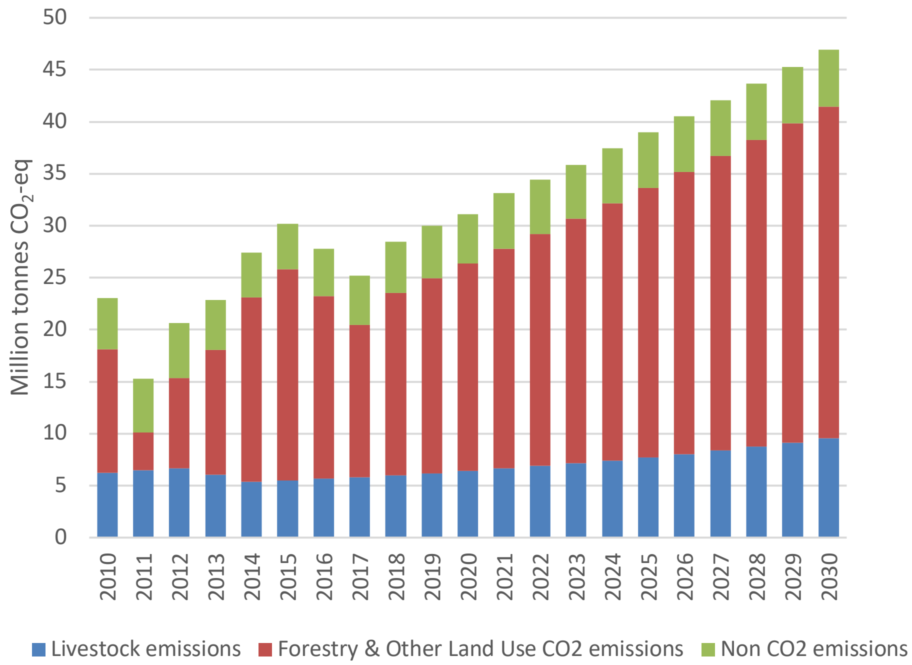


Figure 4.17: AFOLU sector historical and BAU emissions

4.3.3.5 Mitigation Measures in the AFOLU Sector

Table 4.9 shows the mitigation measures for the AFOLU sector which were included in Zimbabwe's key documents namely, the NCCRS, TNC, INDC, LEDS, BUR1 and Revised NDC. The LEDS identified conservation agriculture (CA), improved livestock feeding and reduction of unprescribed burning of forests and grasslands as the major mitigation measures. The NDS1 complements the LEDS by stipulating quantitative targets for actions that address mitigation of GHG emissions.

In the AFOLU sector only 4 mitigation measures were defined in sufficient detail for quantitative modelling in the mitigation assessment based on expert judgement. The mitigation measures included in the Revised NDC represent the mitigation measures that have the highest likelihood of being implemented, and which have a specified agency or institution responsible for their implementation.

Table 4.9: Mitigation Measures in the AFOLU Sector

Description of mitigation action	**Estimate GHG impact**	**Projected non-GHG effects**	**Status**	**NCCRS**	**TNC**	**INDC**	**LEDS**	***Revised* NDC**	**BUR1**	**Comments**
Feedstock improvement		• Economic benefits	Planned		*		*			
Conservation Agriculture	11.36 $MtCO_2eq$	• Improved food security	Under implementation	*	*		*			Supported by government through conservation tillage (Pfumvudza).
Reduction of deforestation	2.77 $MtCO_2eq$	• Increased non-timber forest products value chain	Under implementation	*	*		*			
Fruit Tree planting	0.27 $MtCO_2eq$	• Improved food security	Under implementation				*			
Commercial Forestry	1.0 $MtCO_2eq$	• Timber	Under implementation	*			*	*		
Reduction of prescribed burning	0.37 $MtCO_2eq$	• Reduced air pollution	Under implementation		*		*	*		Initiatives by EMA and Forestry Commission
Low methane rice cultivation			Planned		*					
Mitigate emissions from manure management			Planned		*					
Reforestation	1.28 $MtCO_2eq$ by 2030q	• Increased non-timber forest products value chain. • Environmental aesthetics and air quality	Planned	*	*			*		
Bio-energy Initiatives		• Economic advantages. • Reduced dependence on climate sensitive energy sources.	Planned		*					
Zambezi Valley Biodiversity Project		• Increased non-timber forest products value chain. • Improved environmental aesthetics	Under implementation						*	In progress

Table 4.10: Mitigation scenarios- with measures (2010-2030)

Mitigation Measure	**Source: Plan/Strategy/ Regulation**	**Scenario**	**% GHG reductions vs 2030 baseline (%)**	**Absolute GHG emission reduction 2030 vs baseline (thousand tonnes)**
Increase area of natural forest land from 9.9 million hectares to 10.4 million hectares by 2025: Add 100,000 hectares of natural forest land per year between 2021 and 2025	National Development Strategy	Category 1	12.3	9,598.7
Increase area of plantation forest from 68848 hectares to 118848 hectares by 2025: Add 10,000 hectares of plantation forest land per year between 2021 and 2025	National Development Strategy	Category 1	1.28	1,000.7
Reduce area burned by 500,000 hectares between 2020 and 2025	National Development Strategy	Category 1	26.7	20,925.1
Implementation of conservation agriculture. Increasing area under conservation agriculture from 210,000 hectares in 2020 to 494,955 hectares in 2030	Low Emissions Development Strategy	Additional Measures	12.7	9,980.0

The full implementation of the Category 1 measures i.e., restoration of natural forests, afforestation and reforestation and reduction of forest fires would reduce total GHG emissions by 86.4% (equivalent to 40.5 million tonnes CO_2-equivalent emissions) in 2030 compared to a baseline scenario (Figure 4.18). The implementation of the additional mitigation measure (in addition to the Category 1 measures) would reduce GHG emissions by 109% (51 million tonnes CO_2-equivalent emissions) compared to the AFOLU baseline scenario. The three measures, had the largest emission reduction potentials of any of the individual mitigation measures (

Table 4.10), reducing emissions by 12 and 26%, respectively.

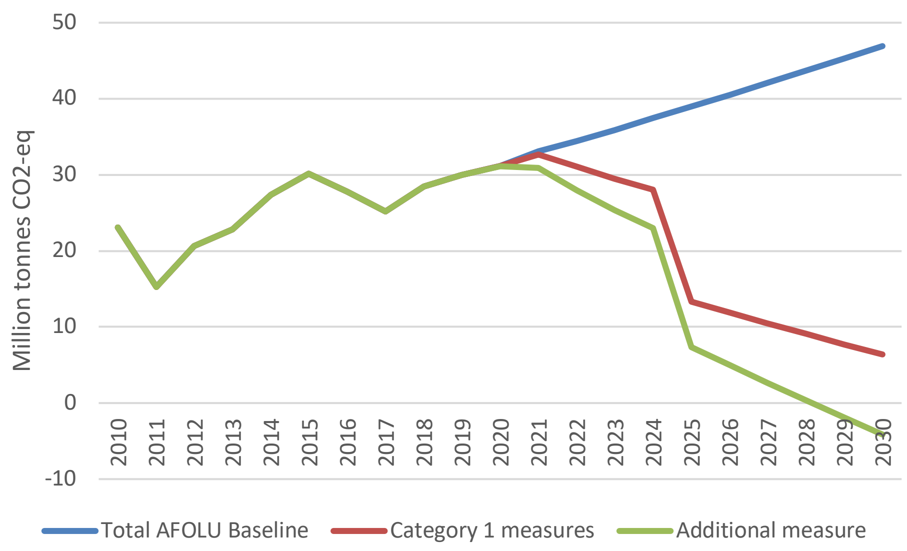


Figure 4.18: Reduction in total GHG emissions from implementation of Category 1 and additional measures in 2030 compared to a baseline scenario

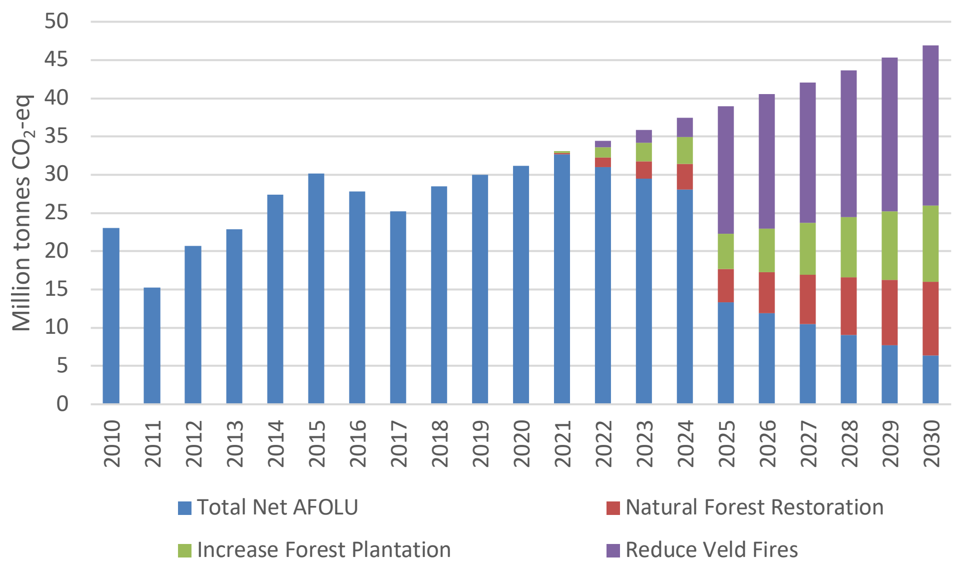


Figure 4.19: Reduction in GHG emissions from implementation of Category 1 measures

To represent soil carbon sequestration due to implementation of conservation agriculture, it was assumed that the SOC sequestration capacity is saturated over 20 years. A default annual rate of increase of SOC 0.16 Mg C ha $^{-1}$ was used for zero tillage systems with residue retention compared to conventional practice in semi-arid regions of Sub-Saharan Africa.

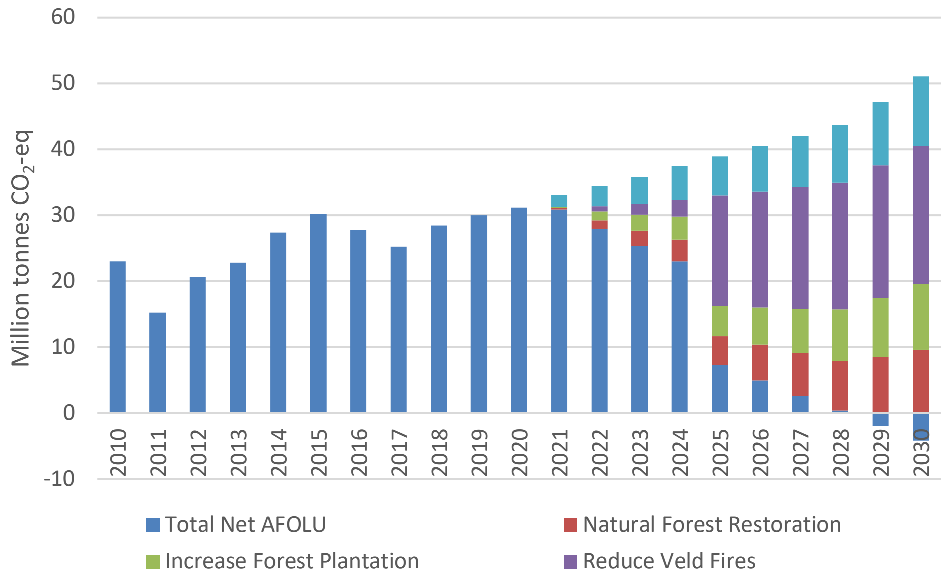


Figure 4.20: Reduction in GHG emissions from implementation of Category 1 + Additional measures

4.3.3.6 Challenges in Emissions Reduction in the AFOLU Sector

- Limited capacity amongst personnel for conducting extensive protocols for ground-truthing forest types, species composition & tree density for monitoring C-stock changes.
- Inadequate financial resources to collect fire and land use data.
- Insufficient disaggregated data for specific planted areas by species & associated C-stocks
- Lack of country-specific data on land use and management appropriately classified into land management systems, including tillage management, and stratified by IPCC climate regions and soil types
- Lack of standardised approaches for collecting disaggregated activity data on animal and feed and country-specific emission factors across agro-ecological regions
- Improvements in policy and institutional arrangements
- Poor integration of climate change mitigation into AFOLU sector policies, strategies, and projects
- Absence of MRV system and inappropriate verification protocols for monitoring carbon stocks & GHG emissions & tracking finance, technology transfer and capacity building support for AFOLU mitigation actions
- Inadequate trained mitigation experts and key stakeholders such as data providers and implementing entities
- Low stakeholder involvement in relevant inter-sectoral planning processes & implementation of mitigation measures due to limited understanding

4.3.4 Waste Sector

4.3.4.1 Overview

The main source of waste GHG emissions in Zimbabwe is solid waste. Zimbabwe produces an average of 2.5 million tonnes per year of solid waste. The per capita waste generation rate tends to be higher in high income areas than in low-income areas. The main activity drivers for waste in Zimbabwe are population growth, urbanization, GDP and unsustainable consumption. The amount of solid waste generated per person per year is increasing. In 2005, generation rates were 0.5kg per capita per day and by 2025 the country is expected to generate 0.7kg per capita per day. Major solid waste types in Zimbabwe include food waste, paper and cardboard, plastics, glass, ceramics, metals, textiles, rubber and leather. The bulk of solid waste is generated in the low and high-density areas.

Wastewater consists of a mixture of industrial and domestic sewage. The amount of wastewater generated in Zimbabwe has been increasing over the years partly due to urbanization and population growth. The waste treatment plants are being overloaded as they were designed to process lower volumes than they are currently handling. The major towns and cities of Zimbabwe (those that have a population greater than 100,000; namely Harare, Bulawayo, Mutare, and Gweru) generate an estimated 532,000 m^3/day of wastewater while smaller towns have an estimated 56,000 m^3/day of wastewater. Consequently, most wastewater treatment plants are facing difficulties in handling the ever-increasing volumes of wastewater.

Table 4.11: Policies relevant in the waste sector

Instrument	Focus areas on waste and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
National Climate Policy (2017)	• Promote waste reduction, reuse and recycling; waste to energy.	CO_2, CH_4, N_2O		Under implementation	2017
NCCRS (2014)	Capacitating local authorities to develop proper, effective and efficient waste management practices; Creating an enabling policy environment which encourages investment into alternative energy production using waste products; Developing an enabling framework to promote waste minimization through education and behavioural change of waste generators	CO_2, CH_4, N_2O	NCCRS advocates for technologies that are gender sensitive.	Under implementation	2015

Instrument	Focus areas on waste and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
National Environmental Policy and Strategies (2009)	Provide economic instruments to improve resource and energy efficiency Promote use of clean energy sources	CO_2, CH_4, N_2O	Principle No. 3 advocates for the participation of all interested and affected parties in environmental governance.	Under implementation	2009
Environmental Management Act (Chapter 20:27, 2002)	To provide for the sustainable management of natural resources and protection of the Environment; prevention of pollution and environmental degradation;	CO_2, CH_4, N_2O	As part of the enablers the policy acknowledges that gender will be mainstreamed in all the strategies.	Under implementation	2003
Zimbabwe Low Emission Development Strategy (2020-2050)	Waste to Energy: It was assumed that 42% of the methane generated would be collected and used for energy production through waste to energy projects in Bulawayo and other major cities	CO_2, CH_4, N_2O		Planned	2021
Zimbabwe's Integrated Solid Waste Management Plan (2014)	To provide a strategic approach to sustainable management of solid wastes covering all sources and all aspects, including generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximising resource use efficiency and reduction in GHGs To reduce GHG emissions from solid waste disposal and treatment through composting. 20% of organic matter to be composted in the long term	CO_2, CH_4, N_2O	Gender, is being mainstreamed throughout the plan	Under implementation	2015
Zimbabwe National Development Strategy 1 (2021-2025)	Sectoral GDP growth rate from 2019	CO_2, CH_4, N_2O		Under implementation	2021

Instrument	Focus areas on waste and climate change mitigation	GHGs Affected	Gender Considerations	Status	Start Date of Implementation
Science, Technology and Innovation Policy (2012)	Provide scientific solutions to global environmental challenges.	CO_2, CH_4, N_2O,		Under implementation	2012
Constitution of Zimbabwe Chapter 4 Section 73 (2013)	Environmental rights, prevention of pollution to be guaranteed by the state.	CO_2, CH_4, N_2O		Under implementation	2013
Urban Councils Act (Chapter 29:15)	Establishment and regulation of local authorities and their function.	CO_2, CH_4, N_2O		Under implementation	
Zimbabwe Transitional Stabilisation Programme (2018-2020)	Improvement on Local Authority service delivery Refuse management, and compactor trucks Relocation of landfills Procurement of testing equipment	CO_2, CH_4, N_2O		Period completed	2018
Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset) (2013 – 2018)	Local Authorities and EMA capacitated to manage pollution. Improved water supplies and wastewater disposal in towns and cities	CO_2, CH_4, N_2O		Period completed	2013
Renewable Energy Policy (2019)	Promote biogas production	CH_4, N_2O		Under implementation	2020

In addition, most of the wastewater treatment plants are old and thus expensive to operate, a situation that has seen most local authorities in the country failing to properly treat wastewater generated within their areas of jurisdiction. The situation is further worsened by inefficiency and frequent breaking down of waste treatment plants. The country's sewerage system has thus been highly dysfunctional.

4.3.4.2 Current Waste Sector Mitigation Policies

Zimbabwe has developed waste management policies, legislation, statutory instruments and measures (mitigation options) that could help in reducing GHG emissions from the sector. Table 4.11 presents updated information on the policies and measures in the waste sector since the TNC (i) whose period has been completed, (ii) adopted, (iii) under implementation or (iv) planned. Any legislative instruments covering energy use in industry is addressed in the Energy sector.

4.3.4.3 Mitigation Analysis for the Waste Sector Measures

The mitigation assessment for the Revised NDC aimed to estimate GHG emissions for two scenarios, namely, baseline projections of emissions from 2010 to 2030; and with mitigation measures adopted for the period up to 2030 in the Waste sector. The measures adopted were from Zimbabwe's LEDS (2020-2050) and Zimbabwe's Integrated Solid Waste Management Plan. The GHG mitigation assessment was developed using LEAP. For the Waste sector, the baseline scenario projections were based on Zimbabwe's macroeconomic indicators as outlined in NDS 1 (2021-2025) and as presented in Table 4.13.

Table 4.12: Assumptions on socioeconomic development in Zimbabwe

Source Sector	Variable used for baseline projections	Value	Source of Data
4A Solid Waste Disposal on Land	Per Capita waste generation rates	GDP per capita growth rates	National Development Strategy 2021-2025
4B Biological Treatment of Solid Waste	Waste collected for composting. Per Capita waste generation rates	Population Growth Rate	National Development Strategy 2021-2025

4.3.4.4 Waste Sector Historical and Baseline Emissions

Since 1990, GHG emissions from the waste sector gradually increased, reaching 1.76 MtCO2eq in 2017. The increase from 1990-2005 and 2011-2017 was due to increased generation and collection rates while the dip from 2006-2011 was attributed to the decline in economic performance with low collection rates for MSW). Compared to 1990, emissions in 2017 increased due to increase in volumes of MSW received at the landfill. Total GHG emissions from 2010 to 2030 for the BAU scenario for the Waste sector are shown in Figure 4.21.

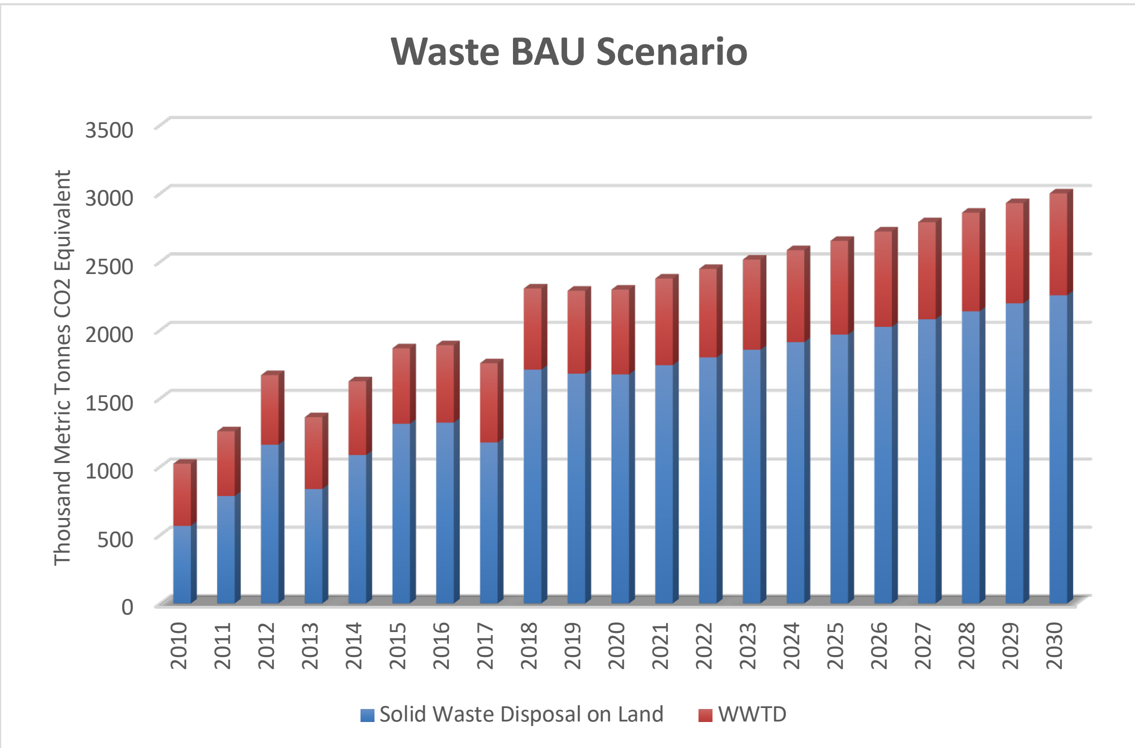


Figure 4.21: Historical and BAU emissions scenario for the Waste sector for period 2010 to 2030

4.3.4.5 Mitigation Measures in the Waste Sector

Table 4.14 shows the mitigation measures for the Waste sector which were included in Zimbabwe's key documents (NCCRS, TNC, INDC, LEDS, BUR1 and Revised NDC). The mitigation measures for the waste sector which are included in the Revised NDC were drawn from the LEDS and Zimbabwe's Integrated Solid Waste Management Plan.

Table 4.13: Mitigation measures in Zimbabwe's key documents for the waste sector

	Description of mitigation action	**Estimate GHG impact**	**Projected non-GHG effects**	**Status**	**NCCRS**	**TNC**	**INDC**	**LEDS**	***Revised NDC***	**BUR1**	**Comments**
Waste	Waste to Energy	1.2 $MtCO_2eq$	• Economic benefits. Reduced dependence on climate sensitive energy sources.	Planned	*	*		*	*		Urban local authorities' initiative
	Composting	1.44 $MtCO_2eq$	• Economic advantages in the agricultural sector	Under implementation		*		*	*		Public and private sector initiatives.
	Solid waste recycling		• Improved environmental aesthetics and local air quality. • Employment creation	Under implementation	*			*			
	Reduction of waste at point of generation		• Economic benefits	Under implementation		*					
	Use of activated sludge and trickling filter water treatment systems and anaerobic digestion of sewage and subsequent methane gas capture		• Reduced pollution to soil and water bodies	Planned	*	*					
	Integrated Solid Waste Management programme		• Healthy and economic benefits • Improved environmental aesthetics and local air quality	Under implementation						*	Supported by EMA

4.3.4.6 Challenges in Emissions Reduction in the Waste Sector

Some of the barriers that are likely to impede the implementation of the waste mitigation measures include inadequate technical and financial capacity to finance and implement the projects. There is a skills gap for the Waste to energy (WtE) project, the project is the first of its kind in the country. Inadequate technological capacity and lack of clear institutional arrangements may pose a challenge. Underdeveloped market for organic fertiliser from compost may pose a challenge and limit the uptake of organic manure.

The barriers can be overcome through;

- Awareness, training and campaigns on behaviour change towards waste reduction and separation at source.
- Capacitating local authorities in integrated waste management practices.
- Promoting investment into WtE through Public-Private Partnership (PPP).
- Promoting awareness on the use and benefit of organic fertiliser.
- Training of engineers on the technical skills required for WtE

CHAPTER 5.0 Research and Systematic Observation and Technology Transfer

5.1 Introduction

Zimbabwe participates in research and systematic observations through a number of government departments and cooperation with a number of research and academic institutions. The programs and projects presented in this chapter includes the fields of meteorology, climatology, hydrology, agriculture and environment. Since the Third National Communication, the following developments have taken place, some of which have been completed and others are in progress:

- Establishment of Zimbabwe Geospatial and Space Agency whose primary objective is to implement any geospatial program in line with policy determined in terms of the Research Act [Chapter 10:22]. The space science component will focus on atmospheric observations and research and development in the in the field of space science.
- The MSD is now able to produce Numerical Weather Prediction (NWP) products which are used for generation of daily weather forecasts using the ZINGSA super computer.
- To enhance systematic observations at local level, 10 Automatic Weather Stations (AWS) were purchased through the NAP Readiness program. These have been installed and now form part of the synoptic station network of the MSD.
- The country is developing the National Framework for Climate Services (NFCS) based on the Global Framework for Climate Services (GFCS), which will enhance the early warning system.
- There is an ongoing data rescue program, supported by the World Food Program (WFP) targeted at updating and recovering data lost during migration from Clicom (an earlier database management system for MSD) to Climsoft. Climsoft is the current database management system for all meteorological data in Zimbabwe.

5.2 Systematic Observations

5.2.1 Surface Observations

Zimbabwe's Global Climate Observation Systems (GCOS) activities are coordinated through the MSD established though an Act of Parliament. The country has 64 synoptic stations of which 47 are functional. Some of the stations serve as agrometeorological stations which provide information to the agriculture sector. Zimbabwe data formats conform to WMO standards. The country also has a Hydrological Monitoring Network which is used for climate studies. Rainfall station network in the country comprises of around 300 stations which are functional. Previously the network was composed of over a 1,000 stations.

Table 5.1: Summary of the Status of Observing Stations

Type of Stations	**Total Number of Stations**	**Number of Functional Stations**
Synoptic	64	47
Rainfall	330	<300
Automatic Weather Observing System	19	3
Automatic Weather Station	17	5
Automatic Rainfall Station	10	0

Table **5.2** shows the location and status of the automatic weather stations in Zimbabwe. It further indicates the project that funded their installations.

Table 5.2: Automatic Weather Stations

Type of AWS station	**Location**	**Status**	**Period established**	**Contributing project**	**Total number of AWS contributed by project**
Synoptic	Henderson	functional	May 2021	National Adaptation Plan (NAP)	6
	Kanyemba	functional			
	Mutoko	functional			
	Buffalo Range	functional			
	Matopos	functional			
	Gokwe	functional			
	Zaka	functional	March 2021	Southern African Regional Climate Information Services for Disaster Resilience Development Project (SARCIS-DR PROJECT)	5
	Rupike	functional			
	West Nicholson	functional			
	Plumtree	functional			
	Binga	functional			
	Lupane	Non-functional,	2017	Danish Church Aid	3
	Insiza	Non-functional			

Type of AWS station	Location	Status	Period established	Contributing project	Total number of AWS contributed by project
Synoptic	Matobo	Non-functional			
	Bumi Hills	Non-functional		Red Cross	1
	Rushinga	Non-functional		China Automatic Weather Station (CAWS)	3
	Belvedere	Non-functional			
	Mwenezi	Non-functional			
Agromet	Bezha (Matabeleland south)	Non-functional	2020	OXFAM	1
	Charandara (Midlands)	Non-functional	2013		1
	Chinyai (Gutu)	Non-functional	2013		1
	Masikati (Zvishavane)	Non-functional	2013		1
	Chakohwa (Chimanimani)	Non-functional	2017		1
	Gunura (Buhera)	Non-functional	2017		1

Table 5.3: Automatic Weather Observing Systems

Location	Status
Robert Gabriel Mugabe International Airport	functional
Joshua Mqabuko Nkomo International airport	functional
Victoria Falls International Airport	functional
Charles Prince international Airport	Non Functional
Thornhill Gweru	Non Functional

Zimbabwe of late has acquired some instruments and equipment to supplement the existing network of systematic observation tools. Below is the list that has been acquired:

- 5 x Hand Held GPS
- 2 X Automatic Weather Stations c/w observation network manager, workstation desktop, and additional guy wire set

- 3 x Digital Barometers
- 5 x Digital Stations c/w Indigo transmitter, relative humidity temperature probe, calibration kit for new instruments and solar power system
- 8 X Digital Thermometers, handheld humidity temperature meter
- 50 x PVC Rain gauges- standard

In addition, 5 Weather Radars were acquired (yet to be delivered) to be situated at various key strategic points in the country that which will assist in provision of early warning information. The weather radar network will suffice to cover the whole country.

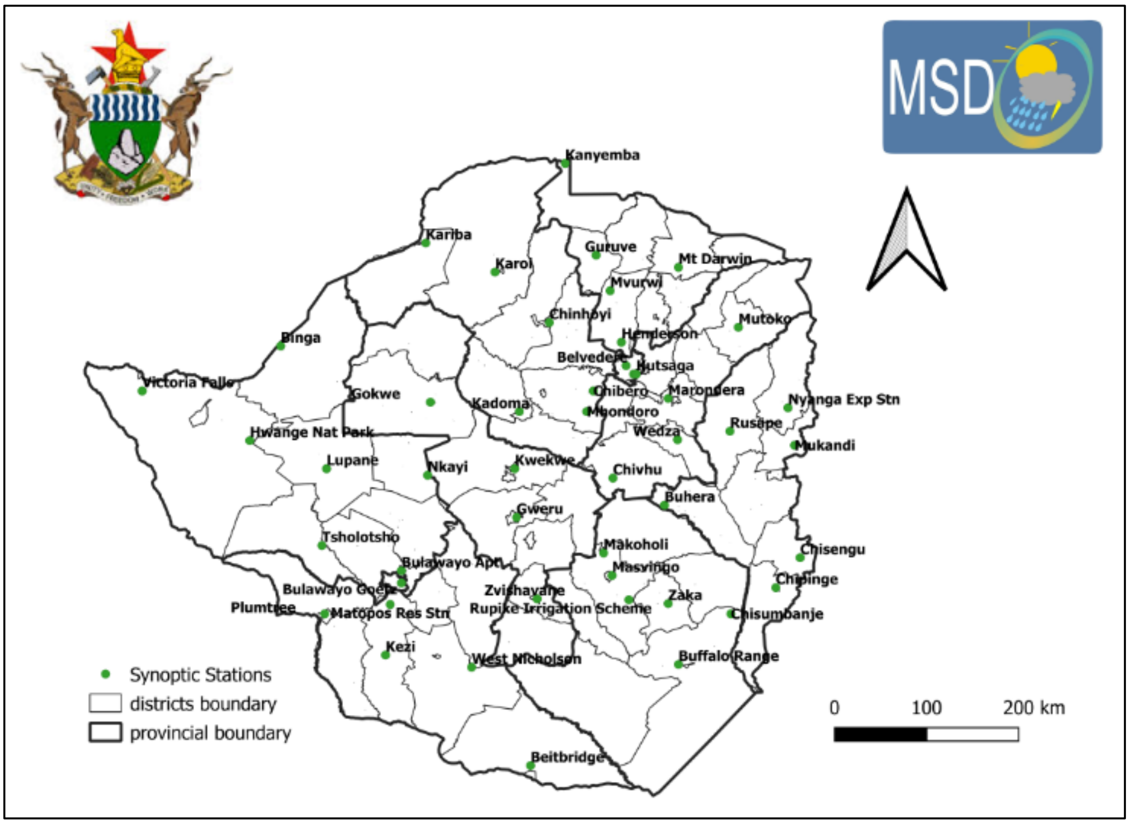


Figure 5.1: Distribution of Synoptic Stations in Zimbabwe

5.2.2 Upper Air Observations

Zimbabwe has 14 stations that make up the Upper Air Network (UAN) of the country. Unfortunately non are currently operational due to unavailability of radiosondes, balloons and hydrogen. Table 5.1 below summaries the type of meteorological stations in the country.

5.2.3 Agroclimatic Monitoring

The MSD cooperates with the Department of Agricultural Research and Extension (Agritex) in carrying agroclimatic observations. Climate data is hosted by MSD while crop yield data is hosted by Agritex (Crops branch). The information sharing contributes to the national early warning system

Zimbabwe is in the process of developing a National Framework for Climate Services (NFCS), a collaboration between the Meteorological Services Department and key stakeholders. The NFCS is based on the Global Framework for Climate Services (GFCS) which is endorsed by the World Meteorological Organization (WMO). The framework is designed to mainstream climate science into decision-making at all levels and help ensure that the country and every climate-sensitive sector of society is well equipped to access and apply the relevant climate information. The NFCS is to enable better management of the risks of climate variability and change at all levels, through development and incorporation of science based climate information and prediction services into planning, policy and practice. The framework for Climate Services is user-need driven, and includes five major components: (i) observations; (ii) climate research, modelling and prediction; (iii) a climate services information system (CSIS); (iv) a climate user interface programme (CUIP); and (v) capacity building.

5.2.4 Hydrological Monitoring

ZINWA has gauging stations in all catchment areas. The stations monitor surface water runoff and siltation levels. Table 7.2 provides a summary of the status of gauging stations by catchment.

Table 5.4: Status of Surface Water Gauging Stations

Catchment	Operational stations
Manyame	22
Save	29
Sanyati	32
Mazowe	58
Gwayi	20
Mzingwane	45
Runde	34
Total	**240**

A number of projects have provided additional real time gauging stations as a way of enhancing the network

5.2.5 Air Quality Monitoring

EMA monitors air pollution. Air pollution is a multifactorial and complex phenomenon spanning across multiple pollutants which have different impacts on human health. EMA obtains data from Plume Labs which they use to develop the Plume Air Quality Index (AQI). The AQI gives an immediate overview of pollution levels.

5.3 Data Collection, Management and Access

While data collection is hampered by limited technological access, it is envisaged that the development of low cost equipment locally which meets WMO standards will improve network density while increasing data availability. The innovation hub concept which is being proposed by government can be used to develop such kind of equipment. Community radios can also complement information centres in awareness raising through the dissemination of weather and climate information.

5.4 Research

Zimbabwe recognises that climate change is occurring and that it threatens among others food security, water resources, health, ecosystems and biodiversity. Added to that are poor socio-economic conditions that further exacerbate Zimbabwe's vulnerability to climate change. Appropriate adaptation and mitigation strategies that foster resilience and reduce carbon emissions can only be informed by research. Research and observations play a pivotal role in providing data and information to support policy formulation and climate change adaptation and mitigation actions for the country. Climate change research in Zimbabwe remains suboptimal due to lack of clear policies as well as data availability which limits the scale to which research can be carried. However some limited research has been undertaken by some institutions.

5.4.1 Current Research

Some of the research work includes:

i) Indigenous knowledge for weather and climate forecasting has been done in some areas in Masvingo, Manicaland and Mashonaland East provinces (University of Zimbabwe, Midlands State University, Great Zimbabwe University, International Water Management Institute. Whilst some smallholder farmers still rely on indigenous knowledge, the fluctuations in climate extremes now outpace the indigenous indicators used by farmers hence making them more vulnerable to impacts of climate change.
ii) With regards to future Climate Change projections, Zimbabwe has developed locally downscaled scenarios through the NAP Readiness Project.
iii) Zimbabwe has conducted some research on GHG emissions with recorded examples including those on nitrous oxide emissions from agricultural soils. These are however still to be linked to the national GHG process.
iv) The Agro-ecological zones map was updated taking into considerations the changes in the climate patterns that have been observed across the country. The map has already been commissioned for use.

The Research Council of Zimbabwe (RCZ) conducts annual international research symposium under various themes which emphasize on various climate change themes. For example the theme for the 12th symposium was "The Nexus between Research and Industry: Key to Innovation and Sustainable Development".

5.4.2 Orientation, Financing and Research Landscape

Government support towards climate change research is limited hence the need for improved coordination to make it all encompassing. The research produced also needs to be linked to the national climate change management discourse. Some research has been done by the EMA; RCZ; and various local universities. Non-governmental Organisations and development partners have also provided funding for research, however most of the research has focused on vulnerability, adaptation, mitigation and Disaster Risk Reduction (DRR).

5.4.3 Climate Science Research

Climate science concerned with atmospheric properties remains an under-researched in Zimbabwe. Available climate indices were done in 1997 but for less than 5 stations. There is need therefore to develop current climate science research targeted at answering some of the pertinent questions related to mitigation and adaptation actions. Policy development needs to be informed by science in order to respond to the climate change impacts appropriately at the local level.

5.4.4 Climate Change Impacts Research

Research on climate change impacts in Zimbabwe have been done to some level, however most research has concentrated on agriculture and water resources and is often generalised for other areas and sectors such as such as forestry, energy, and transport. This calls for collaboration with national, regional and international institutions that are also involved in the field of research in climate change

5.5 Gaps and constraints in Research and Systematic Observations

Gaps and constraints existing in the following areas need to be addressed:

- There is need to document and validate existing Indigenous Knowledge Systems (IKS) practices across the country.
- The current future climate projections for the country area based on the CSIRO MK3 GCM. However, there is need to integrate other models to reduce the level of uncertainty.
- There is limited finance from the national fiscus to support infrastructure and equipment maintenance particularly for the meteorological and hydrological network of observing systems.
- Some of the equipment is now obsolete and cannot be configured to give observations which match with current data management systems.
- Gauging stations are providing limited data as operations are being affected by lack of spare parts and maintenance issues.

CHAPTER 6.0 Climate Change Education, Training and Public Awareness

6.1 Introduction

Education, training and public awareness are the key elements for enhancing the understanding of climate change issues among the general public. Article 6 (a) of the UNFCCC requires Parties to, among others, "*promote and facilitate at the national and, as appropriate, sub-regional and regional levels, and in accordance with national laws and regulations, and within their respective capacities*":

i) The development and implementation of educational and public awareness programmes on climate change and its effects;
ii) Public access to information on climate change and its effects;
iii) Public participation in addressing climate change and its effects and developing adequate responses; and
iv) Training of scientific, technical and managerial personnel.

Within the framework of TNC several workshops and seminars were conducted with various stakeholders that included, teachers, education policy makers, parliamentarians, and heads of Ministries to raise climate change awareness. Among issues covered was the exploration of courses within the educational system which covered climate change concerns. Elements of a climate change communication strategy were proposed. Despite the above preliminary efforts, the general level of public awareness on the complex issues of climate change remains insufficient, even among policy-makers.

Since the publication of the TNC, education, training and public awareness raising activities were undertaken. These included awareness raising and training for GHG inventory data providers, local authorities and traditional leaders, Zimbabwe National Army, Faith Based Organisations (FBO), public sector, private sector, media and the youths. These stakeholder engagements also informed the development of a National Adaptation Plan and National Climate Change Learning Strategy which is to strengthen learning and skills development in key sectors. This chapter also highlights gaps, constraints, and challenges in conducting Education, Public Awareness and Training (EAT) activities.

6.2 Methods of Engagements

Various workshops with different sectors were held as part of the engagement process. A review of climate – related policy and strategy documents was conducted. Interviews with public and private media (both print and electronic) were held. Social media platforms (facebook, twitter, Instagram, linkedin) are also playing a leading role in raising awareness on climate change issues.

6.2.1 Educational Sector Engagement

The main thrust of engagement with the education sector has been through institutions of higher and tertiary education aimed at ensuring climate change mainstreaming in the education curriculum at all levels in partnership with the Curriculum Development and Technical Services Department (CDTS) in the Ministry of Primary and Secondary Education. For the tertiary sector, the engagements were with various state universities, agricultural, polytechnics, and teacher training colleges.

6.2.1.1 The Primary and Secondary Education Sector

Following engagements in TNC reporting period, CTDS has successfully integrated climate change into the primary and secondary school curriculum. Several in-service training climate change workshops for educators in both the primary and secondary school systems were carried out. Riding on the success of the initial engagements with educators, there is an on-going training programme to cover the whole country.

6.2.1.2 Tertiary Institutions

Under the United Nations Climate Change Learning Partnership (UN CC: Learn) there were prospects to integrate Climate Change into teacher training for effective delivery of the new primary and secondary education curriculum. Some of the teachers' colleges engaged in this initiative include Mkoba, Belvedere, Morgan Zintec, Hillside, Morgenster and Masvingo teachers colleges. The intention is to cover all the teachers' colleges and universities offering teacher education. The GoZ also validated and accredited five Green Training Programmes through Higher Education Examination Council which are aimed at impacting green economy practical skills.

Climate change was also mainstreamed in universities' undergraduate and post graduate degree programmes. Such programmes include Master of Science (MSc) in Climate Change and Sustainable Development offered at Bindura University of Education and Lupane State University; M.Sc. in Climate Change and Variability offered by the Midlands State University; MSc in Climate Change and Food Systems offered by University of Zimbabwe; and, Executive Certificate on Climate Change Mitigation Technology offered by Harare Institute of Technology.

With technical support from the CTCN, a Climate Smart Agriculture (CSA) Manual for Agriculture Education in Zimbabwe was developed. CSA was mainstreamed in the curriculum of agriculture education in the country. The Manual is helping the country to transform its agriculture systems and create visible and active networks within the agriculture and climate change communities. This manual is in line with the Government efforts to strengthen the role of CSA in ensuring food and nutrition security in Zimbabwe contained in various government policy and strategy documents. Training of trainers workshops were also conducted in the agricultural colleges to strengthen capacities of agriculture lecturers to impart CSA practices to trainee extension workers who upon deployment will work directly with farmers. Some of the agricultural colleges that benefited from the initiative include Mlezu, Rio-Tinto, Shamva, Kushinga Phikelela and Esigodini. .

6.2.2 Engagement with the Print and Electronic Media Platforms

The media platforms were engaged with the aim to disseminate climate change information to the general public.

6.2.2.1 Print Media

The engagement was through various workshops on climate change awareness raising throughout the country. The media personnel generated and published articles in newsletters in vernacular languages for the general public to have access. Media practitioners raised a concern on their limited knowledge to effectively generate and disseminate climate change information that can be easily understood by the general public. To that end, the government with support from development partners, rolled out capacity building sessions targeting the media practitioners. This programme is on-going so as to cover all media practitioners nationwide for effective generation of climate change articles.

6.2.2.2 Electronic Media

Awareness raising sessions on climate change were also conducted through live radio and TV talk shows, interviews, quiz and competitions. Scripts were developed for all radio and TV episodes and these were used during the airing of the programmes. With this approach, a wider audience was reached since most vernacular languages were employed.

6.2.2.3 Social Media

With the rising in popularity of social media platforms in raising awareness on topical issues, it was prudent to have climate change issues being conveyed through such platforms. The various social media platforms exploited include but not limited to;

- Facebook - @climatechangezim
- Twitter - @ClimateZimDept
- Instagram - @climatezimdept, and,
- Linkedin - @climatechangemanagementdepartment.
- Website – www.climatechange.org.zw

The platforms provided up-to-date information of all activities taking place related to climate change.

6.2.3 Engagement with Private Sector & Civil Society Organizations

The private sector was engaged to take ownership of their role in the inventory compilation process as well as the transition to a green economy. To this end the private sector was engaged in the awareness and training sessions conducted under the Support Towards Implementing Zimbabwe's STIZ-NDC project. Simultaneously within the STIZ project, the private sector implemented and launched pilot projects on Energy Efficiency and Water Management Potential in Industry. The Business Council for Sustainable Development was successful in obtaining funding for pilot projects in ten companies, which was then followed by training and audits.

The civil society play a pivotal role in mobilising the general public in the climate change discourse. Their involvement in climate change programmes has greatly enhanced their ability to execute their role in public awareness promotion of adoption of mitigation and adaptation technologies. They also played a role in translating various climate change awareness and training materials into vernacular languages used in Zimbabwe an also assisted in the hosting of school competitions centred around the climate change themes of education, public awareness raising and training.

6.2.4 Youth Engagement

Youths are important in policy lobbying, advocacy, awareness and coordination of climate change interventions at community level in Zimbabwe. They also play a vital role in the implementation of mitigation and adaptation programmes.

Under the UN CC: Learn project, with co-financing from ACT Alliance, youth capacity building sessions were conducted in 10 rural districts in the country. The sessions were to strengthen the capacity of youths and youths' groups in rural areas to mitigate and adapt to the effects of climate change. In a build up to the NDC revision process, a policy brief was developed as a result of broad consultations from representations of youth, women and people with disability organisations from all the ten provinces of Zimbabwe. All in all, a total of more than two hundred youth representatives were consulted whose footprint is in both urban and rural areas. Youths, women and people with disabilities consultations where important to ensure that the principle of leaving no one behind was attained and is part of the government's mantra in development planning. The policy brief resulted in the setting up of a youth desk in the Ministry of Environment, Climate, Tourism and Hospitality Industry to ensure that youth concerns and needs are mainstreamed in the implementation of not only the NDCs but climate change issues across the country. The policy brief developed by the youths will be used to mobilise resources to support implementation of the youths aligned interventions outlined in revised NDCs.

6.2.5 Internal Trainings of the Public Sector

The government conducted various sector specific climate change trainings and these include:

- Capacity building on climate finance for the Ministry of Finance and Economic Development;
- Training on green procurement;
- Technical training on LEDS (GHG inventory and Mitigation) for the IPPU sector;
- GHG inventory training for the AFOLU sector;
- Energy Management and Energy Efficiency Expert Training;
- Technical training on IPCC guidelines for the LULUCF sector;
- Technical training on IPCC guidelines for the Transport sector;
- Awareness training for Government Officials on the GHG database management system;
- Project Proposal development training for accessing resources from Multi-lateral funds
- Training on Project Management including Budgeting, Accounting and Financial reporting

- Training on the use Geographical Information Systems and Remote Sensing in Mapping Exercises
- Training on Downscaling of Climate Scenarios

6.3 Recommendations

- Engagement of the private sector, especially in raising funds for education, public awareness and training activities.
- Wider dissemination (through print and electronic media platforms) to disseminate EAT programmes being implemented in the country;
- Active efforts should be made to appoint a climate change ambassador who will carry out climate change awareness raising tasks at various public fora.
- Allocation of resources from the fiscus for implementation of behavioural change programmes based on outputs from research.
- Dissemination of climate change information through community information centres.

CHAPTER 7.0 Climate Change Mainstreaming in National Development Planning

7.1 Introduction

Zimbabwe has been mainstreaming climate change in all macro-economic aspects of its developmental planning. Planning at the national and subnational level is being undertaken in line with the country's devolution agenda. In 2020, the country adopted NDS1 (2021-2025) which mainstreams climate change in its 14 thematic areas one of which is environmental protection, climate resilience and natural resources management. The thematic area sets improved climate action as a sector outcome and proposes strategies such as enhancing climate change training and awareness and promoting mitigation and adaptation actions, early warnings and disaster risk reduction management.

7.2 Climate Change Mainstreaming in Public Finance

The Ministry of Finance and Economic Development engaged local Climate Economic and Finance advisors in June 2021 who contribute to capacity enhancement related to planning, resource mobilisation, and climate finance tracking. Furthermore, the Ministry of Finance and Economic Development has made it mandatory for all ministries, government departments and agencies to mainstream climate change adaptation and mitigation actions in their 2022 budgets. Climate interventions such as climate smart agriculture, ecosystem management, weather modification, renewable energy and climate risk management accounted for 6% of the 2022 National budget (Table 7.1). A climate finance tracking tool, DEVPROMIS is also being developed.

Table 7.1: Climate Proofed Interventions

Sector	Intervention	Project/Programme	Allocation (ZW$[2])
Agriculture and Other Land Use	Climate Smart Agriculture	Pfumvudza/Intwasa	20,000,000,000
		Irrigation development	6,282,000,000
		Dam construction	22,453,000,000
		Crop and livestock research	2,155,000,000
	Ecosystem Management	Afforestation Programme	100,000,000
Sub-total			**50,990,000,000**
Energy	Renewable energy	Solar and biogas systems development	900,000,000
Sub-total			**900,000,000**
Disaster Risk Management	Risk management	Weather early warning systems	395,000,000
		Disaster preparedness	100,000,000
Sub-total			**495,000,000**
GRAND TOTAL			**52,385,000,000**

[2] 1USD =104ZW$ (Dec 2021)

7.3 Policies, Strategies and Plans

The policies elaborated in the National Circumstances (Chapter 1) set the tone for mainstreaming of climate change in development planning. LEDS sets the roadmap for sustainable development pathway up to 2050. It sets priority interventions based on cost effectiveness. The Renewable Energy Policy promotes targets to add 1,100MW by 2025 and 2,100MW by 2030 of renewable energy. The Biofuels policy is targeting to increase blending ratio of diesel up to 2% by 2030. The CSA Framework sets out the priority actions and interventions for resilient agricultural practices in the country. In addition, a CSA manual for agricultural education has been adopted and training of trainer workshops were conducted in eight government agricultural colleges.

Zimbabwe, through the NAP Readiness Facility, is in the process of mainstreaming climate change in development planning at national and subnational level. The country driven process entails enhancing institutional capacity to integrate climate change considerations in planning and budgetary processes. The process also entails;

- enhancing the management of climate information ,
- resource mobilisation for national adaptation planning and,
- monitoring and evaluation system.

As part of the mainstreaming process, capacity building initiatives have been conducted targeting provincial and district development committees. Five members of each of the ten Provincial Development Committees (PDCs) underwent a 3-month training and research program facilitated by MECTHI and state universities in the respective provinces. Furthermore, 3-day training of trainers workshops were conducted for PDC members to ensure it cascades to district and ward levels.

A countrywide high level climate change risk and vulnerability assessment was conducted which informed the formulation of adaptation options which will be incorporated into the national adaptation plan. The process is expected to elaborate on a NAP financing strategy and development of a Monitoring and Evaluation system.

CHAPTER 8.0 Constraints and Gaps and Related Financial, Technical and Capacity Needs

8.1 Constraints and Gaps

8.1.1 Legal Framework

Zimbabwe ratified the UNFCCC, Kyoto Protocol and its Doha Amendment as well as the PA as part of its international obligations to the global village on climate change. Section 34 of the country's Constitution provides for the State to ensure that all international laws to which Zimbabwe is a party are incorporated into domestic law. This ensures that Zimbabwe's obligations to the global village find application in the country and are consistent with best practice. Some constraints and gaps still exist in the country's climate change legal framework despite the achievements recorded to date.

After the adoption of the 2013 Constitution, Zimbabwe is in the process of aligning all its laws to be consistent with the constitutional provisions. A considerable number of laws impacting on and supporting climate change are in place and have greatly assisted in policies geared towards the same. Zimbabwe is working on a standalone Climate Change Act which is yet to be promulgated. Acts such as Environmental Management Act [Chapter 20:27], Electricity Act [Chapter 13:19] and the Forestry Act [Chapter 19:05] should only play a complimentary role to the proposed Climate Change Act for constitutionality to be achieved and avoiding legal challenges. In addition to the Climate Change Bill, the country needs support on the proposed Emergency Preparedness and Disaster Management Bill.

The National Climate Policy and NCCRS are the guiding documents in mainstreaming of climate change into sectoral policies and development plans. This is meant to improve planning, policy and institutional frameworks and development of appropriate infrastructure to enhance climate action.

In view of the legal constraints stated earlier, there is need to build capacity among the legal practitioners and the general public in reviewing the legal framework. This will involve identification of relevant existing laws, harmonisation and ensuring that they complement the proposed Climate legislation. Financial resources are also required to conduct baseline studies, consultations on existing legislation and raise awareness on the dynamic climate change legislation.

8.2 Technical Needs

8.2.1 GHG Inventory

The country needs financial resources to improve its inventory compilation system. Financial resources are also required for research in establishing country specific emission factors and improving the data compilation system. Data providers need training on more efficient and accurate data collection methods. This will include use of 2006 IPCC software, estimation of uncertainties in the data collected, QA/QC methods, and the computerized GHG database which has been recently developed. In addition, there is need for technical support, training and tools to be availed in order to;

- Submit transparent, consistent, comparable, complete and accurate GHG inventories,
- Track NDCs as well
- As track support needed and support received.

8.2.2 Gaps: Adaptation, Systematic Observation and EAT

Table 8.1 summarises constraints and gaps as well as needs related to capacity and technical needs. The financial needs are explicitly covered in the NDCs (2020-2030)

Table 8.1: Constraints and Gaps

Gap and Constraints	**Needs**	
	Capacity	**Technical**
Low adoption of climate smart agriculture practices	• Training of farmers on scaling up climate smart agriculture • Research, awareness raising and MRV	Technologies on climate smart agriculture
Limited real time data availability, backup, data quality and gaps and communication network	• Develop an integrated early warning systems which includes, health, agriculture, water, energy and disaster risk reduction sectors • Training	Improve automatic weather stations and hydro network, models
Inadequate climate resilient infrastructure	Design climate resilient infrastructure Research	Improved building codes
Poor water resources development	Capacity building for water resources management at local level - water harvesting and conservation techniques	Technologies on water harvesting
Limited de-risking instruments and guarantees to support private sector investment in agri business markets	Training farmers on climate risk management	Development of enabling policies, infrastructure i.e. roads, processing facilities, viable market development

8.2.3 Mitigation

The following gaps were identified from the mitigation sector. The financial needs are covered in Zimbabwe BUR1

Table 8.2: Capacity Needs

Gap and Constraints	**Needs**	
	Capacity	**Technical**
Limited large scale renewable energy and grid connected solar PV projects	Capacity building on quality control for renewable technologies	Feasibility studies of pipeline projects
Low capacity for tracking mitigation actions	Capacity building for institutions	Instruments and tools for monitoring and measuring
Lack of production and infrastructure capacity of EVs and HV	Capacitated local industry and research institutions	Support infrastructure and standards
Limited de-risking instruments and guarantees to support private sector investment for mitigation projects	Capacity financial institution to access green finance and promote green investments	
Lack of research for green technology and in metal industry	Capacitate institutions	Laboratory equipment

Financial support for the development of the Fourth National Communication to the UNFCCC and Zimbabwe's First Biennial Update Report was provided by Global Environment Facility through the United Nations Environment Programme. The resources totalled 832,000 USD. The Government of Zimbabwe co-financed in kind to the value of 92,000 USD.

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Annexes

Annex 1: GHG Inventory

Base year for assessment of uncertainty in trend: 2000, Year T: 2010

A	B	C	D	E	F	G	H	I	J	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year T	Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A - Fuel Combustion Activities												
1.A.1.a.i - Electricity Generation - Liquid Fuels	CO2	70.10	0.00	5.00	6.14	7.92	0.00	0.01	0.00	0.04	0.00	0.00
1.A.1.a.i - Electricity Generation - Liquid Fuels	CH4	0.06	0.00	5.00	228.79	228.84	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a.i - Electricity Generation - Liquid Fuels	N2O	0.18	0.00	5.00	228.79	228.84	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a.i - Electricity Generation - Solid Fuels	CO2	4,947.26	4,573.83	5.00	12.41	13.38	0.82	0.28	0.17	3.49	1.19	13.62
1.A.1.a.i - Electricity Generation - Solid Fuels	CH4	1.10	1.02	5.00	200.00	200.06	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.a.i - Electricity Generation - Solid Fuels	N2O	24.32	22.48	5.00	222.22	222.28	0.01	0.00	0.00	0.31	0.01	0.09
1.A.1.c.i - Manufacture of Solid Fuels - Solid Fuels	CO2	270.31	179.19	5.00	12.41	13.38	0.00	0.02	0.01	0.22	0.05	0.05
1.A.1.c.i - Manufacture of Solid Fuels - Solid Fuels	CH4	0.05	0.03	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c.i - Manufacture of Solid Fuels - Solid Fuels	N2O	1.17	0.77	5.00	222.22	222.28	0.00	0.00	0.00	0.02	0.00	0.00
1.A.1.c.i - Manufacture of Solid Fuels - Biomass	CO2	30.40	31.29	10.00	18.69	21.20	0.00	0.00	0.00	0.03	0.02	0.00
1.A.1.c.i - Manufacture of Solid Fuels - Biomass	CH4	1.14	1.17	10.00	245.45	245.66	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.c.i - Manufacture of Solid Fuels - Biomass	N2O	0.34	0.35	10.00	304.55	304.71	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.c.ii - Other Energy Industries - Liquid Fuels	CO2	31.86	25.49	5.00	6.14	7.92	0.00	0.00	0.00	0.01	0.01	0.00
1.A.1.c.ii - Other Energy Industries - Liquid Fuels	CH4	0.03	0.02	5.00	228.79	228.84	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c.ii - Other Energy Industries - Liquid Fuels	N2O	0.08	0.06	5.00	228.79	228.84	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CO2	287.42	131.85	5.00	5.00	7.07	0.00	0.02	0.00	0.11	0.03	0.01
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CH4	0.24	0.12	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	N2O	0.71	0.34	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	CO2	0.00	995.65	5.00	5.00	7.07	0.01	0.04	0.04	0.18	0.26	0.10
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	CH4	0.00	1.85	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2 - Manufacturing Industries and Construction - Solid Fuels	N2O	0.00	4.07	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2 - Manufacturing Industries and Construction - Biomass	CO2	0.00	0.00	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2 - Manufacturing Industries and Construction - Biomass	CH4	2.73	3.21	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2 - Manufacturing Industries and Construction - Biomass	N2O	5.38	6.32	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00

1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CO2	231.29	19.75	5.00	4.17	6.51	0.00	0.02	0.00	0.08	0.01	0.01
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CH4	0.03	0.00	5.00	100.00	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	N2O	2.05	0.17	5.00	150.00	150.08	0.00	0.00	0.00	0.03	0.00	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CO2	120.07	8.58	5.00	4.17	6.51	0.00	0.01	0.00	0.04	0.00	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CH4	0.02	0.00	5.00	100.00	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	N2O	1.04	0.07	5.00	150.00	150.08	0.00	0.00	0.00	0.01	0.00	0.00
1.A.3.b - Road Transportation - Liquid Fuels	CO2	1,577.00	944.47	5.00	3.07	5.87	0.01	0.11	0.03	0.33	0.25	0.17
1.A.3.b - Road Transportation - Liquid Fuels	CH4	9.80	4.92	5.00	244.69	244.74	0.00	0.00	0.00	0.17	0.00	0.03
1.A.3.b - Road Transportation - Liquid Fuels	N2O	23.92	8.30	5.00	209.94	210.00	0.00	0.00	0.00	0.39	0.00	0.15
1.A.3.c - Railways - Liquid Fuels	CO2	287.72	217.94	5.00	2.02	5.39	0.00	0.02	0.01	0.04	0.06	0.00
1.A.3.c - Railways - Liquid Fuels	CH4	0.34	0.26	5.00	150.60	150.69	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.c - Railways - Liquid Fuels	N2O	34.43	26.08	5.00	200.00	200.06	0.01	0.00	0.00	0.43	0.01	0.19
1.A.3.c - Railways - Solid Fuels	CO2	30.59	22.94	5.00	24.25	24.76	0.00	0.00	0.00	0.05	0.01	0.00
1.A.3.c - Railways - Solid Fuels	CH4	0.04	0.03	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.c - Railways - Solid Fuels	N2O	3.66	2.74	5.00	233.33	233.39	0.00	0.00	0.00	0.05	0.00	0.00
1.A.4.a - Commercial/Institutional - Solid Fuels	CO2	712.68	441.76	5.00	12.46	13.43	0.01	0.05	0.02	0.61	0.11	0.38
1.A.4.a - Commercial/Institutional - Solid Fuels	CH4	1.58	0.98	5.00	200.00	200.06	0.00	0.00	0.00	0.02	0.00	0.00
1.A.4.a - Commercial/Institutional - Solid Fuels	N2O	3.50	2.17	5.00	217.78	217.84	0.00	0.00	0.00	0.05	0.00	0.00
1.A.4.b - Residential - Liquid Fuels	CO2	0.00	84.86	10.00	6.14	11.73	0.00	0.00	0.00	0.02	0.04	0.00
1.A.4.b - Residential - Liquid Fuels	CH4	0.00	0.24	10.00	200.00	200.25	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b - Residential - Liquid Fuels	N2O	0.00	0.21	10.00	236.36	236.58	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b - Residential - Solid Fuels	CO2	0.00	0.00	5.00	12.46	13.43	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b - Residential - Solid Fuels	CH4	0.00	0.00	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b - Residential - Solid Fuels	N2O	0.00	0.00	5.00	222.22	222.28	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b - Residential - Biomass	CO2	0.00	25,519.50	5.00	18.69	19.35	53.44	0.94	0.94	17.50	6.62	350.14
1.A.4.b - Residential - Biomass	CH4	136.41	1,607.73	5.00	227.27	227.33	29.27	0.05	0.06	10.59	0.42	112.23
1.A.4.b - Residential - Biomass	N2O	268.50	316.44	5.00	297.73	297.77	1.95	0.01	0.01	3.81	0.08	14.53
1.A.4.c.i - Stationary - Liquid Fuels	CO2	6.30	3.15	5.00	6.14	7.92	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c.i - Stationary - Liquid Fuels	CH4	0.02	0.01	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c.i - Stationary - Liquid Fuels	N2O	0.02	0.01	5.00	236.36	236.42	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c.i - Stationary - Solid Fuels	CO2	1,510.76	937.22	5.00	12.46	13.43	0.03	0.10	0.03	1.28	0.24	1.70
1.A.4.c.i - Stationary - Solid Fuels	CH4	100.61	62.42	5.00	200.00	200.06	0.03	0.01	0.00	1.37	0.02	1.88
1.A.4.c.i - Stationary - Solid Fuels	N2O	7.43	4.61	5.00	222.22	222.28	0.00	0.00	0.00	0.11	0.00	0.01
1.A.4.c.i - Stationary - Biomass	CO2	0.00	0.00	5.00	18.69	19.35	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c.i - Stationary - Biomass	CH4	75.11	88.32	5.00	227.27	227.33	0.09	0.00	0.00	0.82	0.02	0.67
1.A.4.c.i - Stationary - Biomass	N2O	14.78	17.38	5.00	297.73	297.77	0.01	0.00	0.00	0.21	0.00	0.04
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CO2	237.69	206.41	5.00	6.14	7.92	0.00	0.01	0.01	0.09	0.05	0.01
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CH4	0.68	0.59	5.00	200.00	200.06	0.00	0.00	0.00	0.01	0.00	0.00
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	N2O	0.60	0.52	5.00	236.36	236.42	0.00	0.00	0.00	0.01	0.00	0.00
1.A.4.c.iii - Fishing (mobile combustion) - Liquid Fuels	CO2	0.00	0.00	5.00	6.14	7.92	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c.iii - Fishing (mobile combustion) - Liquid Fuels	CH4	0.00	0.00	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c.iii - Fishing (mobile combustion) - Liquid Fuels	N2O	0.00	0.00	5.00	236.36	236.42	0.00	0.00	0.00	0.00	0.00	0.00

1.A.5.a - Stationary - Liquid Fuels	CO2	0.00	0.00	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.5.a - Stationary - Liquid Fuels	CH4	0.00	0.00	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.5.a - Stationary - Liquid Fuels	N2O	0.00	0.00	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.vi - Urea-based catalysts	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1 - Fugitive Emissions from Fuels - Solid Fuels												
1.B.1.a.i.1 - Mining	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.i.1 - Mining	CH4	0.11	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.i.2 - Post-mining seam gas emissions	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.i.2 - Post-mining seam gas emissions	CH4	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.i.3 - Abandoned underground mines	CH4	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.i.4 - Flaring of drained methane or conversion of methane to CO2	CH4	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.i.4 - Flaring of drained methane or conversion of methane to CO2	CO2	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.ii.1 - Mining	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.ii.1 - Mining	CH4	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.ii.2 - Post-mining seam gas emissions	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.a.ii.2 - Post-mining seam gas emissions	CH4	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.2 - Fugitive Emissions from Fuels - Oil and Natural Gas												
1.C - CO2 Transport Injection and Storage												
2.A - Mineral Industry												
2.A.1 - Cement production	CO2	447.89	313.53	35.00	0.00	35.00	0.03	0.03	0.01	0.00	0.57	0.32
2.A.2 - Lime production	CO2	19.89	0.00	15.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A.3 - Glass Production	CO2	1.62	0.54	5.00	60.00	60.21	0.00	0.00	0.00	0.01	0.00	0.00
2.A.4.a - Ceramics	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A.4.b - Other Uses of Soda Ash	CO2	1.11	0.43	3.00	1.00	3.16	0.00	0.00	0.00	0.00	0.00	0.00
2.A.4.c - Non Metallurgical Magnesia Production	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A.4.d - Other (please specify)	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B - Chemical Industry												
2.B.1 - Ammonia Production	CO2	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.2 - Nitric Acid Production	N2O	464.57	200.91	2.00	40.00	40.05	0.01	0.03	0.01	1.39	0.02	1.95
2.B.3 - Adipic Acid Production	N2O	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	N2O	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.5 - Carbide Production	CO2	0.00	0.00	5.00	10.00	11.18	0.00	0.00	0.00	0.00	0.00	0.00
2.B.5 - Carbide Production	CH4	0.00	0.00	5.00	10.00	11.18	0.00	0.00	0.00	0.00	0.00	0.00
2.B.6 - Titanium Dioxide Production	CO2	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.7 - Soda Ash Production	CO2	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.a - Methanol	CO2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.a - Methanol	CH4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.b - Ethylene	CO2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.b - Ethylene	CH4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.c - Ethylene Dichloride and Vinyl Chloride Monomer	CO2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.c - Ethylene Dichloride and Vinyl Chloride Monomer	CH4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.d - Ethylene Oxide	CO2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.d - Ethylene Oxide	CH4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.e - Acrylonitrile	CO2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00

2.B.8.e - Acrylonitrile	CH4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.f - Carbon Black	CO2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8.f - Carbon Black	CH4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CHF3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CH2F2	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CH3F	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CF3CHFCHFCF2CF3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CHF2CF3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CHF2CHF2	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CH2FCF3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CH3CHF2	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CHF2CH2F	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CF3CH3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CF3CHFCF3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CF3CH2CF3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CH2FCF2CHF2	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CF4	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	C2F6	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	C3F8	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	C4F10	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	c-C4F8	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	C5F12	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	C6F14	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	SF6	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CHCl3	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CH2Cl2	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.9.a - By-product emissions	CF3 I	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C - Metal Industry												
2.C.1 - Iron and Steel Production	CO2	427.75	1.48	10.00	25.00	26.93	0.00	0.04	0.00	0.97	0.00	0.94
2.C.1 - Iron and Steel Production	CH4	0.28	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.2 - Ferroalloys Production	CO2	313.97	200.64	5.00	25.00	25.50	0.01	0.02	0.01	0.53	0.05	0.28
2.C.2 - Ferroalloys Production	CH4	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.3 - Aluminium production	CO2	0.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.3 - Aluminium production	CF4	0.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.3 - Aluminium production	C2F6	0.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.4 - Magnesium production	CO2	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.4 - Magnesium production	SF6	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.5 - Lead Production	CO2	0.36	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.6 - Zinc Production	CO2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D - Non-Energy Products from Fuels and Solvent Use												
2.D.1 - Lubricant Use	CO2	0.00	10.08	10.00	50.00	50.99	0.00	0.00	0.00	0.02	0.01	0.00
2.D.2 - Paraffin Wax Use	CO2	3.90	1.82	5.00	100.00	100.12	0.00	0.00	0.00	0.03	0.00	0.00
2.E - Electronics Industry												

2.E.1 - Integrated Circuit or Semiconductor	C2F6	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.1 - Integrated Circuit or Semiconductor	CF4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.1 - Integrated Circuit or Semiconductor	CHF3	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.1 - Integrated Circuit or Semiconductor	C3F8	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.1 - Integrated Circuit or Semiconductor	SF6	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.2 - TFT Flat Panel Display	CF4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.2 - TFT Flat Panel Display	SF6	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.3 - Photovoltaics	CF4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.3 - Photovoltaics	C2F6	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.4 - Heat Transfer Fluid	C6F14	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F - Product Uses as Substitutes for Ozone Depleting Substances												
2.F.4 - Aerosols	CH2FCF3	0.00	0.00	10.00	10.00	14.14	0.00	0.00	0.00	0.00	0.00	0.00
2.F.4 - Aerosols	CH3CHF2	0.00	0.00	10.00	10.00	14.14	0.00	0.00	0.00	0.00	0.00	0.00
2.F.4 - Aerosols	CF3CHFCF3	0.00	0.00	10.00	10.00	14.14	0.00	0.00	0.00	0.00	0.00	0.00
2.F.4 - Aerosols	CF3CHFCHFCF2CF3	0.00	0.00	10.00	10.00	14.14	0.00	0.00	0.00	0.00	0.00	0.00
2.F.5 - Solvents	CF3CHFCHFCF2CF3	0.00	0.00	10.00	50.00	50.99	0.00	0.00	0.00	0.00	0.00	0.00
2.F.5 - Solvents	C6F14	0.00	0.00	10.00	50.00	50.99	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CHF3	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CH2F2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CH3F	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CF3CHFCHFCF2CF3	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CHF2CF3	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CHF2CHF2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CH2FCF3	0.00	0.00	10.00	50.00	50.99	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CH3CHF2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CHF2CH2F	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CF3CH3	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CF3CHFCF3	0.00	0.00	10.00	50.00	50.99	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CF3CH2CF3	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CH2FCF2CHF2	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	CF4	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	C2F6	0.00	0.00	10.00	50.00	50.99	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	C3F8	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00

2.F.6 - Other Applications (please specify)	C4F10	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	c-C4F8	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	C5F12	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	C6F14	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G - Electrical Equipment												
3.A - Livestock												
3.A.1.a.i - Dairy Cows	CH4	452.29	714.71	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00
3.A.1.a.ii - Other Cattle	CH4	3,099.69	2,831.82	0.00	0.00	0.00	0.00	0.18	0.10	0.00	0.00	0.00
3.A.1.b - Buffalo	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1.c - Sheep	CH4	34.35	32.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1.d - Goats	CH4	427.11	467.05	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00
3.A.1.e - Camels	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1.f - Horses	CH4	19.66	21.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1.g - Mules and Asses	CH4	141.78	118.18	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
3.A.1.h - Swine	CH4	5.79	8.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1.j - Other (please specify)	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.a.i - Dairy cows	CH4	12.56	19.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.a.i - Dairy cows	N2O	0.88	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.a.ii - Other cattle	CH4	110.78	102.26	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
3.A.2.a.ii - Other cattle	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.b - Buffalo	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.b - Buffalo	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.c - Sheep	CH4	1.03	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.c - Sheep	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.d - Goats	CH4	14.52	15.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.d - Goats	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.e - Camels	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.e - Camels	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.f - Horses	CH4	1.79	1.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.f - Horses	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.g - Mules and Asses	CH4	12.76	10.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.g - Mules and Asses	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.h - Swine	CH4	5.79	8.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.h - Swine	N2O	1.21	1.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.i - Poultry	CH4	3.77	5.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.i - Poultry	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.j - Other (please specify)	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.j - Other (please specify)	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B - Land												
3.B.1.a - Forest land Remaining Forest land	CO2	-15,792.65	-3,528.90	0.00	0.00	0.00	0.00	1.31	0.13	0.00	0.00	0.00
3.B.1.b.i - Cropland converted to Forest Land	CO2	-14,043.84	-14,043.84	0.00	0.00	0.00	0.00	0.77	0.52	0.00	0.00	0.00
3.B.1.b.ii - Grassland converted to Forest Land	CO2	-10,361.70	-10,361.70	0.00	0.00	0.00	0.00	0.56	0.38	0.00	0.00	0.00
3.B.1.b.iii - Wetlands converted to Forest Land	CO2	-22.38	-22.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.iv - Settlements converted to Forest Land	CO2	-37.34	-37.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1.b.v - Other Land converted to Forest Land	CO2	-58.89	-58.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.B.2.a - Cropland Remaining Cropland	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.i - Forest Land converted to Cropland	CO2	20,376.60	20,376.60	0.00	0.00	0.00	0.00	1.10	0.75	0.00	0.00	0.00
3.B.2.b.ii - Grassland converted to Cropland	CO2	2,816.07	2,816.07	0.00	0.00	0.00	0.00	0.15	0.10	0.00	0.00	0.00
3.B.2.b.iii - Wetlands converted to Cropland	CO2	5.02	5.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.iv - Settlements converted to Cropland	CO2	24.54	24.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.2.b.v - Other Land converted to Cropland	CO2	20.74	20.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.a - Grassland Remaining Grassland	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.i - Forest Land converted to Grassland	CO2	17,342.02	17,342.02	0.00	0.00	0.00	0.00	0.93	0.64	0.00	0.00	0.00
3.B.3.b.ii - Cropland converted to Grassland	CO2	1,997.90	1,997.90	0.00	0.00	0.00	0.00	0.11	0.07	0.00	0.00	0.00
3.B.3.b.iii - Wetlands converted to Grassland	CO2	3.98	3.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.iv - Settlements converted to Grassland	CO2	8.29	8.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.3.b.v - Other Land converted to Grassland	CO2	5.03	5.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.a.i - Peatlands remaining peatlands	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.a.i - Peatlands remaining peatlands	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.b.i - Land converted for peat extraction	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.4.b.ii - Land converted to flooded land	CO2	178.47	178.47	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
3.B.5.a - Settlements Remaining Settlements	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.i - Forest Land converted to Settlements	CO2	117.91	117.91	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
3.B.5.b.ii - Cropland converted to Settlements	CO2	27.47	27.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.iii - Grassland converted to Settlements	CO2	52.16	52.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.iv - Wetlands converted to Settlements	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.5.b.v - Other Land converted to Settlements	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.i - Forest Land converted to Other Land	CO2	126.91	126.91	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
3.B.6.b.ii - Cropland converted to Other Land	CO2	4.29	4.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.iii - Grassland converted to Other Land	CO2	6.11	6.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.iv - Wetlands converted to Other Land	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.6.b.v - Settlements converted to Other Land	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C - Aggregate sources and non-CO2 emissions sources on land												
3.C.1.a - Biomass burning in forest lands	CH4	0.00	3,496.01	0.00	0.00	0.00	0.00	0.13	0.13	0.00	0.00	0.00
3.C.1.a - Biomass burning in forest lands	N2O	0.00	1,517.88	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00
3.C.1.b - Biomass burning in croplands	CH4	115.19	73.14	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
3.C.1.b - Biomass burning in croplands	N2O	44.08	27.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.1.c - Biomass burning in grasslands	CH4	611.25	64.53	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
3.C.1.c - Biomass burning in grasslands	N2O	823.86	86.97	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
3.C.1.d - Biomass burning in all other land	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.1.d - Biomass burning in all other land	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.C.2 - Liming	CO2	72.83	5.87	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
3.C.3 - Urea application	CO2	15.33	21.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.4 - Direct N2O Emissions from managed soils	N2O	4,164.36	3,915.40	0.00	0.00	0.00	0.00	0.23	0.14	0.00	0.00	0.00
3.C.5 - Indirect N2O Emissions from managed soils	N2O	1,027.35	953.41	0.00	0.00	0.00	0.00	0.06	0.03	0.00	0.00	0.00
3.C.6 - Indirect N2O Emissions from manure management	N2O	2.88	4.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.7 - Rice cultivation	CH4	10.65	37.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D - Other												
3.D.1 - Harvested Wood Products	CO2	103.54	178.94	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
4.A - Solid Waste Disposal												
4.A - Solid Waste Disposal	CH4	272.38	395.57	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
4.B - Biological Treatment of Solid Waste												
4.B - Biological Treatment of Solid Waste	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.B - Biological Treatment of Solid Waste	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C - Incineration and Open Burning of Waste												
4.C.1 - Waste Incineration	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C.1 - Waste Incineration	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C.1 - Waste Incineration	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C.2 - Open Burning of Waste	CO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C.2 - Open Burning of Waste	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C.2 - Open Burning of Waste	N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.D - Wastewater Treatment and Discharge												
4.D.1 - Domestic Wastewaster Treatment and Discharge	CH4	61.54	50.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.D.1 - Domestic Wastewaster Treatment and Discharge	N2O	35.26	43.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.D.2 - Industrial Wastewater Treatment and Discharge	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.E - Other (please specify)												
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3												
5.B - Other (please specify)												
Total												
		Sum(C): 27,258.042	Sum(D): 67,555.089				Sum(H): 85.724					Sum(M): 499.545
							Uncertainty in total inventory: 9.259					Trend uncertainty: 22.350

Annex 2: EMEP/EEA Emissions factor for precursors in Energy Sector (electricity and heat production)

Emission factor (g/GJ)	NOx	NMVOC	SOx	CO	Source	Comment
Diesel	65	0.8	46.5	16.2	2019 EMEP-EEA Guidebook	Default emission factor was applied
Other Bituminous coal	209	1.0	820	8.7		

1. 1.A.1.c.i Manufacture of solid Fuels

Emission factor (g/GJ)	NOx	NMVOC	SOx	CO	Source	Comment
	21	0.8	91	6	2019 EMEP-EEA Guidebook	Default emission factor was applied

2. EFs for Manufacture of Solid Fuels and Other Energy Industries were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook, Table 5-1 Part B: Sectoral Guidance Chapter 1 Energy Industries (1.A.1.c.i- Manufacture of solid fuels).

3. 1.A.2 - Manufacturing Industries and Construction

Emission factor (g/GJ)	NOx	NMVOC	SOx	CO	Source	Comment
Solid Fuels	173	88.8	900	931	2019 EMEP-EEA Guidebook	Default emission factor was applied
Gaseous Fuels	74	23	0.67	29		
Liquid Fuels	513	25	47	66		
Biomass	91	300	11	570		

4. EFs for Manufacturing Industries and Construction for Solid Fuels, Gaseous Fuels, Liquid Fuels and Biomass were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook, Table 3-1, Table3-2, Table 3-3 and Table 3-4 respectively, Part B: Sectoral Guidance Chapter 1 Energy Industries (1.A.2- MIC).

5. 1.A.3.a – Aviation

Emission factor (kg/t fuel)	NOx	NMVOC	SOx	CO	Source	Comment
Jet gasoline and Aviation Gasoline	4	19	1	1200	2019 EMEP-EEA Guidebook	Default emission factor was applied

6. EFs for Aviation were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook, Table 3.3, Part B: Sectoral Guidance Chapter 1 Energy Industries (1.A.3.a – Aviation).

7. 1.A.3.b - Road Transportation

Category	Emission factor (g/kg fuel)	NOx	NMVOC	SOx	CO	Source	Comment
Passenger cars (PC)	Petrol	8.73	10.05			2019 EMEP-EEA Guidebook	Default emission factor was applied
	Diesel	12.96	0.70				
	LPG	15.20	13.64				
Light Commercial Vehicles (LCV)	Petrol	13.22	14.59		152.3		
	Diesel	14.91	1.54		7.40		
Heavy Duty Vehicles (HDV)	Diesel	33.37	1.92				
	CNG (Buses)	13.00	0.26				
L-Category	Petrol	6.64	131.4				

8. EFs for Road Transportation were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook, Table 3-5 for NMVOC and Table 3-6 for NOx, Part B: Sectoral Guidance, Chapter 1 Energy Industries (1.A.3.b- Road Transportation).

9. 1.A.3.c – Railways

Emission factor (kg/t fuel)	NOx	NMVOC	SOx	CO	Source	Comment
Gas Oil/ Diesel	52.4	4.65	NE	10.7	2019 EMEP-EEA Guidebook	Default emission factor was applied

10. EFs for Railways were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook, Table 3.1, Part B: Sectoral Guidance, Chapter 1 Energy Industries (1.A.3.c-Railways).

11. 1.A.4.b – Residential

Emission factor (g/GJ)	NOx	NMVOC	SOx	CO	Source	Comment
Hard Coal and Brown Coal	110	484	900	4600	2019 EMEP-EEA Guidebook	Default emission factor was applied
Gaseous Fuels	51	1.9	0.3	26		
Other Liquid Fuels	51	0.69	70	57		
Solid Biomass	50	600	11	4000		

12. EFs for Residential were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook, Table 3.3 to 3.5, Part B: Sectoral Guidance, Chapter 1 Energy Industries (1.A.4.bi-Residential Plants).

13. 1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms

Emission factor (g/GJ)	NOx	NMVOC	SOx	CO	Source	Comment
Hard Coal and Brown Coal	173	88.8	840	931	2019 EMEP-EEA Guidebook	Default emission factor was applied
Gaseous Fuels	74	23	0.67	29		
Liquid Fuels	306	20	94	93		
Biomass	91	300	11	570		

14. EFs for Agriculture/Forestry/Fishing/Fish Farms were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook. Hard Coal and Brown Coal Table 3.7 (1.a.4.a/c; 1.A.5.a), Gaseous Fuels Table 3.8 (1.a.4.a/c; 1.A.5.a), Liquid fuels Table 3.9 (1.a.4.a/c; 1.A.5.a) and Biomass table 3.10 (1.a.4.a/c; 1.A.5.a) in Part B: Sectoral Guidance, Chapter 1 Energy Industries.

15. 1.B.1.a- Coal Mining and Handling

Emission factor (kg/Mg coal)	NOx	NMVOC	SOx	CO	Source	Comment
	NA	0.8	NA		2019 EMEP-EEA Guidebook	Default emission factor was applied

16. EFs for Coal Mining and Handling were obtained from the 2019 EMEP-EEA Air Pollutants Emission Inventory Guidebook, Table 3-1 (1.B.1a- Coal Mining and Handling) , Part B: Sectoral Guidance, Chapter 1 Energy Industries.

Annex 1: Energy sector precursors

1.A.1.a.i - Electricity Generation

Diesel (mt)

6		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Other Bituminious Coal	EF(g/TJ)	301	344	172	344	430	301	344	602	688	774	731	645	559	580.07	701.33	716.38
CO	8700	4.8762	5.5728	2.7864	5.5728	6.966	4.8762	5.5728	9.7524	11.1456	12.5388	11.8422	10.449	9.0558	9.397134	11.361546	11.605356
Nox	209000	19.565	22.36	11.18	22.36	27.95	19.565	22.36	39.13	44.72	50.31	47.515	41.925	36.335	37.70455	45.58645	46.5647
NMVOC	1000	0.2408	0.2752	0.1376	0.2752	0.344	0.2408	0.2752	0.4816	0.5504	0.6192	0.5848	0.516	0.4472	0.464056	0.561064	0.573104
Sox	820000	13.9965	15.996	7.998	15.996	19.995	13.9965	15.996	27.993	31.992	35.991	33.9915	29.9925	25.9935	26.973255	32.611845	33.31167

Other Bituminous Coal (mt)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Coal	EF(g/TJ)	52296.6	68447.4	62977.8	46285.2	56863.2	60062.4	38467.8	33333.6	25671	26961	29566.8	32327.4	37152	69596	67209	70975.8	61068.6	52838
CO	8700	0.0522966	0.0684474	0.0629778	0.0462852	0.0568632	0.0600624	0.0384678	0.0333336	0.025671	0.026961	0.0295668	0.0323274	0.037152	0.069596	0.067209	0.0709758	0.0610686	0.052838
Nox	209000	454.98042	595.49238	547.90686	402.68124	494.70984	522.54288	334.66986	290.00232	223.3377	234.5607	257.23116	281.24838	323.2224	605.4852	584.7183	617.48946	531.29682	459.6906
NMVOC	1000	10929.9894	14305.5066	13162.3602	9673.6068	11884.4088	12553.0416	8039.7702	6966.7224	5365.239	5634.849	6179.4612	6756.4266	7764.768	14545.564	14046.681	14833.9422	12763.3374	11043.142
Sox	820000	52.2966	68.4474	62.9778	46.2852	56.8632	60.0624	38.4678	33.3336	25.671	26.961	29.5668	32.3274	37.152	69.596	67.209	70.9758	61.0686	52.838

IA2 MIC (mt)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Motor Gasoline	EF (g/TJ)	620.2	531.6	487.3	398.7	398.7	310.1	310.1	310.1	265.8	620.2	708.8	487.3	2126.4	443	443	443	443	443
NOx	513000	318.1626	272.7108	249.9849	204.5331	204.5331	159.0813	159.0813	159.0813	136.3554	318.1626	363.6144	249.9849	1090.843	227.259	227.259	227.259	227.259	227.259
NMVOC	25000	15.505	13.29	12.1825	9.9675	9.9675	7.7525	7.7525	7.7525	6.645	15.505	17.72	12.1825	53.16	11.075	11.075	11.075	11.075	11.075
Sox	47000	29.1494	24.9852	22.9031	18.7389	18.7389	14.5747	14.5747	14.5747	12.4926	29.1494	33.3136	22.9031	99.9408	20.821	20.821	20.821	20.821	20.821
CO	66000	40.9332	35.0856	32.1618	26.3142	26.3142	20.4666	20.4666	20.4666	17.5428	40.9332	46.7808	32.1618	140.3424	29.238	29.238	29.238	29.238	29.238
Other Kerosene	EF (g/TJ)	350.4	350.4	306.6	262.8	262.8	175.2	175.2	175.2	131.4	131.4	131.4	131.4	131.4	131.4	131.4	131.4	131.4	131.4
NOx	513000	179.7552	179.7552	157.2858	134.8164	134.8164	89.8776	89.8776	89.8776	67.4082	67.4082	67.4082	67.4082	67.4082	67.4082	67.4082	67.4082	67.4082	67.4082
NMVOC	25000	8.76	8.76	7.665	6.57	6.57	4.38	4.38	4.38	3.285	3.285	3.285	3.285	3.285	3.285	3.285	3.285	3.285	3.285
Sox	47000	16.4688	16.4688	14.4102	12.3516	12.3516	8.2344	8.2344	8.2344	6.1758	6.1758	6.1758	6.1758	6.1758	6.1758	6.1758	6.1758	6.1758	6.1758
CO	66000	23.1264	23.1264	20.2356	17.3448	17.3448	11.5632	11.5632	11.5632	8.6724	8.6724	8.6724	8.6724	8.6724	8.6724	8.6724	8.6724	8.6724	8.6724
0	0	0																	
Gas/Desiel Oil	EF (g/TJ)	2838	2924	2709	1720	1720	2365	2279	2193	1806	516	989	1075	1333	1333	1333	1333	1333	1333
NOx	513000	1455.894	1500.012	1389.717	882.36	882.36	1213.245	1169.127	1125.009	926.478	264.708	507.357	551.475	683.829	683.829	683.829	683.829	683.829	683.829
NMVOC	25000	70.95	73.1	67.725	43	43	59.125	56.975	54.825	45.15	12.9	24.725	26.875	33.325	33.325	33.325	33.325	33.325	33.325
Sox	47000	133.386	137.428	127.323	80.84	80.84	111.155	107.113	103.071	84.882	24.252	46.483	50.525	62.651	62.651	62.651	62.651	62.651	62.651
CO	66000	187.308	192.984	178.794	113.52	113.52	156.09	150.414	144.738	119.196	34.056	65.274	70.95	87.978	87.978	87.978	87.978	87.978	87.978
0	0	0																	
LPG	EF (g/TJ)	141.9	141.9	141.9	94.6	94.6	141.9	141.9	141.9	141.9			47.3	141.9					
NOx	74000	10.5006	10.5006	10.5006	7.0004	7.0004	10.5006	10.5006	10.5006	10.5006			3.5002	10.5006					

NMVOC	23000	3.2637	3.2637	3.2637	2.1758	2.1758	3.2637	3.2637	3.2637	3.2637			1.0879	3.2637					
Sox	670	0.095073	0.095073	0.095073	0.063382	0.063382	0.095073	0.095073	0.095073	0.095073			0.031691	0.095073					
CO	29000	4.1151	4.1151	4.1151	2.7434	2.7434	4.1151	4.1151	4.1151	4.1151			1.3717	4.1151					
Coking Coal (hard coal or brown coal	EF (g/TJ)	507.6	507.6	0	366.6	338.4	310.2	310.2	310.2									2284.2	6321
NOx	173000	87.8148	87.8148	0	63.4218	58.5432	53.6646	53.6646	53.6646									395.1666	1093.533
NMVOC	88800	45.07488	45.07488	0	32.55408	30.04992	27.54576	27.54576	27.54576									202.837	561.3048
Sox	900000	456.84	456.84	0	329.94	304.56	279.18	279.18	279.18									2055.78	5688.9
CO	931000	472.5756	472.5756	0	341.3046	315.0504	288.7962	288.7962	288.7962									2126.59	5884.851
0	0	0																	
Other Bituminous Coal (hard coal	EF (g/TJ)	16950.6	12874.2	11068.2	10732.8	6682.2	7378.8	12538.8	14602.8	10087.8	3534.6	8643	11145.6	12435.6	5934	6166.2	6217.8	6264.4	2312.4
NOx	173000	2932.4538	2227.237	1914.799	1856.774	1156.021	1276.532	2169.212	2526.284	1745.189	611.4858	1495.239	1928.189	2151.359	1026.582	1066.753	1075.679	1083.741	400.0452
NMVOC	88800	1505.21328	1143.229	982.8562	953.0726	593.3794	655.2374	1113.445	1296.729	895.7966	313.8725	767.4984	989.7293	1104.281	526.9392	547.5586	552.1406	556.2787	205.3411
Sox	900000	15255.54	11586.78	9961.38	9659.52	6013.98	6640.92	11284.92	13142.52	9079.02	3181.14	7778.7	10031.04	11192.04	5340.6	5549.58	5596.02	5637.96	2081.16
CO	931000	15781.0086	11985.88	10304.49	9992.237	6221.128	6869.663	11673.62	13595.21	9391.742	3290.713	8046.633	10376.55	11577.54	5524.554	5740.732	5788.772	5832.156	2152.844
Other Primary Solid Biomass	EF (g/TJ)	4336	4401	4467	4534	4534	4671	4736	4811	4896	4991	5097	5214	5342	5479	5620	5762	0	5904
NOx	91000	394.576	400.491	406.497	412.594	412.594	425.061	430.976	437.801	445.536	454.181	463.827	474.474	486.122	498.589	511.42	524.342	0	537.264
NMVOC	300000	1300.8	1320.3	1340.1	1360.2	1360.2	1401.3	1420.8	1443.3	1468.8	1497.3	1529.1	1564.2	1602.6	1643.7	1686	1728.6	0	1771.2
Sox	11000	47.696	48.411	49.137	49.874	49.874	51.381	52.096	52.921	53.856	54.901	56.067	57.354	58.762	60.269	61.82	63.382	0	64.944
CO	570000	2471.52	2508.57	2546.19	2584.38	2584.38	2662.47	2699.52	2742.27	2790.72	2844.87	2905.29	2971.98	3044.94	3123.03	3203.4	3284.34	0	3365.28

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Other Kerosene	EF (g/TJ)	2365.2	2409	2190	1839.6	1752	1138.8	1138.8	1138.8	1138.8	1138.8	1138.8	1226.4	1357.8	1489.2	1664.4	1839.6	2014.8	2190
NOx	0.051	120.6252	122.859	111.69	93.8196	89.352	58.0788	58.0788	58.0788	58.0788	58.0788	58.0788	62.5464	69.2478	75.9492	84.8844	93.8196	102.7548	111.69
NMVOC	0.00069	1.631988	1.66221	1.5111	1.269324	1.20888	0.785772	0.785772	0.785772	0.785772	0.785772	0.785772	0.846216	0.936882	1.027548	1.148436	1.269324	1.390212	1.5111
SOX	0.07	165.564	168.63	153.3	128.772	122.64	79.716	79.716	79.716	79.716	79.716	79.716	85.848	95.046	104.244	116.508	128.772	141.036	153.3
CO	0.057	134.8164	137.313	124.83	104.8572	99.864	64.9116	64.9116	64.9116	64.9116	64.9116	64.9116	69.9048	77.3946	84.8844	94.8708	104.8572	114.8436	124.83
LPG	EF (g/TJ)	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	189.2	425.7	662.2	946	1229.8	1513.6
NOx	0.051	2.4123	2.4123	2.4123	2.4123	2.4123	2.4123	2.4123	2.4123	2.4123	2.4123	2.4123	2.4123	9.6492	21.7107	33.7722	48.246	62.7198	77.1936
NMVOC	0.0019	0.08987	0.08987	0.08987	0.08987	0.08987	0.08987	0.08987	0.08987	0.08987	0.08987	0.08987	0.08987	0.35948	0.80883	1.25818	1.7974	2.33662	2.87584
SOX	0.0003	0.01419	0.01419	0.01419	0.01419	0.01419	0.01419	0.01419	0.01419	0.01419	0.01419	0.01419	0.01419	0.05676	0.12771	0.19866	0.2838	0.36894	0.45408
CO	0.026	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298	1.2298	4.9192	11.0682	17.2172	24.596	31.9748	39.3536
Other Primary Solid Biomass	EF (g/TJ)	216531	219738	223096	226453	229860	233316	236552	240375	244753	249884	255195	261055	267461	274312	281354	288392	295430	302468
NOx	0.05	10826.55	10986.9	11154.8	11322.65	11493	11665.8	11827.6	12018.75	12237.65	12494.2	12759.75	13052.75	13373.05	13715.6	14067.7	14419.6	14771.5	15123.4
NMVOC	0.6	129918.6	131842.8	133857.6	135871.8	137916	139989.6	141931.2	144225	146851.8	149930.4	153117	156633	160476.6	164587.2	168812.4	173035.2	177258	181480.8
SOX	0.011	2381.841	2417.118	2454.056	2490.983	2528.46	2566.476	2602.072	2644.125	2692.283	2748.724	2807.145	2871.605	2942.071	3017.432	3094.894	3172.312	3249.73	3327.148
CO	4	866124	878952	892384	905812	919440	933264	946208	961500	979012	999536	1020780	1044220	1069844	1097248	1125416	1153568	1181720	1209872

Annex 3: Broadcast questions

Guiding Questions

1. *Tell us more about climate change, the causes and impacts*
2. *What are some of the observable impacts of climate change in Zimbabwe, are the impacts real?*
3. *Cyclone Idai caused massive destruction of properties and death of people, is this phenomenon linked to climate change and what is being done to make sure that when similar disasters occur, people will be safe?*
4. *What is being done in responding to climate change a) at international level b) at national level?*
5. *Tell us more about the climate change conventions in place and state whether Zimbabwe is Party to all of them?*
6. *As a party to UNFCCC what are the country's obligations with respect to education, awareness and training?*
7. *What is the situation in the country with respect to climate change education, awareness and training?*
8. *Why is Education, Awareness and Training so important in pursuing the climate change agenda?*
9. *We understand the climate change agenda requires substantial financial resources, what is being done to mobilise financial resources for climate change activities in the country and are there any resources mobilised so far?*
10. *What do the following projects intend to achieve: a) National Adaptation Planning b) UN Climate Change Learning c) STIZ-NDC d) SECA,*
11. *Are these projects mainstreaming climate change education, awareness and training?*
12. *Are the Ministries of education involved in mainstreaming climate change education into the curriculum, are you working together with them in the project?*
13. *What are the planned programmes and activities with regards to Education, Awareness and Training?*
14. *What do you suggest should be done to up-scale climate change education, awareness and training in Zimbabwe?*

Ministry of Environment, Climate,
Tourism and Hospitality Industry
GOVERNMENT OF ZIMBABWE
2022

Ministry of Environment, Climate, Tourism and Hospitality Industry
11th Floor, Kaguvi Building
Corner Simon V Mazorodze Street/Central Avenue
P. Bag 7753, Causeway
Harare
Zimbabwe

Tel: +263 242 701681/3
E-mail: climatechange@environment.gov.zw
Website: http://www.climatechange.org.zw