THE FEDERAL REPUBLIC OF SOMALIA

OFFICE OF THE PRIME MINISTER

THE INITIAL NATIONAL COMMUNICATION FOR SOMALIA TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

YEAR 2018

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AUGUST 2018

National Greenhouse Gas Inventory and Enabling Activities for the preparation of the Initial National Communication (INC) under the United Nations Framework Climate Change Convention (UNFCCC) for Somalia

PREFACE

The greatest challenge of the 21st century is to combat climate change while ensuring sustainable national development. Important and ambitious targets in reducing emissions and vulnerability have been recognized in the frameworks of the UNFCCC and the Rio+20 objectives. Furthermore, efforts to halt adverse effects of climate change need to be addressed swiftly to abate and avoid negative impacts.

The Government of Somalia is committed to meet nationally determined reduction targets and implementing a comprehensive nationwide response to climate change actions including; adaptation, mitigation and creating resilient communities. Somalia's climate change actions are aimed at safeguarding the environment, sustaining the society, and supporting economic growth and sustainability for the future generations.

Mitigation actions are identified as voluntary commitments to be elaborated into policy framework for climate change mitigation to achieve the national target of 35% emission reduction compare to business as usual in 2030. The important elements of mitigation actions will be determined through the process of unpacking the NDC.

As a Party to the UNFCCC, The Federal Republic of Somalia has the obligation to report periodically through national communications, and to submit biennial update reports containing updates of national greenhouse gas inventories, including a national inventory report and information on mitigation actions, needs and support received, as mandated by the COP. The information contained in this Initial National Communication to the UNFCCC includes; national circumstances influencing climate change actions, the steps taken to implement the convention, the national inventory of anthropogenic emissions by sources and removal by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol, actions taken, information on vulnerability assessment, adaptation strategies, mitigation actions and support needed and constraints to the implementation of climate change actions..

ACKNOWLEDGEMENT

This report has been compiled for the Directorate of Environment, under the Office of the Prime Minister in response to the Federal Republic of Somalia's obligation to report its greenhouse (GHG) emissions to United Nations Framework Convention on Climate Change (UNFCCC). This INC was compiled using the UNFCCC, guidelines, Intergovernmental Panel on Climate Change (IPCC) 2006 inventory software and the Good Practice Guidance. The Report has been compiled with the support of the United Nations Development Programme (UNDP, Somalia), United Nations Environment Programme (UN Environment) and Global Environment Facility (GEF).

A number of institutes were involved in the compilation of this National Inventory Report. The main information on the energy sector was provided by the Federal Ministries and regional states of Puntland and Somaliland governments. The data for Agriculture, Forestry and Other Land Use (AFOLU) sector foe inventory preparation was provided by FAO-SWALIM, Federal Departments of Agriculture, Livestock, Forestry, and Environment. The waste sector data was estimated from the population data. Climate data was obtained from FAO-SWALIM, UNDP, and ICPAC. We greatly appreciate all the contributions from organizations and individuals who were involved in the process of completing this INC. Special thanks goes to the UNDP-Somalia for providing funding for the compilation of this INC. We would also like to thank all reviewers of the various sector sections.

This publication was compiled and reviewed by the National Climate Change and GHG Inventory team of experts with technical support from GEO-ENVI Solutions international Ltd. This comprised of designated sector experts representing various stakeholder institutions and government lead agencies from the GHG Inventory Sectors and climate Change research institutions; namely, Agriculture, Forestry, and Land Use (AFOLU); Energy; and Waste, and Universities who were all coordinated by Rashid Ateye; UNDP/Directorate of Environment.

This report was subjected to a rigorous review by the national stakeholders. The following national experts are acknowledged for their contribution in this INC Report.

a) Energy Sector

1) Mariam Mohamed Omar	MOPEC
2) Mohamed Ali Maallim	MOEWR
3) Hassan Abdilahi Isak	MOEWR
4) Abdulmajid Abdi Moalim	MOEWR
5) Ali Busiri Aweys	MOP
6) Mohamed Osman Mohamed	MOP
7) Abdi Fatah Omar	MOE
8) Mumtaz Mohamed Gaaxnuug	MOFMR
9) AbdiAziz Mohamed Ahmed	AMOUD
10) Mohamed Abdullahi Ahmed	MOEW/EAU
11) Faadumo Maxamuud Maxamed	MOPW&T
12) Mohamed Salah Mumin	MOCI
13) Nimco Osman Mohamed	MOPIC
14) Abdimalik abdullahi Noor	PPMA

b) Agriculture Sector

15) Sayid Ali Abdullahi	MOPEC
16) C/qadir Husein Walaal	MOLF
17) Mohamud Hassan Ali	Fisheries
18) Mohamud Muse cadaawe	Fisheries
19) Xaliimo Cabdi Maxamed	Fisheries

20) Abdullahi Mukhtar Sheikh	SWS
21) Ahmed Dahir Mire	Agriculture
22) Abdulkadir Hussein Walaal	Agriculture
23) Ibrahim Abdinur	Livestock
24) Abdulkhalaq Hassan Ciid	Livestock
25) Dr. Abdala Abdirahman	MOL
26) Abdikani Yusuf	MOA &NR
27) Abdirahman Hussein Adan	MOERD
28) Abdihakim Shire Ali	PENHA
29) Mohamed Nur Nageye	MOAI
30) Mohamed Yussuf Isse	MOLAH
31) Mohamdu Mohamed Said	HADMA

c) **LULUCF Sector**

32) Ibrahim abdinur Yaqub	MOLF
33) Abdikhlaq Hassan Eid	Livestock
34) Ahmed Dahir Mire	MOLF
35) Bashir Mohamud Hersi	GM
36) Mohamed Abdi Hussein	HIR
37) Abdirahman Ismail Yussuf	JL
38) Amoun Ali Haybe	MOERD
39) Ismail Isse Hayir	MOERD
40) Adan Ibrahim Jama	MOERD
41) Mohameed Hussein	MOWR
42) Keyse Mohamed Khalif	MOFMR
43) Mohamed Abdi Shire	MOEWT
44) Mohamud Ali Osman	MOEWT

d) **Waste Sector**

45) Mohamed Abdirizak Mohamed	MOPEC
46) Fahad Ali Ahmed	Environment
47) Yassin Mohamed Ibrahim	Environment
48) Abdirashid Abdilahi Aamir	Environment
49) Abdirahman Mohamud Abdirahman	Environment
50) Khalif Hassan Dalmar	Environment
51) Mohamed Mohamud Sh. Ahmed	Environment
52) Maryan Ibrahim Abdullahi	OPM
53) Mohamed Hussein Iftin	JL
54) Zakaria Abdirahman Bashir	GM
55) Mubaarak Ismail	MOERD
56) Mohamed Yassin Abdirahman	UOH
57) Abdirahman Elmi Hassan	MOERD
58) Hibo Hashi	MOERD
59) Kafi Nidamudin Adam	MOEWT
60) Mohamed Abdulahi Ali	BSWEN
61) Deeqa C/lahi Jaamac	MOEWT

e) **Regional State Representative**

62) Mohamed Abdikarim Hussein	Hirshabele State
63) Zakaria Abdirahman	Hirshabele State
64) Abdirahim Ismail Yussuf	Jubaland State
65) Mohamed Husein Iftin	Jubaland State
66) Hussein Ahmed Mohamud	Galmudug State
67) Bashir Mohamud Hersi	Galmudug State
68) Abdullahi Mukhtar sheikh Habib	South West State
69) Ismail Mohamud Mohamed	South West State

LIST OF ACRONYMS AND ABBREVIATIONS

ADRA	Adventist Development and Relief Agency
AFDB	African Development Bank
AFOLU	Agriculture, Forestry and Other Land Use
BECO	Banadir Electric Company
CBOs	Community Based Organizations
CCAP	Climate Change Action Plan
CoP	Conference of Parties
EC:	European Countries
EPA	Environmental Protection Agency
ERP:	Economic Recovery Plan
ESA	Environmental Security Assessment
FAO,	Food & Agriculture Organization
FGS,	Federal Government of Somalia
GDP	Gross Domestic Product
GHA	Greater Horn of Africa
GHG	Green House Gas
GHGs	Green House Gases
GPG	Good Practice Guidance
HADMA	Humanitarian Affairs and Disaster Management Agency
HDI	Human development index
HOA	Horn of Africa
ICPAC	IGAD Climate Prediction and Application Centre
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IUCN:	International Union for the Conservation of Nature (IUCN).
MoEWT	Ministry of Environment, Wildlife and Tourism
MRV	Monitoring, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategies and Action Plans
NDC	Nationally Determined Contributions
NDP	National Development Plan
NERAD	National Environmental Research and Disasters Preparedness
NERDA	Natural Environmental Development and resource Agency for Somalia
NGOs	Non-Governmental Organizations
NIR	National Inventory Reports
OAU	Organization of African Union
PV	Photovoltaics
QA	Quality Assessment
QC	Quality Control
SET	Somali Energy Transformation Project
SWALIM:	Somalia Water and Land Management Information System (SWALIM
TED	Technology Education & Design
ToR	Terms of Reference
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme

UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UXO	Unexploded Ordnance of War
WFP	World Food Program
WSIS	World Summit on the Information Society

ABBREVIATIONS FOR CHEMICAL COMPOUNDS

CH_4	Methane
N_2O	Nitrous oxide
CO_2	Carbon dioxide
CO	Carbon monoxide
NO	Nitrogen oxides
NMVOC	Non-methane volatile organic compound
CFCs	Chlorofluorocarbons
HFCs	Hydro-fluorocarbons
PFCs	Per-fluorocarbons
SF_6	Sulphur hexafluoride

LIST OF STANDARD EQUIVALENTS, UNITS AND CONVERSION FACTORS

1 Mega joule (MJ)	= 10^6 Joules
1 Gigajoule (GJ)	= 10^9 Joules
1 Tera joule (TJ)	= 10^{12} Joules
1 Pet joule (PJ)	= 10^{15} Joules
1 Exa-joule (EJ)	= 10^{18} Joules
1 toe	= 41.868 *10^9 Joules
1 ton	= 1,000 Kilogram
1 Cubic Meter	= 1,000 Litres
1 Gallon	= 3.785 Litres
1 tonne	= 1 megagram
1 kilotonne	= 1 gigagram
1 megatonne	= 1 teragram
1 gigatonne	= 1 petagram
1 kilogram	= 2.2046 lbs
1 hectare	= 10,000 m
1 calorie	= 4.1868 Joules
1 atmosphere	= 01.325 kPa
Dm	= dry matter
g	= gram
Gg	= gigagrammes
GW	= gigawatts
GWh	= gigawatt-hours
Ha	= hectare
J	= joule
L	= litre
l/s	= litres per second
mm	= millimetres
m^3	= cubic metre
mamsl	= metres above mean sea level
mbmsl	= metres below mean sea level
Mt	= million tons
MW	= megawatt
MWh	= megawatt-hour
^oC	= degree Celsius
t	= ton

GLOBAL WARMING POTENTIALS[1] -AR4 (100-YEAR TIME HORIZON)

Gas	GWP
CO_2	1
CH_4	25
N_2O	298
HFC-23	14,800
HFC-32	675
HFC-125	3,500
HFC-134a	1,430
HFC-143a	4,470
HFC-152a	124
HFC-227ea	3,220
HFC-236fa	9,810
HFC-4310mee	1,640
CF_4	7,390
C_2F_6	12,200
C_4F_{10}	8,860
C_6F_{14}	9,300
SF_6	22,800
NF_3	17,200

[1] Source: IPCC (2007)$_a$ The CH4 GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapour. The indirect effect due to production of CO_2 is not included.

EXECUTIVE SUMMARY

ES-1.1 Background

The ever increasing concentrations of greenhouse gases are the major cause of global warming leading to negative climatic changes. The proliferation of the GHGs due to anthropogenic activities which include using fossil fuels for transport and energy production/generation, expansion of agricultural land and settlements causing deforestation and land use changes and. The resulting Climate change bears huge negative implications on the economy, people, and natural and built environment. Due to increased concerns arising from the risk of global climate change; the UN General Assembly in 1990 established Intergovernmental Negotiating Committee for Framework Convention on Climate Change (INC). The international efforts succeeded, and the United Nations Framework Convention on Climate Change (UNFCCC) entered into force on 21st March, 1994. Kyoto Protocol entered into force in February, 2005. UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by global climate change.

Somalia continues to make efforts and carrying out actions towards the implementation of commitments as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC). Somalia ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 2009, and since then the country has been working towards the achievement of the objectives of the convention. As a Party to the United Nations Framework Convention on Climate (UNFCCC), Somalia has submited reports to the Convention including the preparation of the INDC and NAPA. This Initial National Communication give account for the national common but differentiated responsibilities and specific national and regional development priorities, objectives and circumstances.

ES-1.2 National Communication Process

This INC preparation was coordinated by the Directorate for Environment within the Office of the Prime Minister, which is the National Climate Change Focal Point for the UNFCCC for the Federal Republic of Somalia. To support the preparation of this National Communication, Sectoral Technical Working Groups (TWGs) based on the IPCC GHG Inventory sectors were established to source and interpret information on the impacts of climate change and activity data used in estimating GHG emissions. Credible contributions were made by TWGs consisting of the following thematic areas: Energy, Transport, Land Use Change and Forestry, Industrial Processes and Product Use, Agriculture, Waste, and Meteorology Reviews. The Thematic Working Groups worked under the guidance of the present GHG Inventory coordinator at the Directorate of Environme within the Office of the Prime Minister. The established Thematic Working Groups form the National GHG Inventory team; a multi-sectoral National Climate Change Committee which is comprised of representatives from various government ministries and departments. The team is responsible for developing and coordinating programmes and projects aimed at addressing climate change in line with the country's development priorities and are focal points for climate change at their respective institutions. Stakeholder involvement and or participation in the national communication were anticipated to strengthen the capacity of the relevant stakeholders to fulfill the country's obligation under the Convention for the subsequent communications. This was also meant mobilize physical, financial and technical resources to support regular compilation of the required information for updating national strategies and the UNFCCC

In following the UNFCCC requirement under Article 4, to develop and submit national greenhouse gas emissions estimations, the emissions and sinks presented in this report are organized by source and sink categories and calculated using internationally-accepted methods provided by the IPCC. In addition, the calculated emissions and sinks in a year are presented in line with the UNFCCC reporting guidelines under the international agreement. The applied consistent methods in calculating emissions and sinks by all parties to the UNFCCC ensure comparability of the estimations.

ES-1.3 National Greenhouse Gas Inventory

In following the UNFCCC requirement to develop and submit results on the national greenhouse gas emissions estimates, the emissions and sinks presented in this report were calculated using internationally-accepted methods provided by the IPCC. The Revised 2006 IPCC Guidelines was used to estimate Greenhouse Gas emissions by sources and removals by sinks in the country for the years 1990-2015. The National Greenhouse Gases Inventory was estimated using Tier 1 of the 2006 IPCC Reporting Guidelines and the IPCC GPG for LULUCF. In 2015, the total GHG emissions for the three main greenhouse gases (C_2O, CH_4 and N_2O) with land use change and forestry (LUCF) were estimated

Emissions/removals of seven gases namely Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Nitrogen Oxides (NO_X), Carbon Monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOC) and Sulphur Dioxide (SO_2) were addressed. Somalia is not obliged under the Climate Change Convention to reduce its greenhouse gas (GHG) emissions. Somalia's contribution (62.92 Mt CO2e as at 2015) to the total global GHG emissions is marginal, representing less than 0.12 percent of total global emissions in 2015. Of the 62.92 Mt CO2e in 2015, about 96 percent of GHG emissions came from the AFOLU while the Energy and Waste contribute 3 percent and 1 percent respectively and the IPPU sector is not considered significant.

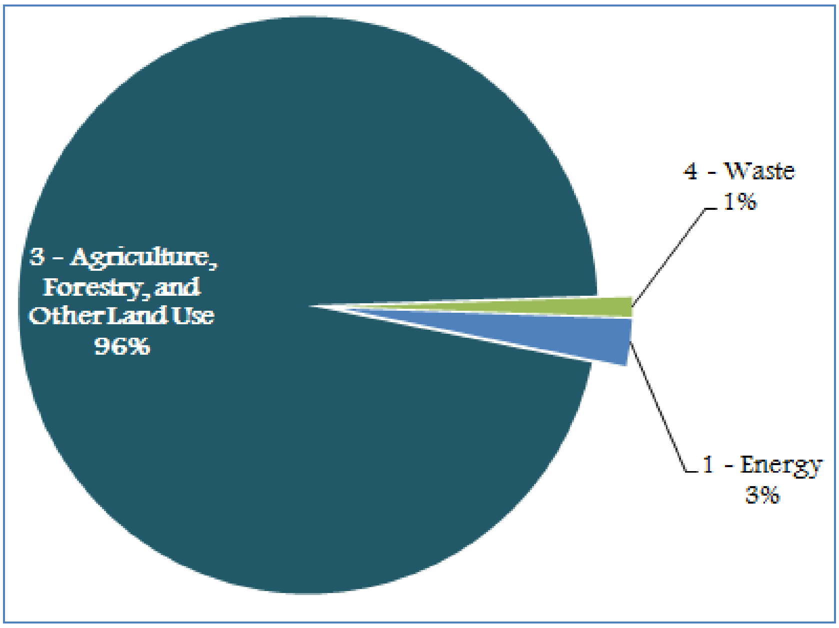

Figure ES 1-1Year 2015 Emissions Percentage by Sector

ES-1.3.1 Major Emission Sources

The main contributing sectors were AFOLU (including LULUCF (96%) followed by Energy (3%), and Waste (1%). The GHG emissions (in CO equivalent) were distributed unevenly between the three gases at 59%, 29% and 12% for C_2O, CH_4 and N_2O respectively. The results for CO_2-equivalent emissions and removals clearly indicate that the AFOLU and Energy sectors are most important sources of emissions, while the land-use change and forestry sector (LUCF) is the most important with respect to removals. Methane and Carbon dioxide (CO_2) are the primary greenhouse gases emitted from the anthropogenic activities. The pie charts in figure ES1-3 show the emissions by sector and by gas emitted in the year 2013. The Figure ES 1-1 indicates that 78 percent of all emission was from the AFOLU sector while Energy and IPPU contributed 15 percent and 5 percent respectively and the waste sector only 2 percent.

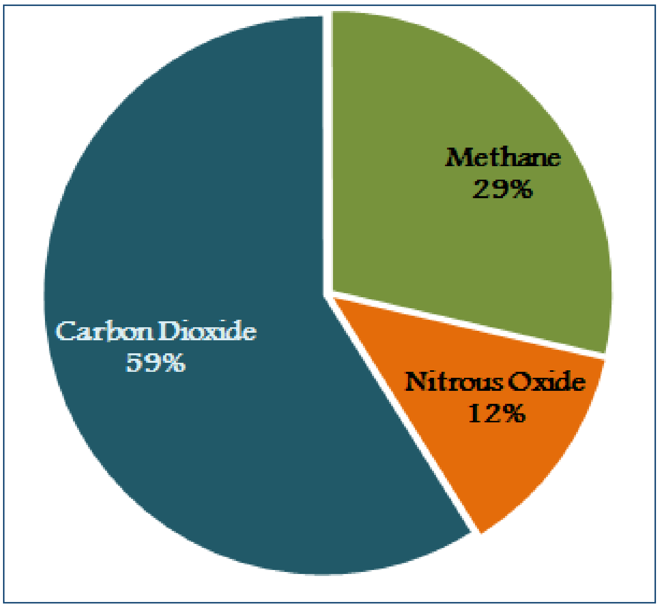

Figure ES 1-2 Year 2015 Emissions Percentage by Sector and Gas

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CHAPTER ONE

NATIONAL CIRCUMSTANCES

1.1. Introduction

This report outlines the national circumstances of Federal Republic of Somalia covering geographical attributes, demographic profile, socio-economic environment and institutional set up related to climate change and environmental governance. Somalia is a party to the United Nations Framework convention on climate change; therefore, this report provides information about Somalia's national circumstances in the context for the national communication (INC). According to Intergovernmental Panel on Climate Change (IPCC) in the Fourth Assessment Report (AR4), there is a significant likelihood for high land temperatures and intense precipitation occurrence which could lead extreme weather events, including droughts and floods. The current trends and events already indicate a tendency for more recurrent and alternating floods and droughts in the country. Some areas in the country have shown a decline in total annual rainfall. These mounting evidences of global warming and climate change require the world to design appropriate policy measures to combat its effects.

Although a national adaptation plan actions has been developed, adaptation is costly and the ability to adapt depends on the available resources. The poor communities in developing countries that include Somalia have the least capacity to adapt and are most vulnerable. Somalia adaptive capacity is severely constrained by its low level of income, high level of poverty, insecurity and inexorable need for economic development

1.2. Geographical Profile

Somalia is located in the horn of Africa, has a land area of 637,540 km². The country has over 3,025Km coastline; the longest in the mainland Africa and the Middle East, which ranges from the Gulf of Aden in the north to the Indian Ocean in the east and south, approximately 1,000 km and 2,000 km respectively. Somalia is bordered by Kenya, Ethiopia and Djibouti to the west. The country stretches for almost 1,550 km from north to south between latitudes 120 N and 10S, and 1,095 km from west to east between longitudes 410 and 510 E. Located in the Horn of Africa, adjacent to the Arabian Peninsula, Somalia is geographically located in a very advantageous region, bordering both Indian Ocean and the Red Sea.

1.3. Historical Profile

The Cushitic populations of the Somali coast in the Horn of Africa have a long history, and were known by ancient Arabs as the Berberi. By the 7th century A.D., the Berberi mingled with Arab and Persian traders who had settled along the coast. This led to the emergence of a Somali culture based on a single language, the Islamic faith and a clan-based social and political system.

About 60% of all Somalis are nomadic or semi-nomadic pastoralists. Somalia is home to the greatest national proportion of pastoralists in Africa. Less than 25% of the population is settled farmers, who live in the fertile agricultural zone sandwiched between the country's two main rivers, the Juba and Shabelle. The remainder of the population is urban based in the main centers of Mogadishu (Federal

Capital), Hargeisa, Burco, Las anod, Bosasso, Garowe, Galkacyo, Kismaayo and Baidoa. Somalia is officially divided into eighteen administrative regions, which in turn are subdivided into districts.
The modern history of Somalia constitutes about 130 years (1880-2010):

a) 80 years (1880-1960) of colonial rule (Lewis, 1988) and division;
b) 30 years (1960-1990) of democratic but mostly military rule and;
c) 20 years (1991-2010) of chaos and State of collapse/ state rebuilding process.

The widespread famine in Somalia in 1992-93 due to several years of droughts combined with bloody civil strife has resulted the largest UN humanitarian efforts and peacekeeping operations in history. Despite being politically disintegrated, Somalia has culturally and ethnically homogenous society. Poverty, which together with injustice is threatening the integrity of the nation, is the major root of social conflict and cause of the current political crisis in Somalia.

1.4. Climate Profile

Somalia is generally arid and semi-arid with bi-modal rainfall. The rainfall is influenced by the Inter-Tropical Convergence Zone (ITCZ), the north-south movement, which results in two rainy seasons and two dry seasons in a year. January to March is the longest dry season known as "Jilaal".this season results from ITCZ emerging from the dry Arabian Peninsula. This is followed by the "Gu" a major rainy season running from April to June. Then the dry "Jilaal" dry season from July to September, which is associated with cool sea breezes from the Indian Ocean that results in light coastal "Hagaa" rains in July and August. There is also the "Deyr" light rainy season in October and November. Total annual average rainfall is 280 mm and the highest annual rainfall is about in about 500-600 mm in high rainfall years. Droughts occur every 2-3 years and are often followed by devastating floods, particularly in the south where the Shabelle and Jubba are vulnerable to heavy rains in the Ethiopian highlands.

1.4.1. Climate Change

Climate change poses great risks to livestock and agriculture, forest ecosystems, water resources, energy resources, transport, public health safety and human settlements which are the key sectors of the economy. One way to reduce the risk of climate change is to do environmental conservation which faces challenges such as poverty and impunity, food insecurity, demographic change, energy demand, water resources stress and climate change.
Using the climate envelope/species-area techniques studies have shown that the projected changes in climate by 2050 may lead to extinction of 15–52% of the 1,103 endemic species (mammals, birds, frogs, reptiles, butterflies, and plants) analyzed (R13.1.3)[2]. Somalia has increasingly suffered in the recent decades from alternating flash floods and droughts, thus can't escape the given impacts of climate change as direct drivers of biodiversity loss.
The extent and nature of biodiversity loss due to climate change needs to be adequately investigated. The harm to biodiversity owing to impacts of climate change will continue to grow worldwide with countries as Somalia having the least preparedness and bound suffer the most.

[2] World Resources Institute, 2005; Ecosystems and Human Well-Being. Biodiversity Synthesis. A Report of the Millennium Ecosystem Assessment. http://www.millenniumassessment.org/documents/document.354.aspx.pdf. Accessed on 15/6/2018

1.4.2. Climate Variability

The changes in extreme temperatures across the Greater Horn of Africa (GHA) region have been observed over the last 50 years. An analysis of global data from 1901-2005 shows temperatures has increased 1.0°C in a century. Inter-annual analyses of national data for Somalia shows that mean air temperatures remain high throughout the year. The hottest months in the south are March and April, only a few degrees warmer than the coolest months, July and August. At Afgoye, near Mogadishu, mean daily temperatures for the period 1953-1976 were 25.2°C to 28.8°C with an annual mean of 27°C. Diurnal temperature fluctuations are high and can range from 20°C to 35°C. The temporal patterns of high rainfall variability over Somalia can be directly associated with extreme events such as floods and droughts impacting the country (UNDP/ICPAC, 2013). The occurrences of extreme events happens when the Indian and Pacific Ocean experiences anomalous sea temperatures and circulation anomalies during El Niño/La Niña, together with IOD events. These include the recent droughts of 2000, 2004, 2008 and 2010-2011; and floods of 1997/1998.

1.4.3. Rainfall Patterns

Rainfall in Somalia is generally low and erratic. The northern maritime plains are extremely hot and arid with average annual rainfall less than 250 mm; with approximately 400 mm of rainfall in the south, and 700 mm in the south-west. The rainfall received in the central semi-arid parts of the country is as low as 50-100mm/year. A few small areas along the coastal strip of Somalia are classified as sub humid.

The amount of rainfall received across Somalia varies dramatically from year to year with recurrent drought periods that persist for several years, and erratic periods of intense downpours and flooding. Based on various analysis of weather station rainfall data, across all regions and seasons in Somalia, there is a very high inter-annual and inter-seasonal variation. Rainfall is shown to vary between the range of 57mm and 660mm at one weather station in central Somalia during a 20 year observation period.

1.5. Demographic Profile

The country has an estimated population of about 10 million in 2014, of which 65% in rural areas. The overall rate of population growth is about 3%, while Mogadishu is growing by a rate of 10% a year (World Bank, 1995). Agricultural livelihood is the second traditional occupation for most Somalis, after nomadic livestock grazing/raising. Livestock and banana export is country's two principal revenue sources. Somalia has one of the lowest human development index (HDI) in the world.

The most recent National Human Development Report indicates that the Human Development Index (HDI) for Somalia is 0.285 out of 1.0. Somalia ranks 165 out of 170 countries in the 2010 Global Human Development Report. The life expectancy in Somalia is 50 years, up from 47 in 2001. Out of the three key dimensions used to measure a country's development, in Somalia, education is the lowest at 0.118 out of 1, followed by income at 0.253 out of 1 and health slightly higher at 0.486 out of 1.

Table 2-1 The Population[3] of Somalia[4]

	Population 2013[5]	Percent	2000	2002	2004	2006	2010	2012	2014
Total	12316895		8601830	9090276	9606459	10151952	11337623	11981418	12661771
Urban	5216392	42.4	3116880	3116880	3116880	3955238	3116880	3116880	3116880
Rural	2806787	22.8	2172320	2172320	2172320	2461756	2172320	2172320	2172320
Nomadic	3186965	25.9	2467680	2467680	2467680	2796468	2467680	2467680	2467680
IDPs	1106751	8.9	847967	847967	847967	960945	847967	847967	847967
Average Household size[6]		6.5 Persons							
Population growth rate		2.8							
Number of Households			1417173	1511337	1605501	1699665	1887993	1982157	2086058
Urban	782354	38.6	547028.8	583376.1	619723.4	656070.7	728765.3	710591.6	805218.3
Rural	482674	23.8	337287.2	359698.2	382109.2	404520.3	449342.3	438136.8	496481.7
Nomadic	465718	22.9	324532.6	346096.2	367659.7	389223.3	432350.4	421568.6	477707.2
IDPs	298493	14.7	208324.4	222166.5	236008.6	249850.8	277535	270613.9	306650.5

1.5.1. Education

Somalia has the world's lowest primary school enrollment rates where about 40% of children are in school and the world's highest youth unemployment rates. Primary school enrolment is only 20.8% for boys and 16.9% for girls. The overall adult literacy rate is of 25% for males, and 12% for females with the literacy in rural areas being very low.

In addition to low education, the Social Services such as health and education indicators are among the poorest in Africa. The high mortality rates stand at 115 deaths per 1000 births and the estimated life expectancy at birth is 52. Life expectancy is low as a result of high infant and maternal mortality rates, the spread of preventable diseases, poor sanitation, chronic malnutrition, and inadequate health services. Inadequate educational and job opportunities are a major source of tension for Somalia's large youth cohort, making them vulnerable to recruitment by extremist and pirate groups.

1.5.2. Poverty

The Poverty levels in the country are high with over 94% of rural population (98% for nomadic populations) living in multi-dimensional poverty (UNDP Somalia, 2012). Poverty is the main direct source of Somalia ecological problems which is also aggravated by the civil strife. This leads to malnutrition, high mortality, poor or inadequate medical facilities, inadequate educational facilities, low income per head and poor productivity. The prolonged civil wars and drought cause starvation that has forced the citizens into refugee camps. This situation has subjected the Somalis into

[3] Population data is modified from UNFPA, 2016 Report based on the recorded population dynamics for Puntland and Somaliland as from year 2000

[4] UNDP 2005, Population Estimates and Projection for Somalia, 2005- 2010

[5] UNFPA (2016). Population Composition and Demographic Characteristics of the Somali People. http://analyticalreports.org/population.html. Accessed 23/7/2018

[6] UNDP/ World Bank Socio-Economic Survey 2002 – Report No. 1, Somalia Watching Brief 2003

extreme poverty, violations of human rights, tribalism and xenophobia and environmental degradation.

The resilience of rural households cannot be decoupled from the resilience of ecosystems. High levels of poverty fuels unsustainable exploitation rates and negative coping strategies. This in turn degrades the quality of natural resources and leaves ecosystems and communities vulnerable to shocks and stresses, including extreme weather events associated with climate change.

1.6. Economic profile

The common feature in the structure of the economy of the three sub-entities of Somalia is the predominance of agriculture and livestock which accounts for about 65% of the GDP and employment. The GDP of Somalia was estimated at about US$ 5.8 billion in 2010, with a per capita GDP of USD 600. Livestock accounts for about 40% of GDP and more than 50% of export earnings. The other main products in the economy include fish, charcoal and bananas, sugar, sorghum and corn. According to the Central Bank of Somalia, aggregate imports of goods average about US$460 million per year, higher than the pre-civil war in 1991. Exports of about US$270 million annually have also surpassed pre-war aggregate export levels (before 1991), but still resulting in a trade account deficit of about US$190 million per year.

The economy is largely dominated by the informal sector based on international trade networks controlled by a small group of wealthy businessmen. The majority of the population lives at the subsistence level and is engaged in small-scale businesses, as petty traders, livestock or grain producers. The private sector has demonstrated resilience and vitality in areas such as telecommunications, livestock, financial sector, water, electricity and fisheries. The private Telecommunication firms provide wireless services in most major cities and offer the lowest international call rates on the continent. Further, the extensive Somalia community in the diaspora has played a major role in injecting a significant inflow of funds using strained banking systems.

Somalia's capital city, Mogadishu, has recently witnessed the development of the city's first gas stations, supermarkets, and international flights since the collapse of central authority in 1991. In the absence of a formal banking sector, money transfer/remittance services have sprouted throughout the country, handling up to $1.6 billion in remittances annually. Due to the incidences of terrorism, the international concerns over the money transfers into Somalia continue to threaten the existing financial services.

Table 2-2 Somalia Gross Domestic Product; Source: indexmundi.com

GDP - (purchasing power parity):	$4.431 billion (2014 estimate.) $4.186 billion (2013 estimate.) $5.607 billion (2008 estimate.)
GDP – (composition by sector):	Agriculture: 60.2% Industry: 7.4% Services: 32.5% (2013 estimate)
GDP - per capita (PPP):	$400 (2014 est.)
Note: Data are in 2010 US dollars	

Somalia is still characterized with limited basic economic and social statistics leading to great uncertainties in reported analyses. The situation has been worsened by the two-decade of conflict resulting to a collapse of the country's institutions. The existence of de facto spatial and political entities results in complex economic realities, inadequate data reliability and inconsistency. The statistical system is very weak, and no comprehensive household income and expenditure survey has been conducted for a very long time.

1.6.1. Agricultural Resources

The agricultural sector, including livestock, crops, fisheries and natural resources are the primary and most important source of livelihood and socio-economic growth for Somalia. The conflicts that have lasted over 14 years, have derailed the growth of national economy, destruction of agriculture infrastructure, loss of human resources, strategic historical information and a deterioration of traditional livelihood systems.

Agriculture still remains the second most important production system in Somalia. In the recent past, agriculture contributed up to 19 per cent of GDP and accounted for 20 percent of employment (IUCN, 1997). Southern Somalia's alluvial plains, the country's most fertile soils and the inter-riverine area of Bay account for almost 90 percent of agricultural production. The agriculturally rich south and central regions have suffered the most from civil conflict. The government and private institutions collapsed in 1991 and no services are provided to farmers since then. Irrigation and flood control infrastructure along the two main rivers has deteriorated. As a result, overall production of staple food crops (sorghum and maize) has decreased by 50% in most of the agriculturally important regions of Somalia. Production of major export crops, including banana, grapefruits and watermelons have dropped dramatically. However, there are a number of NGOs providing extension and rehabilitation services, but the impact of these efforts have been minimal due to insecurity, limited technical experience and inadequate institutional support.

Irrigation farming is practiced the Jubba and Shabelle river valleys, while in Bay, the lower Jubba and lower Shabelle regions, rain fed farming is combined with camel and cattle rearing. Rain fed cropping is practiced in the coastal hinterland towards the north-eastern of Mogadishu. There is very limited crop production in the northern part of the country. Rice, maize and sesame are the main irrigated crops in the Shabelle and Jubba riverine areas. There is high risks for flooding due to poor irrigation management and deteriorated infrastructure for flood control. Maize, cow peas and sorghum are the main rain fed crops grown in areas with rainfall above 450 mm per year. The rain fed farming is exposed to the risks of erratic and low rainfall levels caused by the recurrent droughts.

Poor management practices on rain fed crops and fallowed land is leading to lower levels of soil fertility and soil erosion. This in turn, translates into lower productivity and increased hardship for populations dependent on rain fed agriculture. The major cash crop is bananas whose annual exports exceeded 120,000 tones before the civil strife. However, production and exports collapsed during the war and have not yet recovered. Despite some recovery in 1990s, the El Niño rains affected commercial farming in 1997-1998 when 80% of the country's banana plantations got destroyed, causing income loss for about 100,000 families[7].

In farming, the primary strategic focus is the rehabilitation of vital crop production Infrastructure and services including small irrigation system infrastructure and dams. This will be accompanied by strengthening of agricultural institutions at federal level in terms of policy, legal and regulatory framework. At the district level, the implementation, maintenance, monitoring, and revitalization of irrigation systems and formation of river basin water authorities need to be considered. There is need to address limited access to farm inputs through establishment of financing schemes.

1.6.1.1. Livestock

Livestock production has been the backbone of the Somali economy for centuries. It is also the most important source of income for the predominantly rural population. Meat and milk production accounts for 55 percent of the calorific intake of the entire population in Somalia. Most recent projections estimate livestock numbers at about 5.2 million cattle, 13.5 million sheep, 12.5 million goats and 6.2 million camels, with cattle being concentrated mainly in the south and camels in the northern part of the country.

Somalia, unlike other nomadic livestock systems, livestock keeping is very market-oriented. Approximately 2.5 million animals are exported each year with livestock exports (including raw hides and skins) representing about 40 per cent of gross domestic product (GDP) and 80 per cent of foreign currency earnings. There are challenges facing the livestock keeping in Somalia which include; export bans placed on Somalia by countries like Saudi Arabia, absence of an animal health surveillance system and the collapse of the public veterinary system[8].

The lack of a regulatory framework for livestock exports may also be a weakening factor in this trade since it is controlled by individuals. Overstocking, overgrazing, declining fertility of pastures, disease outbreaks and unpredictable rainfall are among other risks facing livestock farming. The numbers of livestock are reported to be exceeding the carrying capacity within the nomadic pastoralism areas causing overgrazing and susceptibility to outbreaks of disease.

1.6.2. Fisheries

Despite the country's long coasts, Somalis are not traditionally a fishing or fish-eating people, although some small coastal communities have in the past been engaged in subsistence fishing. Somalia has one of the world's lowest fish consumption rates in the world with just 2 per cent of protein intake coming from fish. Fishing was however strongly promoted by the government during the 1970s, partly in response to the drought of 1973-1975, when the Coastal Development Project resettled 14,000 nomadic people from inland regions to the coast.

Somalia exported almost US$2.5 million-worth of fish and fish products in 2000, a 464 per cent increase from 20 years earlier. Near-shore fisheries now target just a few key species, lobster and

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[7] EU 2004; Feasibility Study Report June, 2004. Promotion of Employment through Training in Somalia. http://www.somali-jna.org/downloads/pett%20final%20rpt.pdf . Accessed on 3/7/2018

[8] EU 2004; Feasibility Study Report June, 2004. Promotion of Employment through Training in Somalia. http://www.somali-jna.org/downloads/pett%20final%20rpt.pdf . Accessed on 3/7/2018

shark for export. Recent observations suggest that better arrangements for fishing regulation, control and processing reduce overfishing and wastage.

Hundreds of fishing vessels from a variety of nations ply over the waters of Somalia, operating without license. Local Somali fishermen are attacked and their equipment destroyed by the alien unlicensed fishermen. Illegal fishing by foreign interests represents a loss of revenue for the new Federal Government and the regional authorities of Puntland and Somaliland.

1.7. Natural resources:

Somalia's natural resources fall into three broad categories: marine resources, land and water resources and mineral resources. The main examples of the natural resources include; Surface and groundwater, fish, salt; forests and forest products such as the aromatic extracts of frankincense (from Boswellia spp.) and myrrh (from Commiphora spp., both Burseraceae), resources such as rocks and minerals, fossil fuels, and groundwater. The exploitation of most of these resources has been affected directly or indirectly by the extended civil conflict. In the absence of a government, many traditional forms of natural resource management and control systems have been abandoned. In several instances, this has resulted in clearly unsustainable exploitation. For instance there is pronounced degradation in the parts of north-west, and the Kismaayo area as a result of overgrazing and deforestation for charcoal making. The recurrent droughts in Somalia are symptoms of complex trends and inter-linkages that are related to population growth, dwindling capacity of a fragile ecological system, environmental degradation, weather cycles and the absence of agricultural and non-agricultural rural development.

1.7.1. Water Resources

Somalia's is dominated by surface water resources. The Juba and Shabelle are the two main perennial rivers in Somalia, having a basin covering 810 427 Km^2, spreading over about one-third of Ethiopia, Kenya and Somalia. It has been noted that following over extraction, seepage losses, evaporation, and overbank spillage the downstream flows along the Shabelle River has decreased rapidly beyond the Sablaale wetlands[9].

The Shabelle River is a tributary of the Juba River but the Shabelle flows rarely reaches the Juba. Extreme floods have been noted to destruction since early 19^{th} century, especially in the year; 1946, 1961, 1981, and 1997/1998. Usually the lower floodplains of Juba are the most affected when heavy rains occur in the upstream of the basin in Ethiopia. During the flooding periods, sedimentation and siltation of the riverbeds and irrigation channels aggravates the damage. Along the Gulf of Aden in the northern side, there is extensive erosion resulting from the torrential flows coupled with the rugged terrain of the mountainous zone. In this area slopes face southwards with the water courses being dissipated along the Haud plateau. This hinders ground recharge and thus limiting groundwater potential in the Gulf of Aden[10].

[9] FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on [2018/07/10]. http://www.fao.org/nr/water/aquastat/countries_regions/SOM/

[10] FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on [2018/07/10]. http://www.fao.org/nr/water/aquastat/countries_regions/SOM/

Table 2-3 Water Resources of Somalia; Source: FAO; Aquastat, Water report.

Renewable Water Resources			
Average precipitation		282 180	mm/yr.
Internal Renewable Water Resources		6	$10^9 m^3$/yr.
Total Actual Renewable Water Resources		14.2	$10^9 m^3$/yr.
Dependency Ratio		57.75	%
Total Actual Renewable Water Resources per inhabitant	2004	1377	m^3/yr.
Total Dam Capacity	2003	0	$10^9 m^3$

The internal potentially renewable water resources capacity of Somalia is 6 km^3/year, with surface water and groundwater being 5.7 Km^3 and 3.3 Km^3 are respectively having an overlap of about 3 km^3. It is estimated that the renewable water resources totals to 14.2 Km^3/year but the resources cannot be harnessed to optimal levels due to frequent flooding. The Juba and Shabelle rivers basins have no dams within Somalia and the flood-control structures constructed prior to 1991 have deteriorated. However, in the upstream at Jowhar there is an off-stream storage (0.2 Km^3), near the irrigated lands and the Jowhar sugar estate (collapsed in mid-1990s) downstream. There is a potential for hydropower and irrigation of about 175000Ha of land at Baardheere along the Juba River as was proposed in a development project in the 1980s[11].

Drinking water comes mainly from natural lakes, streams, rivers and water falls. However, these sources are mostly unhygienic since the people and cattle use these water resources simultaneously. This has caused the communities great suffering from various harmful environmental and hazardous effects to human health.

1.7.1.1. Water Usage

It is estimated that the total water withdrawal is 3.298 km^3/year (2003) mainly for agriculture (irrigation and livestock) accounting for 99.5 percent. In the rural areas water supply is derived from surface dams, water pans, boreholes, shallow wells and springs using donkey carts to households. During the dry season groundwater remains the main water supply for domestic, municipal and livestock use[12].

Table 2-4 Water Uses in Somalia; Source: FAO; Aquastat. Water report

Water Withdrawal			
Total Water Withdrawal	2003	3298	$10^9 m^3$/yr.
-Irrigation + livestock	2003	3281	$10^9 m^3$/yr.
-Municipalities	2003	15	$10^9 m^3$/yr.
-Industry	2003	2	$10^9 m^3$/yr.
-Per Inhabitant			
-Surface water and groundwater withdrawal	2003	3298	$10^9 m^3$/yr.
-as %of total actual renewable water resources	2003	22.4	%
Non-Conventional Water Resources			
Produced wastewater			$10^9 m^3$/yr.
Treated wastewater			$10^9 m^3$/yr.
Reused Treated wastewater			$10^9 m^3$/yr.

[11] FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on [2018/07/10]. http://www.fao.org/nr/water/aquastat/countries_regions/SOM/

[12] FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on [2018/07/10]. http://www.fao.org/nr/water/aquastat/countries_regions/SOM/

Desalinated water produced			$10^9 m^3$/yr.
Reused Agricultural Drainage Water			$10^9 m^3$/yr.

Many urban rivers and surface water bodies in the country are chocked with pollution. The Shabelle River in Somalia can be mentioned as an example of surface water mainly serving as an outlet for liquid and solid, domestic and industrial waste material (ESA-HOA).

In some parts of Somalia ground water has been contaminated with hazardous substances infiltrated from hazardous waste disposal sites (ESA-HOA). Borehole drilling statistics show that one in three attempts is successful due to limited ground resources. This is attributed to the fact that drilling projects are not informed by hydro-geological surveys and aquifer mapping as many of the aquifers' characteristics are not well understood. There have been several small-scale programs to remedy the lack of hydro-geological maps, but this remains a significant barrier to sustainable exploitation of water resources in Somalia. Further, over 60% of the aquifers in Somalia are saline. Therefore the existing groundwater sources should be managed well to ensure that the rate of extraction does not exceed the recharge rate.

A recent study by FAO SWALIM 2012 covering 1,270 sites in northern Somalia showed that unregulated and uninformed drilling of boreholes is depleting ground water sources and contaminating freshwater aquifers. Aquifer levels have declined by 30% in some areas while the close proximity of boreholes has resulted in interference and low yield rates, contributing to conflict between communities.

1.7.1.2. Access to Safe Water

Water statistics for Somalia indicate that only 29.55% of the total population (UNODC, 2013) has access to an improved water supply. Somalia is a water deficit country and individual water accessibility has been on the decline. Total renewable water per capita declined from 4,980 m^3 to 1,538 m^3 per inhabitant per year between 1962 and 2012 (FAO AQUASTAT, 2013). A further decline is projected for 2015 with individual access dropping to 888 m^3 per person per year. This is attributed to climatic conditions in the country, inadequate investment in appropriate technology to harness rain water and efficient exploitation of water resources. The Global Water Stress Index of 2011, indicating the relationship between water supply and demand, categorized Somalia as a 'high risk' country.

In the north and north-east, sub-surface water is generally saline and permanent source of water are found in deep boreholes. In the south, however, water is obtained from rivers as well as shallow wells. During the tsunami, many wells in coastal areas were buried by sand washed in by the waves, resulting in brackish and polluted water. Seawater may have also invaded the porous rocks contaminating the underground water with salt.

Recent data on access to water are not available for much of the country, but it is thought that fewer than 5 per cent of the total population may have secure access to water throughout the year. An estimated 31 per cent of the population has access to safe drinking water in the north-west. The north-east and southern part of the country has access to safe drinking water at 19 percent and 20 percent respectively. In Mogadishu, the figure is not more than 35 per cent in the urban area and 10 per cent in rural Banadir.

In many parts of Somalia, such as the Galguduud region and the middle regions, the nearest water source is about 70 km or further from settlement areas. Elsewhere, the water table may be very deep and not easily accessible; drilling is done to a depth of 170-240 m before reaching water. Accessing safe and reliable water sources for the populations, livestock and agriculture is therefore a major concern in most areas.

1.7.1.3. Water Regulations

There is inadequate enforcement of standards and regional water policies in the country mainly due to weak institutional arrangements. Several agencies have worked with regional governments to draft crucial legislation (most notably FAO Somalia), but without implementation and enforcement by the government, the exploitation of groundwater sources continues unchecked.

There law of the Water Development Agency enacted in 1971, remains part of the limited constitutional and legal regulations governing social and economics water resources in Somalia. In addition, Somaliland, developed a water Act and a Water Policy in 2004. In most of the rural communities, the traditional Somali law (xeer) and the Islamic Sharia law are upheld while in some advanced cases juridical system is being restored to ensure equity in natural resource management. However in most areas ownership of land and water is clan based where particular territories are associated with given clans. The Somali social organization law considers water a public property and allows appropriation and usage by administrative permits.

1.7.2. Land Use/ Land Cover

Somalia's terrain consists mainly of plateaus, plains, and highlands. In the far north, however, the rugged east-west ranges of the Karkaar Mountains lie at varying distances from the Gulf of Aden coast. In the north, there is a maritime plain parallels the Gulf of Aden coast which is about 12 km wide in the west narrowing to about 2 km. to the east. The plain is covered with guban, a semi-arid Scrub. The plains also have inter-twinned broad, shallow watercourses that have beds of dry sand except in the rainy seasons. The guban provides conditions suitable for grazing livestock in the rainy season when grass and leafy vegetation emerges[13].

Somalia is largely a flat country with rugged terrain in the southern and central regions. In the Karkaar ranges there are cliffs facing north wards and extending to tip of the Horn of Africa, just inland from the guban from the border with Ethiopia the north-western side of Somalia. These forms the highest mountains in the country with an altitude of up to 2,000m and peaking at 2,407 m at Shimbiris in Sanaag region (EC/IUCN, 1993). The ranges descend to the south forming an elevated plateau without perennial rivers. The area with the rugged terrain with shallow valleys and mostly dry watercourses is called the Ogo. The Ogo in the central part form the Mudug plain while the eastern part gently undulates towards the Indian Ocean. This plateau merges in the Haud

[13] UNEP 2005; The State of the Environment in Somalia, A Desk Study. https://postconflict.unep.ch/publications/dmb_somalia.pdf. Accessed on 12/06/2018

to the south forming broad undulating plains best for grazing by the nomads, despite having inadequate rainfall for a greater part of the year[14].

1.7.3. Biodiversity

Somalia enjoys significant stature in World's biodiversity since the ancient times when it was known as the land of Punt. The Puntland was famous for its production of Myrrh and Frankincense. Livelihood in Somalia has a strong association with the biodiversity with high dependency on the ecosystem the products and services. Biodiversity plays a dominant role in abating the effects of climate change, especially with the restoration of mangroves and corals for artisanal fishery.

The Somalia's arid biome is a renowned source of biological resources for thousands of years. Along with the Succulent Karoo of the south-western Africa, the Horn of Africa is one of only two biodiversity hotspots that are entirely arid. This hotspot also holds more endemic reptiles than any other region in Africa. Other distinctive endemics include the Somali wild ass and the sacred baboon. Unfortunately, the Horn of Africa is one of the most degraded hotspots in the world, with only about 5 percent of its original habitat remaining. Apart from climatic changes; overgrazing and charcoaling with insufficient resource management efforts are main causes of the deterioration.

1.7.3.1. Terrestrial Biodiversity threats in Somalia

Global biodiversity richest places are concentrated in 34 hotspots of biological diversity. Somalia lies in the Horn of Africa biodiversity hotspot. Beside its harsh climate and xeric vegetation, the country is still home to high level of endemism within the two global zones of endemism; the Horn of Africa Biodiversity Hotspot and the Coastal Forests of Eastern Africa Hotspot. Early colonial officials (R.E Drake Brockman, 1910) have reported on the abundance and rich diversity of wildlife. Till 1980s the country was reported to host around 3,023 species of higher plants and was considered as a center of floral endemism.

The fauna has been depleted by poaching and land degradation. The degradation is a result of overgrazing of livestock, deforestation for charcoaling and firewood collections. These activities have adversely affected the species composition, ground cover and the structure of vegetation and soil systems. The threats to biodiversity and ecosystems are caused by multiple, interacting drivers which include; habitat degradation, fragmentation as a result of agriculture expansion, gully and sheet erosion, expansion of Settlement and charcoal based deforestation.

1.7.3.1.1. Habitat Fragmentation and Degradation

The habitat fragmentation and degradation is brought about by various factors which include; deforestation, erosion, gullies formation, encroachment for agriculture and infrastructure for communication and settlement. The impact of fragmentation has become significant on biodiversity due to interference with migratory corridors and transboundary movements. Although habitat degradation is pronounced in the form of gully formation and encroachment for settlement, (FAO-SWALIM)

[14] UNEP 2005; The State of the Environment in Somalia, A Desk Study. https://postconflict.unep.ch/publications/dmb_somalia.pdf. Accessed on 12/06/2018

1.7.3.1.2. Invasive Species

The introduction of alien species is the second leading cause of species extinction and habitat destruction. The major invasive species in Somalia are Prosopis juliflora, Prosopis pallida and Prosopis chilensis. These were initially introduced to East Africa for the stabilization of dune systems and for providing fuel wood after prolonged droughts in the 1970's. In many areas, the species have hybridized to an extent that the current varieties have lost most of their valuable woody attributes and have aggressively suppressed native shrub and tree vegetation.

The other leading invasive species is Indian crow, particularly affecting the avian biodiversity. The species has brought about competition for food and preying over the chicks and eggs of various birds. So far the available eradication measures for the invasive are not cost-effective and there is limited financial and institutional capacity of the Government.

1.7.3.1.3. Hunting and Poaching

There is no reliable data on poaching; nevertheless the anecdotal information reveals that random hunting for meat still exists particularly in poaching/hunting antelopes for food while other species as cheetah, is smuggled to the gulf countries.

1.7.3.1.4. Overgrazing

Overgrazing has led to habitat degradation due to browsing pressure, marring the natural regeneration of the woody vegetation. Further, the hoeing phenomenon, and removal of the vegetation cover have caused gully and sheet erosion. Free range grazing prevails on the indigenous nomadic pattern of following the available forage and water without any rotational purposes to allow for re-vegetation grazed areas on a sustainable basis.

1.7.3.1.5. Deforestation

Somalia has less than 3% area under a close canopy forests. This is largely found in the Golis Mountains of the north and the Coastal Forest Mosaic, south off-Kismaayo. Close to open canopy Acacia and Camiphora vegetation covers a vast part of the country. Despite being a forest poor country, deforestation for firewood, timber and charcoal making in somalia has been reported since 1970s.

According to (FAO SWALIM); Acacia bussei is the most common wood for charcoaling. In Puntland, the estimated annual rate of Acacia bussei decline is about 5%; this rate is validly applicable across Somalia. The output of charcoal in north-eastern Somalia was estimated to be 4.8 million bags (about 25-30kg each). Considering the fact that this volume of charcoal requires about 2.1 million Acacia bussei trees and an approximate average density of 60 trees per hectare, it can be deduced that the rate of deforestation is about 35 000 hectares per year[15]. Further, this can translate to 72916 hectares annual deforestation rate in the southern Somalia where 10 million bags (approximately 4.375 million trees) of charcoal are produced annually based on the 2011 export statistics[16].

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[15] Somalia Report, 2011.Charcoal Trade Stripping Somalia of Trees. www.somaliareport.com.

[16] UNEP 2015; Federal Government of Somalia and United Nations Joint Programme for Sustainable Charcoal Reduction and Alternative Livelihoods (PROSCAL). http://mptf.undp.org/document/download/17225. Accessed on 7/6/2018

The Acacia bussei tree was put into IUCN Red List of threatened species in 2009 by the International Union for the Conservation of Nature (IUCN)[17] following the very high rates of deforestation of the species in Somalia without any measures for re-planting (FAO – SWALIM, 2014).

1.7.3.2. Aquatic Biodiversity threats in Somalia

The aquatic biodiversity of Somalia is looked in the context of coastal marine environment and inland and onshore wetlands. The long coasts with marine and coastal wetlands, inland wetlands, lakes, reservoirs, rivers, inland flood plains, swamps are among Somalia major ecological systems in which aquatic biological resources thrive. Further, important coral reefs, sea bed colonies and turtle nesting beaches are currently unprotected in the country. At the end of the last century there were believed to be large dugong populations and extensive sea grass beds in near shore waters. The identified, important seabird nesting sites include Maydh Island, Zeila Island and islets off Mogadishu. However, immediate and appropriate measures on protection and controlled management are required to replenish the deteriorating marine and coastal resources[18].

Somalia's long coastline (approximately 3,333 km) is endowed rich diversity in fisheries and a wealth of marine resources. The coastline zone of the country has a capacity of approximately 200,000-300,000 tons of fish production per year with an estimated annual harvest of about 15,000 tons before the civil war. Due to the current uncontrolled, unregulated, and rampant illegal fishing; the marine resources have declined. For instance the lobster export trade that once thrived has now derailed to an extent of hindering livelihoods of artisan fishermen dependent on lobster harvesting owing to the declining stocks[19].

There are foreigners carrying out uncontrolled illegal fishing causing coral reefs destruction. Further, oil transport by the world's main tankers sailing through the Gulf of Aden without surveillance mechanisms continue to pose biodiversity threats by occurring and potential oil spillage and dumping of toxic waste the Somali coastline[20].

1.7.3.2.1. Coastline Pollutions

Somalia has a long resources-rich coastline with great untapped potential. However, there are pollution challenges posed by foreign vessels that indiscriminately pollute the shoreline and the sea of Somalia causing deaths of indigenous people from direct and immediate effects of contamination from hazardous waste materials[21]. For instance, in Eil-dheer, in Gal-guduud region, in April 1996, an oily-liquid and sealed strange containers found floating at the shoreline caused deaths to curious residents who came into contact. Similar events were witnessed in Adale seashore in 1992. The

[17] http://threatenedplants.myspecies.info/sites/threatenedplants.myspecies.info/files/Acacia%20bussei.pdf. Accessed on 7/6/2018

[18] FROS (2015). Somalia's Intended Nationally Determined Contributions (INDCs). State Minister for Environment, Office of the Prime Minister and Line Ministries and Ministry of Planning, Federal Government of Somalia, November, 2015.

[19] FROS (2015). Somalia's Intended Nationally Determined Contributions (INDCs). State Minister for Environment, Office of the Prime Minister and Line Ministries and Ministry of Planning, Federal Government of Somalia, November, 2015.

[20] FROS (2015). Somalia's Intended Nationally Determined Contributions (INDCs). State Minister for Environment, Office of the Prime Minister and Line Ministries and Ministry of Planning, Federal Government of Somalia, November, 2015.

[21] http://www.angelfire.com/ne/NEDRA/NEDRA.html. Accessed on 3/5/2018

common source of marine pollution is external diffuses of pollution from seabed activities and deliberate ocean dumping into Somalia sea water by foreigners[22].

1.7.3.2.2. Garbage Dumping

The civil unrest and war in Somalia has led to the displaced people with least waste management arrangements, and thus led to increased solid waste generation and dumping of garbage directly onto the sea shore. Due to lack of regulation, almost all the coastal cities and towns use the beaches as garbage dumping sites. Over the years, a huge volume of garbage has accumulated on the beaches. In addition, runoff from agricultural lands and urban areas also bring into the coast animal and human wastes, pesticide and fertilizer residues that degrade water quality and ecosystem health.

1.7.3.3. Threat to the coastal biodiversity

The major driver to the change of the coastal biodiversity of Somalia are the excessive use of these resources on one hand and the pollution in the shape of waste disposal, oil spillage, run-off, waste coming from the settlements, etc. Various threats are mentioned as follows:

1.7.3.3.1. Mangroves

Mangrove forests are home to a rich assortment of wildlife, such as birds and many aquatic species, but they also provide another crucial and often overlooked service to their ecosystems: they are natural buffers that shelter coastal communities and wildlife from the brunt of storms and waves, such as tsunamis. The patches of mangroves in Somalia play a vital role in reducing shoreline erosion. Also, mangroves perform several other ecological and hydrological functions including water supply, erosion protection and habitats for fish. They are critical for the conservation of biological diversity.

Somali mangroves are found in three tidal estuaries between Saada Din Island and Saba Wanak in the extreme south of the country. There are narrow (20m) mangrove fringes in the Caanoole Estuary and Bushbush Estuary that are tidal for approximately 30km inland. The Bushbush Estuary running through Bushbush Game Reserve is the only marine protected area with mangroves in Somalia[23]. In the northern areas of Somalia, there are subtropical and thickets with scattered mangroves, especially the *Avicenna marina*. However, important mangrove development is hindered by upwelling cold water currents in these areas. Further, Mangroves have formed in the low intertidal zones of channels along the Kismaayo coast[24].

The mangrove in Somalia are facing depletion due to cutting the mangrove for timber and firewood, overgrazing and browsing, waste disposal, urbanization, sand dune encroachment, flood water erosion and oil spillage, (FAO-SWALIM, 2010). Trends in mangrove area over time clearly show the deforestation, the annual rate of deforestation is around 1 per-cent.

[22] http://www.angelfire.com/ne/NEDRA/NEDRA.html. Accessed on 3/5/2018

[23] UNEP-WCMC 2003; Mangroove of East Africa . http://apps.unep.org/redirect.php?file=/publications/pmtdocuments/-Mangroves%20of%20East%20Africa-2003513.pdf. Accessed on 12/72018

[24] UNEP-WCMC 2003; Mangroove of East Africa . http://apps.unep.org/redirect.php?file=/publications/pmtdocuments/-Mangroves%20of%20East%20Africa-2003513.pdf. Accessed on 12/72018

1.7.3.3.2. Coral Reefs

Somalia has excellent fringing and patches of coral reefs along the Gulf of Aden coastline and southern Somalia near the Kenyan border which are highly bio diverse. The rock-like structure of coral reefs serve as a natural water break; a physical barrier near the ocean's surface that breaks waves offshore and dissipates most of their force before they reach the land. Therefore, they have the capacity to create rigid, wave-resisting structures that modify their physical environment, thus creating a wide variety of associated depositional movements.

The coral reefs of Somalia have undergone major, although often partially reversible, bleaching episodes due to the local sea surface temperatures increase by 0.5–1o Celsius above the average of the hottest months. Precipitation patterns have changed spatially and temporally, and global average sea level rose 0.1–0.2 meters. By the end of the century, climate change and its impacts may be the dominant direct driver of biodiversity loss and changes in ecosystem services globally; Somalia can't be an exception to this at the least.

There could also be significant damage to the coral reefs as a result of land runoff of wastes and pollutants, debris, soil and organic matter, particularly, those near the coastal towns of Kismaayo and Mogadishu. Due to the absence of appropriate national institutions there are no mechanisms to assess the damage to coral reefs by natural hydrological related disasters and human activity and plans for their protection. An assessment of the coral reefs is therefore needed to determine the extent of damage caused by the tsunami and other natural disasters such as El Nino as well as general degradation arising from long years of pressure from human activities and management neglect.

Coral Bleaching: Although varying considerably in condition the coral community on the reefs have been affected by bleaching to some degree. The shallow reefs to the east of Berbera had suffered badly, where the deeper reefs were in better condition. The Red Sea coral reefs from Berbera to the border of Djibouti are reportedly in relatively good condition, where at Saada adin islands, coral diversity, fish populations and individual fish sizes were large. Coral mining: Limestone mining on the coral reef exists mainly off southern towns such as Marka and Barawe. The communities in these two towns mine limestone on the shore for use in house construction. Lime making is also common for whitewashing and house decoration. The mining for limestone degrades the coastal landscape in addition to causing inundation, sedimentation and erosion. Sand Mining: Sand mining is very popular in all coastal towns and fishing villages in Somalia. Most of the mining takes place in sand dunes. Mined sand is mixed with cement, coastal soil and gravel to make bricks for construction. This activity destabilizes the coastal sand dunes.

1.7.4. Forest and Woodland

The vegetation in Somalia is predominantly dry deciduous bush land and thicket dominated by species of Acacia and Camiphora, with semi-desert grasslands and deciduous shrub land in the north and along much of the coast. In general, the vegetation becomes denser towards the south – much of the north-eastern part of the country is devoid of trees.

Forest growth in general is limited due to poor soils and low rainfall. Closed forest cover occupies only about 2.4 per cent of the country but, if the Juniperus forests and evergreen tracts in the mountains in the north are included, the total forest coverage would probably amount to around 14 per cent (90,000 km2) of the land. Virtually all of the tropical floodplain forest that once existed along the Shabelle River has been cleared for smallholder agriculture together with sugar and banana plantations, except for a small patch set aside as a reserve at Balcad by the Somali Ecological Society.

Trees that produce aromatic resins; frankincense and myrrh are usually indigenous to the mountain slopes while the timber producing trees are found mainly around the riverine areas. Different ecological zones have different trees and grasses predominating. For instance, eucalyptus, euphoria, palm leaves, timber, and mahogany trees are found in the south[25].

1.7.5. Wildlife

The status of wildlife in Somalia was reported as being sparse and scattered due to a combination of livestock grazing and illegal hunting. As with the fauna depleted by poaching & land degradation, nevertheless, large concentrations of livestock together with the felling of trees for charcoal and firewood adversely affect species composition, ground cover and the structure of vegetation.

Only small remnant pockets of wildlife now exist, with many species approaching extinction. The species that have been wiped out in the country include; elephant (Lexodonta Africana), black rhino (Deceros bicornis), lion (Panthera Leo), and Swayne's hartebeest (Alcelaphus buselaphus swaynei). On the other hand the wild ass (Equus asinus somalicus) has been reduced to just a few dozen[26] from thousands that once existed in the country.

1.8. Technology

Somalia offers some of the most technologically advanced and competitively priced telecommunications services in the world. Funded by Somali entrepreneurs and backed by expertise from China, Korea and Europe, these nascent telecommunications firms offer affordable mobile phone and internet services that are not available in many other parts of the continent. Customers can conduct money transfers and other banking activities via mobile phones, as well as easily gain wireless internet access. Prominent Somali telecommunications companies include Golis Telecom Group, Hormuud Telecom, Somafone, Nationlink, NEtco Telecom and Somali Telecom Group. It is estimated that there are currently 10 privately owned Somali newspapers, over 15 radio and television stations, and numerous Internet sites offering information to the public.

1.9. Energy Profile

Somalia use fossil fuel to meet energy demands for lighting and industrial use. As with the charcoal industry, the electric utility sector is poorly regulated; power in urban areas is supplied almost entirely by the private sector. The cost of energy in Somalia ranges from USD 1.00 to $1.50 per kilowatt hour making Somalia one of the most expensive places to buy energy in the world. Small businesses and service providers in Mogadishu spend almost 26% of their income on energy making

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[25] http://www.angelfire.com/ne/NEDRA/NEDRA.html. Accessed on 3/5/2018

[26] FROS (2015). Somalia's Intended Nationally Determined Contributions (INDCs). State Minister for Environment, Office of the Prime Minister and Line Ministries and Ministry of Planning, Federal Government of Somalia, November, 2015. http://www4.unfccc.int/ndcregistry/PublishedDocuments/Somalia%20First/ Somalia%27s%20INDCs.pdf. Accessed on 16/5/2018

electricity a significant limiting factor to industrial development across Somalia. The cost to households is just as high; an analysis of the energy sector in Mogadishu estimates that on average, households pay between US$ 19-36 per month depending on the usage, after paying exorbitant connection costs of between one hundred and fifty to three hundred dollars. Given the high cost, on average only about 30% of urban households use electricity with a per capita consumption of between 20 and 30 kWh per month.

Electricity supply in Somalia has several problems that stem from serious regulatory gaps. Without standards for safety, price and efficiency, the industry is mainly characterized by irregular power supply, low capacity utilization, poor maintenance and safety practices, and high transmission and distribution losses. Power losses have been estimated at an average of 40%. This is more than four times the international standard of 10-12%. This drives the high cost of electricity and contributes to greenhouse gas emissions.

The Promotion of Economic Growth program has made some gains in addressing gaps in power supply in Hargeisa through two activities. One is the pilot wind farm at the airport and the other is the drafting of a regulatory framework for the industry. There have also been requests from the private sector for help in developing efficiency guidelines, designing systems and training staff; this will be crucial in supporting compliance to the new policy.

1.9.1. Alternative Energy

Somalia is rich in renewable energy resources and has an untapped potential for year round supply of renewable energy, particularly wind, untapped hydropower, extensive geothermal energy resources and solar. The major obstacles to development of these potentially available energy resources are political, financial and institutional. Traditional biomass fuels such as firewood and charcoal, primarily used in rural and poor communities, account for 82% of the country's total energy consumption. Somalia, despite the prolonged civil conflict and least development status, it has a great potential to achieve sustainable development and to contribute in the reduction of Green House Gases (GHG).

There are already signs of recovery that could utilize renewable energy, including solar, wind, hydropower and geothermal energy resources. Some of these signs are the development initiatives in solar energy utilization in the capital Mogadishu and some cities in Puntland and Somaliland. Wind energy was in use prior to the civil war, but the infrastructures, which were mainly in Mogadishu, were destroyed. The Fanoole Dam in Middle Jubba, which was constructed with assistance from China, from1977 to 1982 at a cost of about US $ 50 million, currently needs rehabilitation for irrigation and hydroelectricity generation. In addition, there was a plan to construct the Baardheere Dam upstream of the Fanoole Dam, which was interrupted by the civil conflict. The solar energy potential ranges from 5 to 7 kWh/day with over 310 sunny days in a year, which amounts to 2500 to 3000 hours of sunshine per annum.

Table 2-5 Sources: Center for Global Development; 2011-12 Rankings of the impacts of Climate Change

Electricity access	Population without electricity:	8.9 million	
	Population with Electricity	Total Population	15 %

	Electrification	urban areas	33 %
		rural areas	4 % (2013)

1.9.1.1. Solar Energy

The average solar potential for Somalia is estimated at 5-7 kWh/ m2/day. This makes Somalia ideal candidate for harnessing solar energy considering the over 3,000 hours of constant sunlight per year. Solar resources are very adoptable in country with a number of municipalities particularly Garowe, and domestic consumption of solar being utilized off-grid generation Solar is mainly used for water heating, lighting in municipal buildings particularly health center, cooking[27].

The Banadir Electric Company (BECO), which is the dominant private agency that provides electricity for Mogadishu, is expected to mount soon solar equipment that will generate 5 Megawatts. Solar equipment for other 10 Megawatts (for two sites) is expected to arrive in Mogadishu in the near future. Existing power generation in Mogadishu by BECO is predominantly by diesel generators. Therefore the introduction of 15 MW of solar power would avoid the emission of greenhouse gasses by 75,000 tCO2. In addition, the town of Las anod, Sool region of North Somalia, the electricity is purely generated by a solar power. The European Union (EU) in collaboration with the Adventist Development and Relief Agency (ADRA) launched the 3 year "Somali Energy Transformation (SET) Project, which is intended to provide 100,000 households in Somaliland, Puntland and South Central Somalia with sustainable and affordable solar energy service that would contribute, also, to a low carbon development.

1.9.1.2. Hydro-Electricity

The Fanoole Dam in Middle Jubba was constructed with assistance from China, from1977 to 1982 at a cost of about US $ 50 million. The dam had the potential to irrigate 13,000 ha and generate 4,600 KW of electricity. Although the dam had the capacity to irrigate about 13,000, however, only 1,800 ha were developed prior to the civil conflict. In addition, the 1998 El Nino rains changed the path of the river flow, but the dam still stands and needs extensive rehabilitation and directing the river to go through it. In addition, there was a plan to construct the Baardheere Dam, upstream with a generating capacity of 493 MW, but the onset of the civil war interrupted the project funding and implementation.

1.9.1.3. Wind Energy

The country has large areas of shallow sea along its coastline, particularly suitable for off-shore wind power, with the added benefit that this resource is close to a number of major urban centers, including Mogadishu and Berbera. Studies estimate that approximately 50% of the land area of the country has suitable wind speeds for power generation and 95% could benefit, and profit, from replacing diesel-powered water pumps with wind systems.

Wind speeds vary from 3-11.4 m/s. Four 50 kW turbines were installed in Mogadishu in 1988. Wind energy has also been utilized for water pumping, with installations made by the UN

[27] FROS (2015). Somalia's Intended Nationally Determined Contributions (INDCs). State Minister for Environment, Office of the Prime Minister and Line Ministries and Ministry of Planning, Federal Government of Somalia, November, 2015. http://www4.unfccc.int/ndcregistry/PublishedDocuments/Somalia%20First/ Somalia%27s%20INDCs.pdf. Accessed on 16/5/2018

Trusteeship Administration of Somalia from as early as the 1940s. However, these facilities no long exist due time and the civil war. Average wind speed in northern Somalia is 0.2 to 8.5m/sec. Hargeisa is one of the highest wind speed areas in the north, with an average of 17 m/sec31 in the month of July.

1.9.1.4. Charcoal Production

Charcoal plays an important role in both the energy sectors and economies of many African countries, and Somalia is no exception. Charcoal making provides a considerable amount of employment in rural areas but the scale of this operation has escalated to such an extent that environmental degradation has now been reported from most parts of the country.

The output of charcoal in north-eastern Somalia was estimated to be 4.8 million bags (about 25-30kg each). Considering the fact that this volume of charcoal requires about 2.1 million Acacia bussei trees and an approximate average density of 60 trees per hectare, it can be deduced that the rate of deforestation is about 35 000 hectares per year[28]. Further, this can translate to 72916 hectares annual deforestation rate in the southern Somalia where 10 million bags (approximately 4.375 million trees) of charcoal are produced annually based on the 2011 export statistics[29].

The Acacia bussei tree was put into IUCN Red List of threatened species in 2009 by the International Union for the Conservation of Nature (IUCN)[30] following the very high rates of deforestation of the species in somalia. The increasing loss of the natural resource base throughout Somalia is a key contributing factor in determining the severity of Humanitarian Crises– as evidenced during the most recent drought event to hit the region in 2010& 2016, the impacts of which are still in effect today[31].

The coping strategies employed in the arid/semi-arid area of Somalia have become impractical since the critical resource base is getting depleted. The shrinking natural resource assets are heavily relied upon in the drought events. The indigenous vegetation species that are usually drought-tolerant and evergreen providing a feedstock to the pastoralists in drought are lost to the demands for charcoal production. The efficacy of the current resilience and coping mechanisms has been reduced to an extent that even low-intensity drought cycle causes huge losses and reliance on external assistance. The natural disasters shocks are becoming overwhelming as shown in the 2010 drought with a record severity and magnitude when over 4 million Somalis (50% population) were affected. Further, millions livestock population impacted were unaccounted for.

These frequently recurring shocks causing untold losses are expected to increase in the future. There is need to device efforts to enhance resilience and coping capacities of the huge vulnerable

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28 Somalia Report, 2011.Charcoal Trade Stripping Somalia of Trees. www.somaliareport.com.

29 UNEP 2015; Federal Government of Somalia and United Nations Joint Programme for Sustainable Charcoal Reduction and Alternative Livelihoods (PROSCAL). http://mptf.undp.org/document/download/17225. Accessed on 7/6/2018

30 http://threatenedplants.myspecies.info/sites/threatenedplants.myspecies.info/files/Acacia%20bussei.pdf. Accessed on 7/6/2018

31 UNEP 2015; Federal Government of Somalia and United Nations Joint Programme for Sustainable Charcoal Reduction and Alternative Livelihoods (PROSCAL). http://mptf.undp.org/document/download/17225. Accessed on 7/6/2018

population. The losses resulting from recurring shocks of natural disasters caused Somalia to be ranked 7th globally as the most affected country by the impacts of the climate change[32].

1.10. The State of the Environment

1.10.1. Natural Environmental Problems

Being a natural disaster, drought causes loss of life both human and animal every year in Somalia. The extreme droughts are often followed by devastating floods that mainly affect the southern part of the country. The floods are known to be common along the Juba and Shabelle rivers, distressing the lives of the people and their animals[33]. Further, evaporation rate (over 2000 mm/y) exceeds the rainfall (250 mm/y) in some areas in the country. The frequency of droughts is increasing due to climate change. This has led to water high scarcity and starvation among the rural communities[34].

1.10.2. Man Made Environmental Problems

The most common environmental problems caused by human activities include: water pollution; soil erosion and desertification resulting from deforestation and overgrazing; salinization resulting from inefficient and poor irrigation methods that destroy otherwise productive land; poor fishing methods and control, and dumping of foreign hazardous waste along the coastline and seas of Somalia. There is also improper disposal of solid waste and waste water by local people; extinction of important species of wildlife caused by poaching/hunting and general degradation of the environment due to over exploitation especially the coastal zones[35]. Due to the ever increasing population in the coastline, there is substantial pressure on freshwater aquifers.

1.10.3. Land Ownership and Land Disputes

Land ownership and land disputes are central of the conflict in contemporary Somalia. The pastoral lands have always been community land and conflicts in the pastoral setting are usually matters of power struggles between clans. In the 1970s, a modern land tenure law was passed decreeing that land titles be acquired from the state which owns all the land. The civil war and state collapse accelerated due to this struggle for land. Unraveling the thousands of land and property disputes emanating from the collapsed State has been at the center of every peace process since 1991 and will be a major hurdle in reconciliation efforts.

1.10.4. Inadequate Institutional Arrangements

There is no central governmental body responsible for coordination of environmental protection. There is a huge gap in environmental governance to address these major concerns. This gap has been existing even prior to the collapse of the state in 1991. However, various ministries and state agencies have been made responsible for environmental protection and management functions before the civil war. For instance the National Parks Agency, established in 1970, was responsible for establishing reserve and park area. However, up to 1991 there were no gazzeted protection areas. In 1977, the Ministry of Fisheries and Marine Resources was founded and made responsible

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[32] Center for Global Development; 2011-12 Rankings of the impacts of Climate Change.

[33] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia,

[34] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia

[35] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia

for preventing pollution of the Somalia seas albeit with limited capacity to control the long coastline.

There are tangible steps taken by the government concerning environmental issues which include the prohibition of the export of charcoal and firewood in 1969, an order meant to protect trees. However, this was amended to give way for charcoal exports monopoly by the National Commercial Agency.

1.10.5. Environmental Degradation

The prolonged civil wars and draught starvation dragged the citizens into refuge and perpetual vagrant life. As a result of that, a state of anarchy has emerged, which in turn induced famine and starvation. Cities, towns and villages are harshly tackled into anarchy by the cross-long wars, lack of job opportunity, lack of production, lack of stability and amenity. Some of these serious problems are becoming increasingly visible such as the environmental degradation which is the most serious problem. Thus, Somalia is in a state of a major environmental degradation. Severe damage is being done to Somalia's environment and natural resources. Land degradation is usually caused by many factors including:

a) Overgrazing,
b) Deforestation,
c) Soil erosion and more frequent dry periods;
d) Water pollution from inadequate waste and sanitary facilities and
e) Poor water management;
f) Marine resources degradation from illegal fishing and
g) Hazardous waste disposal in the ocean;
h) Chemical contamination from poor or lack of disposal of pesticides and
i) The disappearance of wildlife.
j) Charcoal production and trade accounts for 95% of all energy consumed in Somalia and represents the biggest threat to Somalia's environmental resources because of employing practices that are highly inefficient and environmentally damaging (FAO, 2013).

1.10.5.1. Deforestation

The rate of deforestation, in response to the rising demand for charcoal, wood for construction and establishment of enclosures has been rising to an extent that millions of hectares of woodlands have been cleared. Deforestation is contributing to diminishing rangelands integrity, water ineffectiveness and watershed degradation. It is causing severe soil erosion and compaction, and flash floods with destructive effects. Moreover, deforestation is a direct threat to rural livelihoods as Somalia domestic economy is heavily dependent on pastoral production.

1.10.5.2. Soil Erosion

As a result of overall decline in biomass production, reduced ground cover, litter and organic matter content and the resultant soil compaction, large tracts of land became exposed to increased run off and erosion processes such as soil erosion and gully erosion. Shifting sands is also becoming more common in many areas, particularly in treeless plains causing transportation and deposition of soil material. The main causes of soil erosion are over-grazing, deforestation, inappropriate agricultural practices and woodland fires.

1.10.5.3. Land Degradation

Degraded lands due to tree felling to meet the increasing charcoal demand are a common sight across Somalia. The north-east and north-west regions are impacted most due to steep topography and occurrence of frequent flash floods leading to the formation of deep gullies. Land degradation is most advanced around the main roads leading to the ports, water holes and wells, where the diminished carrying capacity of the rangeland no longer supports the feeding requirements of the animal populations.

As such, the capacity of denuded rangelands to sustain the pastoral economy is already under irreversible loss threatening the medium to long-term sustainability of pastoral systems. A recent study by Food Agriculture Organization (FAO) / Somalia Water and Land Management Information System (SWALIM) for Puntland estimates the annual rate of Acacia bussei decline at about 5% in Puntland and this rate seem also to be applicable across Somalia. The output of charcoal in north-eastern Somalia was estimated to be 4.8 million bags (about 25-30kg each). Considering the fact that this volume of charcoal requires about 2.1 million Acacia bussei trees and an approximate average density of 60 trees per hectare, it can be deduced that the rate of deforestation is about 35 000 hectares per year[36]. Further, this can translate to 72916 hectares annual deforestation rate in the southern Somalia where 10 million bags (approximately 4.375 million trees) of charcoal are produced annually based on the 2011 export statistics[37].

The Acacia bussei tree was put into IUCN Red List of threatened species in 2009 by the International Union for the Conservation of Nature (IUCN)[38] following the very high rates of deforestation of the species in somalia. The increasing loss of the natural resource base throughout Somalia is a key contributing factor in determining the severity of Humanitarian Crises– as evidenced during the most recent drought event to hit the region in 2010& 2016, the impacts of which are still in effect today[39].

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36 Somalia Report, 2011.Charcoal Trade Stripping Somalia of Trees. www.somaliareport.com.

37 UNEP 2015; Federal Government of Somalia and United Nations Joint Programme for Sustainable Charcoal Reduction and Alternative Livelihoods (PROSCAL). http://mptf.undp.org/document/download/17225. Accessed on 7/6/2018

38 http://threatenedplants.myspecies.info/sites/threatenedplants.myspecies.info/files/Acacia%20bussei.pdf. Accessed on 7/6/2018

39 UNEP 2015; Federal Government of Somalia and United Nations Joint Programme for Sustainable Charcoal Reduction and Alternative Livelihoods (PROSCAL). http://mptf.undp.org/document/download/17225. Accessed on 7/6/2018

1.10.5.4. Natural Hazards and Disasters

Extreme weather conditions such as decrease in precipitation levels, soaring temperatures, increase in the frequency of droughts and flash floods are becoming more common. Moreover, there are changes in the biological succession of some of the plants in certain vegetation zones. For example, the unexplained high mortality of Acacia tortilis {Qudhac} and Balanities orbicularis {Kulan} in the Guban areas is a disturbing trend. Changes in weather patterns have also contributed to the disturbance of calendars for both livestock mating and crop production. The cumulative effects of climate change led to erosion of assets and deterioration of livelihoods among pastoral and agro-pastoral communities in Somalia.

1.10.5.5. Wildlife Poaching

Political unrest during the past three decades has created better access to automatic weapons. Therefore, other than poaching and illegal exportation of wildlife to the Arabian countries, habitat loss is another major cause for their decimation.

1.10.5.6. Solid Waste Dumping and Pollution

With rising urban populations, the inadequate municipal services and low public environmental awareness, waste litter has been crowding all major urban centers. The most eye-catching thing is the plastic bags strewn everywhere and hanging from acacia trees. In the rural areas, these bags, when not disposed of properly, are eaten by livestock (due to shortage of browse and grass) and consequently contribute to the death of large number of animals.

Improper disposal of effluents such as those originating from tanneries and the existing few factories – many of them improperly sited in or near residential areas or water sources – render water unsafe for any domestic use and also represent potential hazard to human health.

1.10.5.7. Unsustainable fishing practices

It is unfortunate that foreign fishing vessels maintain continuous presence in the sea and in many cases inside the twelve nautical miles territorial range of the coast intended to be utilized by artisanal fisher folks. Selective fishing practice where higher value species in the sea are collected and the rest are dumped into the sea is often reported by local fishing associations who have also been raising their concerns through the local media.

Because of the inadequacy of surveillance mechanisms in terms of knowledge, capacity and logistical arrangement, there are gaps in carrying out the strict monitoring required for the sustainable utilization fishery resources. As a result, as reported by artisanal fisher folks, there has been a continuous decline of fish catches.

1.10.5.8. Institutional and public awareness challenges

Inadequate of political will and commitment to protect the environment is exemplified in the fact that the ministry which is mandated for environmental conservation and protection is one of the least funded government institutions. There is also absence of Federal states cooperation on issues related to environment.

1.11. Illegal Hazardous Waste Dumping in Somalia

Treatment and disposal of toxic waste in Europe or in other industrialized regions are costly operations. With disposal costs being far cheaper in developing countries, many African coastal regions are being used as dumping grounds. Dumping of hazardous waste alongside the long coast of Somalia by foreign companies has been evident since the early 1990. The dangerous situation during the civil war in Somalia left this matter largely out of reach of international media attention. This is exacerbated by the very high interests of the waste dumping industry (dumping companies and Somali warlords), putting anyone investigating or revealing the issue at grave risk. This is demonstrated by the case of two Italian reporters who were killed while carrying out research in Somalia into the waste dumping industry.

The 2004 tsunami, uncovered the issue by scattering toxic wastes, leaking barrels and radioactive and chemical waste containers on the Somali shoreline. The hazardous waste dumped along Somalia's coast comprises of uranium, radioactive waste, lead, cadmium, mercury, industrial, hospital, chemical, leather treatment and other toxic waste[40][41]. Most of the waste was dumped on the beaches in containers and disposable (and leaking) barrels, ranging from small to big tanks. These activities suggest that neither the health effects for the local population nor any potential environmentally devastating impacts have been considered. Although hard evidence is lacking, there are many signals that mainly European companies are involved. Also Iran has been mentioned as a source of some of the vessels. In 1992, Swiss and Italian firms were allegedly involved in dumping toxic waste, after having made a deal with a former official appointed to the government of Ali Mahdi, just after the start of the civil war.

1.11.1. Hazardous Waste Dumping Investigation Reports

According to the UNEP statement (Tolba, 1992), hazardous waste was being disposed in the Somalia territory by a number European firms. The UNEP carried out a five years investigation the matter in the country, particularly focusing on the coastal zones Somalia. However, the investigation report was not published. However, several articles have been published based on the investigation by the UNEP and extra efforts to unearth some details on the issue by the Italian Newspaper; Familgia Cristiana (Familgia Cristiana, 1998).

According to Familgia Cristiana (1998c), there is evidence of the hazardous waste dumping presented in pictures and maps. The available evidences have indicated dumping in both the

[40] Hunter C & Herring E 2016; Evaluating Claims of Nuclear Waste Dumping in Somalia/Somaliland Initial Scoping of Open Sources in English, Transparency Solutions. https://transparencysolutions.com/wp-content/uploads/2018/06/Nuclear-Waste-Dumping-Claims.pdf. Accessed on 22/5/2018

[41] United Nations Environment Programme, 2006. National Rapid Environmental Desk Assessment - Somalia.

coastlines and inland Somalia[42]. Although the major part of the waste dumping in Somalia occurred after the state collapse in 1991, the activity has started even during the former regime in 1989. According to the newspaper, there are ongoing dumping activities inside the country

Further the Italian Parliament commissioned a study with an investigation report of 2000 indicating the existence of "Eco-Mafia" companies handling hazardous waste to a tune of 35 million tons a year, and making $US 6.6 million. The report indicates that some of the radioactive waste dumped in Somalia, may have affected the Italian soldiers working under the UN based in Somalia in the 1990s. The report disclosed that about 30 percent of hazardous waste disposal is controlled by the "Eco-Mafia" run companies[43].

The hazardous wastes dumps bear insurmountable negative impacts human populations and environmental components in the country. According to Familgia Cristiana, 1998, UNEP investigations and the local people witnesses, give account of enormous negative health effects. Some of the incidences recorded include the death of a fisherman after opening a container picked from sea in Brawe town, death of a number of people along the Somalia coastline after drinking water from container, an upsurge of cancer patient cases related to the toxicity of waste dumps

However, there are no scientific research findings to prove existing or potential environmental and social impacts from the waste dumping. There are huge expected long-term negative impacts, particularly in groundwater pollution and fish resources, eventually affecting public health and socio-economy of Somalia.

1.11.2. Somalia's Vulnerability to Hazardous Waste Dumping

There are several predisposing factors that have made Somalia an attractive illegal hazardous waste dumping destination. These factors include, the volatile political environment, expansive and unmanned land areas, Suitable geographical location, inadequate public awareness and general greed. The long Somalia's long coastlines and expansive territory has lacked a central government since 1991 which translates to inadequate capacity to control the dumping activities within the country. This has attracted illegal waste-dealers to dump foreign hazardous waste in Somalia. The openly and easily accessible land areas in Somalia, provides a great opportunity for alien waste companies to dump hazardous waste which is otherwise very costly to manage, recycle, incinerate, store or dump in the countries of origin. The American University of Washington (1996), estimates that about US$ 3000 is required in the developed and as low as US$ 5 in a developing country to dispose hazardous waste[44].

Somalia is geographically in a central location, making it cheaper to reach the country and thus reducing the cost and time required for transportation and disposal of hazardous waste within the country. This situation is aggravated by the inadequate public awareness of the impending dangers posed by the waste dumps and even being brief to the ongoing waste dumping activities. The

[42] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia,

[43] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia,

[44] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia,

dumping activities are carried out with guidance from local individuals mostly politicians and businessmen mainly for self-interests and gains[45].

1.11.3. Violation International Legal Instruments of Hazardous Waste

These waste dumping companies are clearly violating international treaties. For instance the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Disposal, prohibits the hazardous waste shipments to Somalia. The convention that was adopted in 1989 and came into force on May 1992, additionally states that, unless there is a special agreement, shipments of hazardous waste to a country that has not signed the Convention are illegal[46]. Further the convention's main principles requiring the treatment and disposal of hazardous waste to be carried out as close as possible to the source of generation is also violated by the companies dumping dangerous material in Somalia. .

Equally important regional instrument of significance is the resolution Organization of African Unity (OAU) banning member states from accepting industrial waste products. In spite the OAU's ban some member states have violated the resolution based on national economic interests.

1.12. Environmental Governance

The institutional and human capacity is limited both at the Federal level and state level. The ministries are considerably structured at both the Federal and state levels. However, the situation gets complex at the implementation level in the region or districts. Thus the policies formulated even in participatory manner have lesser prospects of effective implementation on the ground. The regions /districts are staffed with just few persons, there are more people on the list (employed) but due to limited finances available, most of them are not paid and are dormant till the funds arrives.

1.12.1. Institutional Arrangements

At the Federal level, the Office of Environment based at the office of Prime Minister, coordinates the environment related policy, strategy and medium-term plans. It coordinates the broader institutional aspect of environment. It also serves as the focal point for various Multi-lateral Environment Agreements (MEA) and convention. The office also performs the function of GEF coordinating body and looks after the subject of many environmental issues.

In Somaliland, the Ministry of Environment and Rural Development is mandated to manage environment, including biodiversity conservation. The Ministry is responsible for developing policies and strategic plans related to environment, including biodiversity. It is also responsible for coordinating the environment related interface among other relevant ministries, non-government organizations, international development partners and private sector towards enhanced environmental conservation. The responsibility of forest conservation and wildlife conservation, management & breeding also rests with this Ministry. Conducting research and its dissemination is also part the responsibility of this Ministry.

In Puntland, the Ministry of Environment, Wildlife and Tourism is mandated to conserve & sustainably use biodiversity and its products. The Ministry is also responsible for the development of

[45] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia,

[46] Abdullahi E.M. 2001, Somalia's Degrading Environment: Causes and Effects of Deforestation and Hazardous Waste Dumping in Somalia,

relevant policies and strategic plans, besides overseeing the implementation of these policies and plans. As focal institution, this also carry the responsibility to coordinate & collaborate between various governmental, non-governmental organizations, international development partners and private sector for the promotion of sustainable management of the components of environment. In all other emerging states the ministries are not fully developed, they are understaffed, unpaid or ill staffed.

Besides understaffing the ministries as well as the regional hubs are poorly endowed with essential equipment, materials and infrastructure that are necessary for effective operation. The fiscal allocation and the available essential equipment are few compared to what is required. The challenges are manifold such as limited skills and understanding of biodiversity conservation among the lower tier of the relevant staff, the very limited human capacity (in number, skills, systems, equipment, finances, networking, etc.) on the ground. The staff at the ministry level is reasonably educated and the strength is although lean, still comparatively much better when it comes to field staff.

Lack of political will and commitment to protect the environment is exemplified in the fact that the ministry which is mandated for environmental conservation and protection is one of the least funded government institutions. There is also absence of regional cooperation on issues related to environment. For example, while the Somali government recognizes charcoal export as an illicit trade, large quantities of charcoal harvested from the different regions are marketed and sent to the Arabian markets. While there are number of natural resource management policies in writing, their implementation, like many other existing policies, is a challenge.

There is weak institutional capacity for environmental management in the country. This requires strengthening through proper institutionalization and capacity building for environmental professionals on climate change negotiation and assessment. The areas that require strengthening include efficient water resource management, energy resource management, rehabilitating water wells and ensuring efficient dissemination of the water, improving environmental planning, policy and regulatory framework.

1.12.2. Policy and Legislation

Environmental Policy and legislation is weak and outdated, and would benefit from environmental input, in terms of assessing the potential impact of such policies on the environment, or how they could contribute to environmental conservation and livelihood improvement. A process of Strategic Environment Assessment (SEA) could be used as an important internationally recognized tool. SEA would identify, in all sectors, policies and laws where environmental issues are, or could be important (Environmental Country Profile; IUCN). The regulatory framework for most of Somalia is poorly developed, although the country has signed a number of important international conventions relating to natural resource use and management.

Despite the many challenges a considerable work is done, although an environmental and conservation policy framework still needs to be in place. National environmental policy is drafted and is awaiting cabinet's approval. As an enactment apparatus of this policy, the Ministry's

Environmental Strategic Plan was updated, however several elements still need revision due to rapidly changing policy landscape. The Environmental conservation Act developed in 1998 is still in place and deals with various aspects of environmental protection.

Three policy and legal instruments that are directly dealing with biodiversity conservation of Somalia comprise the National Wildlife Policy, National Wildlife Strategic Plan and National Forestry and Wildlife Act. All of these instruments are in draft shape and are in varying stages of approval by the Federal Cabinet. The Food and Water Security Strategy of 2013, was developed by Ministry of Planning & International Cooperation., it is a broader framework that provides a starting point for the overall mainstreaming of biodiversity conservation in the National development process.

CHAPTER TWO

DESCRIPTION OF STEPS TAKEN OR ENVISAGED TO IMPLEMENT THE CONVENTION CHAPTER FOR THE FIRST NATIONAL COMMUNICATION FOR SOMALIA

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2.1. Introduction

There are a number of specific steps that have been taken or are envisioned in order to implement the Convention in Somalia. The information provided covers institutional coordination of climate change and other major UNFCCC activities, as well as the policies and programmes related to climate change.

2.2. Integrating Climate Change into National Development, Policies and Planning

In recent years, Somalia has introduced a number of environmentally oriented policies, strategies and action plans that will contribute directly or indirectly to the goals and objectives of the Convention. The Federal government of Somalia strongly believes that the full implementation of these policies and regulations as well as strategies and action plans in the form of funding, technical assistance, training and technology transfer through the Convention mechanisms is very vital for the successful implementation. In this section the relevant policies, strategies and action plans are briefly discussed.

2.2.1. Preparation and submission of the INDC

The Federal Republic of Somalia has prepared and submitted the INDC to the UN Framework Convention on Climate Change (UNFCCC) on 17, November 2015. The INDCs was prepared in line with UN Framework Convention on Climate Change (UNFCCC) and in accordance with the decision of the "Lima Call for Action" to formulate its policy, plans and mitigation and adaptation projects intended to achieve the objectives of the INDCs. The following are some of the intended project areas covered in the INDC[47].

a) Sustainable Land Management to Build Resilient Rural Livelihoods and Enable National Food Security[48]
b) Integrated Water Resources Management to Ensure Water Access and Supply to Vulnerable Populations and Sectors
c) Reducing Risks among Vulnerable Populations from Natural Disasters
d) UN Joint Programme on Sustainable Charcoal Production and Alternative Livelihoods (PROSCAL)
e) Rehabilitation of Fanoole Hydro-Electric Dam and Irrigation Infrastructure
f) Project for Domestication of Indigenous and the Introduction of Economically Important Plant Species
g) Project Proposal Charcoal Production from Prosopis and Replacement with Crop Production
h) Up scaling the Use of Solar Energy
i) Marine and Coastal Environmental Governance and Management of Somalia

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[47] FROS (2015). Somalia's Intended Nationally Determined Contributions (INDCs). State Minister for Environment, Office of the Prime Minister and Line Ministries and Ministry of Planning, Federal Government of Somalia, November, 2015.

[48] FROS. (2013). Somalia, National Adaptation Programme of Action on Climate Change. http://unfccc.int/resource/docs/napa/som01.pdf Accessed on 23/5/2018

2.2.2. The Draft Environmental Policy

As of 2016, the Federal government of Somalia had put in place a draft environmental policy.[49] The policy aims to provide a framework for an environmental approach to the planning and sustainable management of Somalia's environment and natural resources. It is envisioned that this will be achieved by pursuing the following specific targets:

i. Ensuring the sustainable management of environmental education, such as unique terrestrial and aquatic ecosystems, for national economic growth and improved livelihoods.
ii. Promoting and supporting research and capacity development as well as the use of innovative environmental management tools such as incentives, disincentives, total economic valuation, indicators of sustainable development.
iii. Fostering the domestication, coordination and maximization of the benefits from Strategic Multilateral Environmental Agreements (MEAs).

The implementation of these specific objectives and targets are to be guided by a number of principles; These are mentioned in the draft environmental policy as i) Environmental Right; ii)Ecosystem Approach, iii)Right to development; iv)Total Economic Value, v) Sustainable Resource Use; vi) Equity, vii) Public participation; viii) Subsidiary; ix) Precautionary Principle Polluter; x) International Cooperation and good governance; xi)Benefit sharing; xii) Community Empowerment. The overarching goal of the draft environmental policy is to improve and enhance the health and quality of life for the present and future generations, and to promote sustainable social and economic development through the sound management and use of the environment and natural resources. The draft environmental policy addresses various cross-Sectoral issues which include; (i)Forest Ecosystems, (ii) Coastal, marine ecosystem, (iii)Fresh Water and Ecosystem (iv)Mountains Ecosystem, (v) Arid and Semi-Arid Ecosystem, (vi) Land, Soil and Minerals, (vii) Biodiversity, (viii) Wildlife Resource, (ix) Livestock, (x) Fisheries, (xi)Trade and Environment, (xii)Tourism, (xiii) Industrialization and Environment, (xiv) Chemicals Management, (xv) Human Settlement.

2.2.3. National Development Plan 2017 – 2019

The National Development Plan is the first for Somalia in 30 years, and was crafted to cover three fiscal years (2017-2019) and not the conventional five years. This was occasioned by the fact that a conservative outlook was needed after 30 years without an NDP. The primary target of this NDP was to lay a solid foundation for future NDPs. Under these circumstances, the NDP is a comprehensive and robust guiding document that covers all priority areas for Somalia. It is in tandem with both the Sustainable Development Goals (SDGs) and the Interim Poverty Reduction Strategy Paper (IPRSP), a widely accredited international poverty eradication plan. It has a full subsection on environmental conservation, stating the envisioned actions and benchmarks over the three year period. Among other important milestones, the NDP aims to achieve the following results by the end of 2019;

i) To safeguard the environment, and nurture more open political and reconciliation processes;
ii) To decrease extreme poverty consistently;

[49] https://www.scribd.com/document/313123100/Enviromental-Policy-of-Somalia

iii) To build more resilient communities able to survive internal and external, shocks such as cyclical droughts, famine and other natural calamities;
iv) To create a vibrant economy, with specific focus on agriculture, livestock and fishing;
v) To increase the accessibility to quality basic education, health care, water and sanitation facilities;
vi) To improve healthcare outcomes;
vii) To enhance employment opportunities, particularly for the youth;
viii) To achieve a federal political and economic setting that empowers the three federal member states to satisfactorily deliver services.

With these envisioned targets, the NDP will see climate change preparedness and environmental conservation at the heart of Somalia's development agenda and therefore facilitate the success of the efforts of supportive development partners including the United Nations and the European Commission.

The NDP has the following targets which directly enhance climate change adaptation strategies and mitigation actions;[50]

i) National Action Plan on Desertification developed and approved
ii) Strategic environment assessment for Somalia as baseline of environmental resources and hazards (including UXO and mines)
iii) River management policy established to protect the volume and quality of water available
iv) Improved Environmental waste management in the cities
v) Control over the charcoal trade?
vi) Number of key pastures under improved management regimes

There is also a detailed dedication on the Disaster Management Authority in the NDP, which envisions that throughout the span of the NDP, effective disaster preparedness and response will be mainstreamed in both public and private sector work and by individuals significantly reducing the loss of lives and damage to property in the event of disasters. A national disaster management policy is also planned for, in the NDP. This is further testimony that the NDP recognizes the importance of climate change adaptation.

2.2.4. National Adaptation Program of Action (NAPA)

In compliance with the requirements of the articles of the UNFCCC convention, which need the parties to address climate change through the preparation of a national adaptation document and the integration of climate change into its Sectoral development policies and plans, Somalia prepared and submitted its NAPA in 2013. This was made possible by the UNDP and the federal government coordinating through the Ministry of National Resources. The NAPA preparation process adhered to the guiding principles outlined in the guidelines of the Least Developed Countries (LDC) Expert Group (LEG). The National Adaptation Programme of Action (NAPA) was a first step towards implementing a national strategy that seeks to address the effects of climate change across Somalia. The overall goal of the NAPA was to make the Somali people, known to be highly vulnerable, more resilient to climate change. The main objectives of the NAPA preparation and implementation were:

[5050] http://mopic.gov.so/wp-content/uploads/2016/11/SOMALIA-NATIONAL-DEVELOPMENT-PLAN-2017-2019.pdf

i) To develop a NAPA for Somalia following a participatory process in order to be able to address the most immediate climate related risks and vulnerabilities.
ii) To formulate and implement urgent and immediate project based activities towards the adaptation to climate change and variability
iii) To increase public awareness on climate change
iv) To increase the monitoring and risk forecasting capacities of the country
v) To support the adoption of government policies and strategies that seek to improve resilience against climate risks among vulnerable population groups and economic sectors.

2.2.5. Water Policy

By geographic location and climate regime, Somalia is a water scarce country. Precipitation variability, which is increasing, in part due to climate change, brings severe droughts, often followed by destructive flooding. Like is the case in many developing countries, rural populations are especially vulnerable to such disasters, because of their limited adaptive capacity or resources, as well as dependency on crop and animal husbandry. According to the Somali Centre for Water and Environment (2000), Somalia suffers from all possible kinds of water scarcity, including:

(i) Natural water scarcity resulting from the harsh climate;
(ii) Demographic water scarcity due to a growing population and
(iii) Technical water scarcity occasioned by the low level of water resources development.

With facilitation from UNICEF in the year 2004, the Somaliland Ministry of Water and Mineral Resources prepare a draft Water Act, Water Strategy and a Water Policy,[51] which were then endorsed by the government in Somaliland. Generally, therefore, public administration has been established in many areas with efforts to develop and regulate water infrastructure, supply and usage. In most of the rural communities, however, traditional Somali law, locally known as xeer, and Islam based guidance continue to apply. According to the Somali social organization, each clan is associated with a particular territory and water is public property, where usage and appropriation is acquired by special administrative permits.

The National Development Plan of 2017-2019 also targets to have a River management policy established, which will control the quantity and quality of river water available for utilization. This policy will be particularly useful because, water resources in Somalia are dominated by surface water, specifically the two perennial rivers; the Juba and Shabelle.

2.2.6. National Biodiversity Strategies and Action Plans

Somalia ratified the Convention on Biological Diversity (CBD) in September 2009 to become became the 193rd party to the convention. This indicates commitment and great interest by the country to initiate conservation of biodiversity in the context of climate resilience and adaptation. By ratifying the CBD, the country committed to achieve the objectives of the convention and to ensure her contribution to the global effort[52]. In addition, Somalia is committed to proactively participate in the international decisions towards conservation of biodiversity, the sustainable use of

[51] https://www.unicef.org/somalia/SOM_WaterandEnvironmentalSanitationFNL.pdf
[52] Ullah, Saleem and Gadain, Hussein 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia, FAO-Somalia.

its elements and equitable sharing of the benefits arising from the utilization of genetic resources. Further the country is committed to conservation of its biodiversity as demonstrated by the preparation of Somali National Biodiversity Strategy and Action Plan with the technical assistance of FAO. Through the NBSAP, Somalia was able to holistically and systematically examine the overall of biodiversity spectrum ranging from ecosystems, species and genetic diversity, for the first time. The NBSAP focuses on situation analysis which forms the basis for formulating the strategic & action planning a follow-up of the CBD Strategic Plan 2011-2020 and its Aichi Targets[53].

The NBSAP indicates that the extreme climate events as the recurring droughts and floods have caused negative effects on biodiversity. Further, it is noted that drought exacerbates deforestation due to charcoaling, increases hunting as an alternative livelihood, and accelerates soil erosion, bush fires, wildlife migration and reduction of biodiversity[54]. The flooding on the other hand is known to cause soil erosion and loss of nutrients, wildlife migration, reduced aquatic reproduction and productivity of habitat and causing local extinctions due to salt water intrusion and coral reef destruction due to higher Sea Surface Temperature (NAPA Somalia, 2014).

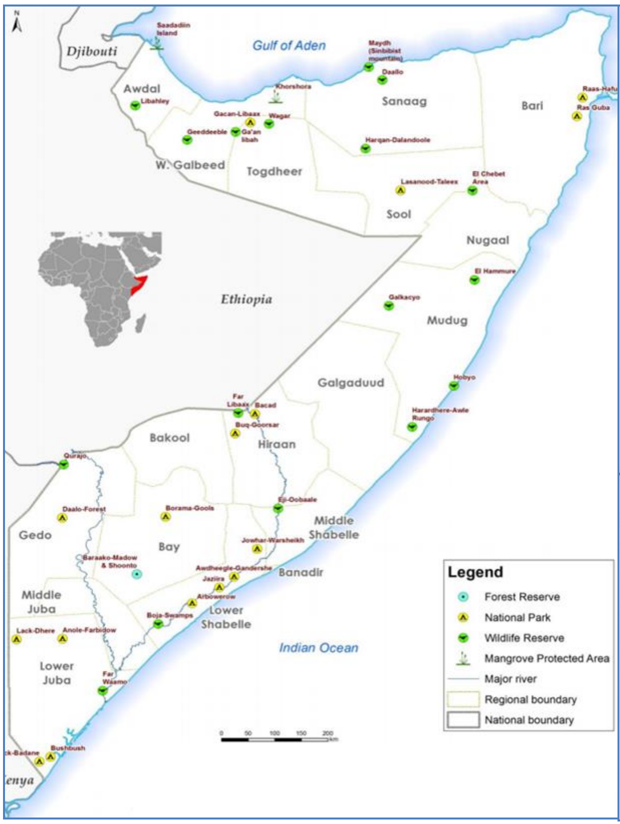

Figure 3-1 Proposed National Parks and reserves for Somalia

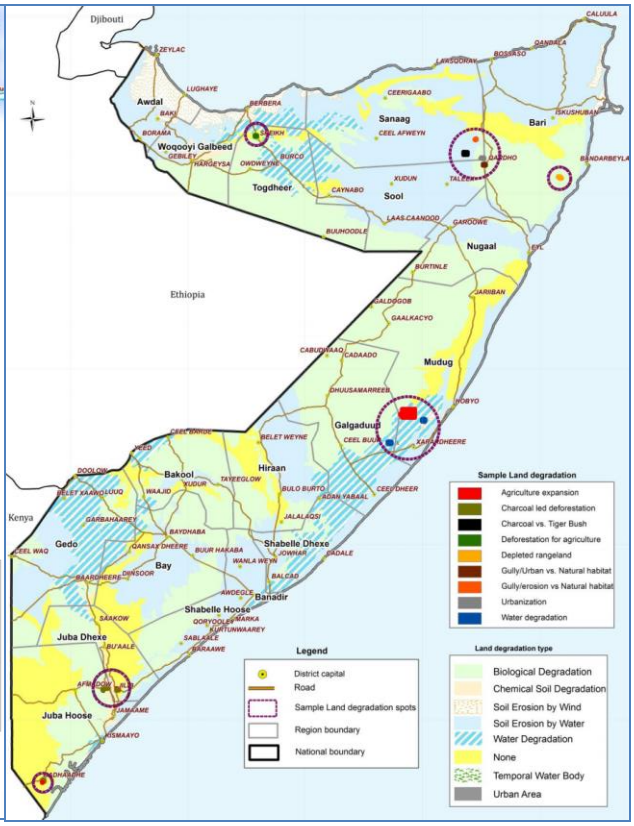

Figure 3-2 Proposed National Parks and reserves for Somalia

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53 Ullah, Saleem and Gadain, Hussein 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia, FAO-Somalia.

54 Ullah, Saleem and Gadain, Hussein 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia, FAO-Somalia.

2.2.7. Energy Policy

According to the Somaliland Energy Policy (2010),[55] and Nuñez (2015),[56] the energy sector in Somalia has for a long time operated in a regulatory vacuum, in terms of legal or policy framework. However, as the country continues to transition from humanitarian intervention towards sustainable recovery and development, there are draft recommendations under consideration and an energy policy will soon be put in place. These are being spearheaded by the Ministry of Energy and Water Resources. Even then, not the entire country has entirely operated without inspectorate and monitoring systems in the energy sector. With facilitation from the ADRA Somalia organization and funding from the European Union, for example, the region of Somaliland development and continues to implement an energy policy since the year 2010.

By highlight, Somalia records the lowest consumption of modern forms of energy in Sub-Saharan Africa, and relies heavily on fuel wood and charcoal, to meet its energy needs. These then account for an estimated 82% of the country's total energy consumption (Somalia, 2012; Karekezi and Kithyoma, 2003, Mohamed, 2001).This puts the reducing forest cover under sustained pressure. Electricity is similarly insufficient in the availability and distribution. In fact, the lack of large dams in Somalia means that diesel powered generators serve as the main source of power.

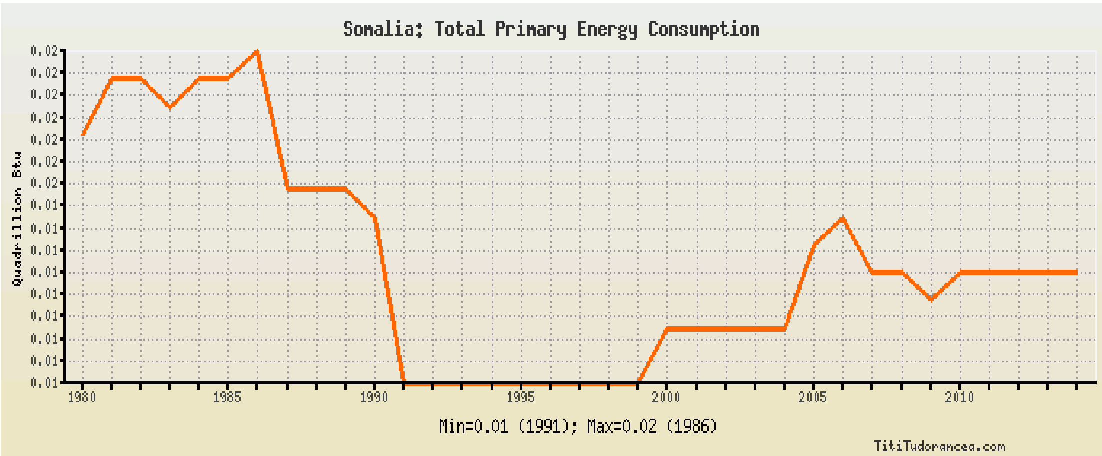

Figure 3-3 Somalia Total Primary Energy Consumption; The picking trend[57]

Despite these persistent challenges, Somalia is one of the countries in Africa which are richly endowed with unexploited energy sources. There were discovered reserves of oil and natural gas, which remain un-drilled, potential for hydro-power and geothermal energy sources, suitable wind energy sites and ideal solar power positioning. The clear hindering factors to their harnessing comprise a complex network of financial, political and institutional factors, which are further compounded by relative insecurity.

[55] http://energyfacilitymonitoring.eu/wp-content/uploads/2016/06/somaliland_energy_policy.pdf
[56] http://shuraako.org/sites/default/files/Renewable-Energy-Policy-Brief.pdf
[57] https://www.tititudorancea.com/z/ies_somalia_total_primary_energy_consumption.htm

Figure 3-4Solar panels installed at the villa Somalia. Source: UNDP 2017.[58]

The Federal Government is also tapping into solar power with the appreciation of its huge potential in Somalia. A solar power system was installed in August, 2017 at the Office of the Prime Minister in Mogadishu. In fact, 298 solar panels were installed in a 76KVA hybrid solar system, which immediately helps to save 35% on fuel consumption. A new project between the government in partnership with UNEP, UNDP and the OPEC Fund for International Development (OFID) aims to scale up the provision of affordable and clean energy across civil service offices in Somalia.[59]

In order to stimulate development in the energy sector, and economic development in the country at large, the trend in embracing renewable energy need to be fast-tracked. The energy sector should generally outgrow the distributed private generation and become the envisaged formal electricity market, for the social-economic and community livelihood improvement.

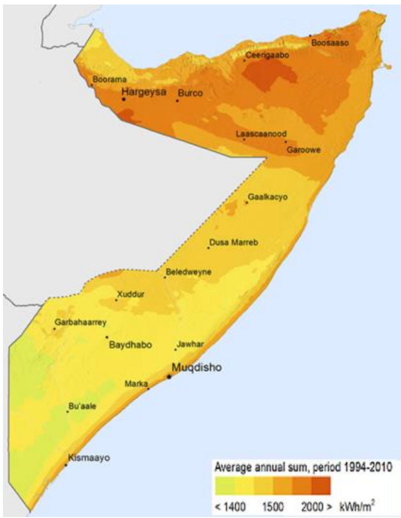

Figure 2.8. Potential wind power production in Somalia. Source: www.evwind.es, 2016[60]

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[58] http://www.so.undp.org/content/somalia/en/home/presscenter/pressreleases/2017/08/13/solar-power-at-villa-somalia.html

[59] http://www.so.undp.org/content/somalia/en/home/presscenter/pressreleases/2017/08/13/solar-power-at-villa-somalia.html

[60] https://www.evwind.es/2016/11/08/wind-power-in-africa/57870

2.2.8. Somali National Disaster Management Policy

Natural and man-made disasters are a common phenomenon in Somalia. The most common disaster occurring is drought, according to UNEP (2005) and Adeso (2017). The droughts being the most recurrent and severely devastating (See Figure 3.5); exposes the vulnerable and less prepared communities and their environment to catastrophic effects (Humanitarian Response).

2.3. Establishment of Livelihood Safeguards and Humanitarian Action Framework

The overarching objective of improving livelihoods and building resilience against climate change is sufficient evidence to the federal government's commitment to mainstreaming the climate change agenda. The main causes of exercitation of the climate change impacts include conflicts, displacements, drought and disease which intern leads to malnutrition and increase in IDP and dependent populations. Mostly, individuals and or households undergo restrictive access to nutrition services due to age, gender, social discrimination or due to a specific vulnerability such as disability and ethnic profiling[61].

To address the main challenges of exclusion and delivery of humanitarian service, Somalia has made important progress in developing institutions and supporting international community participation in promoting food security and nutrition, access to safe water, sanitation and health care and protection during extreme events caused by drought, floods and other climate related disasters. It is on record that humanitarian situation deteriorated in the year 2016 and 2017 following poor rainy seasons. The government has made great efforts to create conducive environment for humanitarian responses. However, this remains a challenging and high-risk task due to armed conflicts in the country[62].

Figure 3-5 Recurrent drought, food insecurity and famine Somalia. Photo: UNDP Somalia[63]

[61] UNOCHA 2017; The 2018 Humanitarian Response Plan
[62] UNOCHA 2017; The 2018 Humanitarian Response Plan
[63] http://www.undp.org/content/undp/en/home/blog/2018/in-somalia--humanitarian-and-development-solutions-seek-to-ensur.html

In spite of the risks and structural challenges the local institutions and international humanitarian partners are prepared to provide the most needed response to famine and other disasters related to the climate change impacts in Somalia. As a result, the Somalia Humanitarian Country Team (HCT) working in collaboration Federal and State authorities have developed the 2018 Humanitarian Response Plan (HRP). This is an integrated and a multi-Sectoral service provision meant to provide lifesaving assistance; reducing acute malnutrition; reinforcing provision of protection services to affected communities; and strengthening resilience[64].

The 2018 Humanitarian Response Plan (HRP) is anchored on the following strategic objectives;

1) To provide life-saving and life-sustaining integrated, multi-Sectoral assistance to reduce acute humanitarian needs and excess mortality among the most vulnerable people.
2) To reduce emergency levels of acute malnutrition through integrated, multi-Sectoral response. Enhance integration of Nutrition, WASH, Health and Food Security programmes to strengthen nutrition sensitive programming.
3) To Support provision of protection services to affected communities, including in hard-to-reach areas and in IDP sites, targeting the most vulnerable, especially those at risk of exclusion.
4) To Support the protection and restoration of livelihoods, promote access to basic services to build resilience to recurrent shocks, and catalyze more sustainable solutions for those affected, including marginalized communities.

The Food Security and Nutrition Analysis Unit- Somalia (FSNAU), is working closely with FEWS-NET to provide evidence-based analysis on food, nutrition and livelihood security. This is meant to facilitate both short-term responses and long-term strategic planning to enhance food and livelihood security. The overall of the FSNAU Project is to ensure food, nutrition and livelihood security and strengthened households for greater resilience against conflict, drought, flood, and disease.

2.4. Water Infrastructure Development for Resilience in Somalia

The Federal Government of Somalia has embarked on strengthening institutions, policy formulation and building of water infrastructure across the country. There are a number of project interventions for developing water resources for Somalia. The projects are both funded and implemented by the African Development Bank (AfDB), EC/EU, UNICEF, CARE International, and FAO through grants to the Federal Government of Somalia[65].

Somalia is ensuring that proper water service coverage is maintained sustainably addressing the key challenges of inadequate management of water resource use pattern, inadequate access to safe strategic sustainable water sources such as boreholes and protected wells, inequitable control and access to water supplies at the community level, and operation and maintenance of water supply

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[64] UNOCHA 2017; The 2018 Humanitarian Response Plan. http://www.faoswalim.org/resources/site_files/W-19%20UNICEF%27s%20Water%20Interventions.pdf. Accessed on 13/6/2018

[65] Gadain, H. M. and Mugo, M. W. (2009), Report on UNICEF Water Interventions Mapping (2005-2009), Technical Report No. W-19, FAO-SWALIM, Nairobi, Kenya. http://www.faoswalim.org/resources/site_files/W-19%20UNICEF%27s%20Water%20Interventions.pdf. Accessed on 17/72018

systems. There are a number of projects being carried out the Somaliland, Puntland and Central and Southern Regions in close collaboration with the institutions mandated with Water Resources Management.

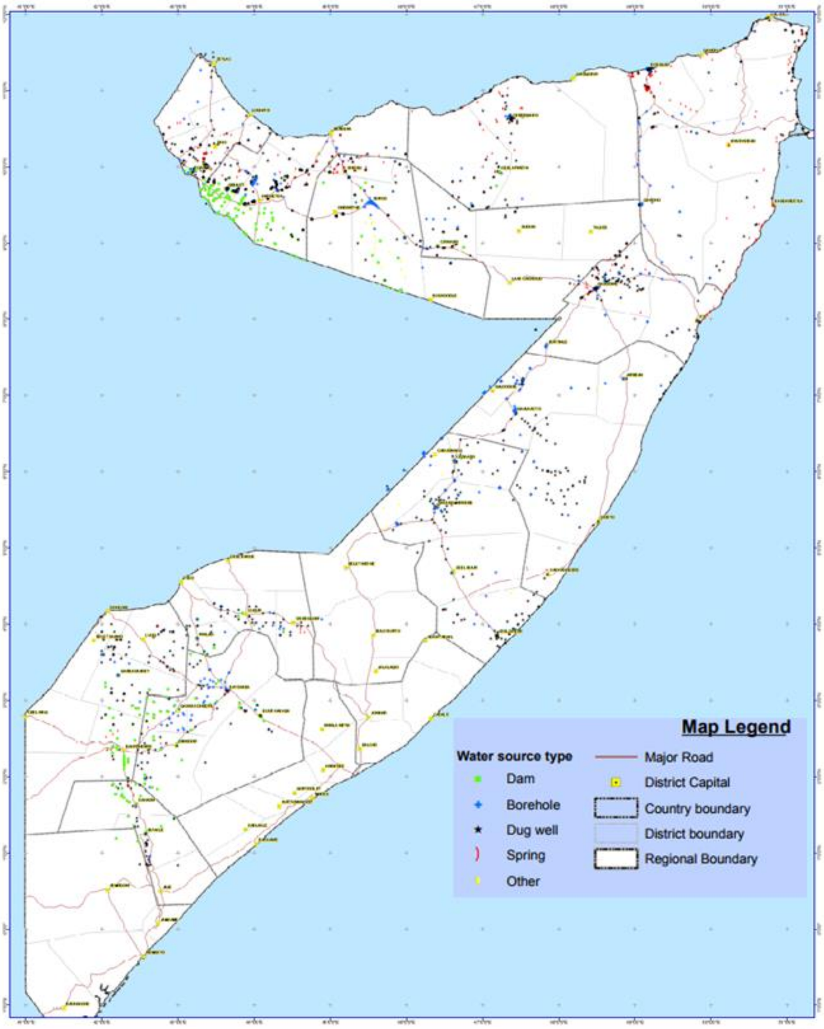

Figure 3-6 UNICEF Water Resources Interventions in Somalia. Source, SWALIM, 2010.

The Federal Government of Somalia has an overall goal to build a water and sanitation sector that is resilient to climatic variability and climate changes, and sustainable enough to improve livelihoods. There are a number of different types of water sources developed; which include berkads, borehole water yard, dam, motorized well (water yards), WASH facilities, shallow well, solar system, spring, municipal water supply system[66].

In partnership with the African Development Bank (AfDB) and the IOM, the government is implementing a nationwide infrastructure improvement project, whose objective is to build the capacity of the ministry of Energy and Water Resources (MoEWR). In addition the government is supporting the regional governments by facilitating the formulation of national and regional water

[66] Gadain, H. M. and Mugo, M. W. (2009), Report on UNICEF Water Interventions Mapping (2005-2009), Technical Report No. W-19, FAO-SWALIM, Nairobi, Kenya. http://www.faoswalim.org/resources/site_files/W-19%20UNICEF%27s%20Water%20Interventions.pdf. Accessed on 17/72018

sector strategies and policies, with components on the rehabilitation of water resource infrastructure and capacity development[67].

2.5. Somalia Water and Land Information Management System (SWALIM)

The FAO initiative to develop a Somalia Water and Land Information Management System (SWALIM) started in the year 2001 through a UNDP funded concept note (Nicholson and Flasse, 2008). Between 2002 and 2007, an establishment phase and two project phases were implemented with financial support from the European Commission, Cooperazione Italiana and UNICEF. The fifth phase (2013 to 2017) had a specific focus on wider data dissemination and access, improved information outreach, as well as intensified capacity building among the stakeholder community and partners. Over the years, SWALIM's breakthrough accomplishments in mobile data gathering, dynamic mapping and remote monitoring brought has created Somalia's most important climate database, and won international recognition including 2016 2016 WSIS prize.[68]

According to the then SWALIM coordinator Dr. Hussein Gadain, the SWALIM web site is very dynamic and has tools such as the updated Flood Risk and Response Management Information System (FRRMIS), and the dynamic "Live Map" platform, which presents multifaceted data sets on an easy-to-read interface. This map system displays data on land degradation and soils in general, infrastructure interventions among other important data for decision makers and researchers. An important accomplishment was when in anticipation of the destructive El Niño rains in 2015; SWALIM developed and shared an SMS-based mobile phone application to capture data about imminent floods, which was then used to alert vulnerable communities along the rivers Juba and Shabelle. This system, known as FRISC/Digniin (from the Somali word for "warning"), was also ably used to notify coastal communities and fishing vessels about two giant cyclones that swept across the coast of Puntland in December of 2015, thereby saving lives and preventing severe property damage. The FRISK/Digniin system was later expanded and has the capability to gather rainfall data throughout the country. The rainfall data, like the river levels, is directly fed into the on-line FRRMIS system to provide near-real-time updates on potential floods and inundations.[69]

The SWALIM initiative is lauded for expanding the national agro-meteorological network in Somalia, facilitating improved disaster-preparedness and ensuring the timely early warning in the event of floods and other climate related disasters. The establishment of monitoring stations on the major rivers was especially important to the livelihoods of resident communities. Furthermore, the vulnerable security situation in much of the country required innovative approaches to data collection; SWALIM's advanced remote sensing capability to track events through satellite imagery was particularly phenomenal.

With only internet access and without the need to travel, users can access hundreds of records of Somali digital maps from the SWALIM Geo-Network for free. These maps cover a wide range of

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[67] Gadain, H. M. and Mugo, M. W. (2009), Report on UNICEF Water Interventions Mapping (2005-2009), Technical Report No. W-19, FAO-SWALIM, Nairobi, Kenya.
http://www.faoswalim.org/resources/site_files/W-19%20UNICEF%27s%20Water%20Interventions.pdf. Accessed on 17/72018

[68] http://www.fao.org/resilience/news-events/detail/en/c/418025/

[69] http://www.faoswalim.org/resources/site_files/SWALIM Update Issue 11.pdf

themes including administrative areas, climate information, water resources, irrigation areas, disasters such as floods and droughts, land use and suitability, soils and land degradation among others. Furthermore, all the map records have detailed metadata description and related reports that have been professionally drafted using "state of the art" mapping tools. The SWALIM project through its data collection endeavors, also established a number of automatic gauging remotely controlled stations, which are fully operational. Useful information about the stream flow regime and floods can be collected and utilized.

There is growing consensus that a natural disaster cannot be avoided, and can hit even the best developed and technologically advanced communities. However, with enough preparedness and disaster management strategies in place, a lot can be done to mitigate the adverse effects of such natural calamities and prevent or reduce damage from human induced ones.

The Somalia Disaster Management Agency (SODMA), which is the national government agency responsible for the coordination and management of disasters established in the year 2011, facilitated a consultative process in 2016, which resulted in a draft National Disaster Management Policy. The consultations and formulation process were supported by USAID/OFDA through Adeso, and brought together representatives from the federal and regional governments, as well as experts from the United Nations, Private Sector, NGOs and CSOs. The draft National Disaster Management Policy has already been approved by the Federal Ministry of Humanitarian Affairs and Disaster Management, and awaiting further deliberation and approval by the federal council of ministers as of September 2017.

2.6. Somalia Energy Transformation (SET) Project

SET is a nationwide multi-year project with a focus on climate change mitigation and poverty alleviation by reducing community vulnerability and fragility[70] with a definite leaning to initiating and fostering energy policy dialogue (SET, 2015). It is being funded by the European Union with substantial co-financing from the implementing agency, ADRA Somalia. In principle, the project envisions a transformed electricity and biomass sub-sectors of the broader energy sector, through the successful deployment of renewable energy sources. The government in the various regions has been very receptive and supportive of this project, which successfully enabled the drafting of the energy policy in Somaliland.

The overarching goal of the project is planned to be achieved by implementing the following specific project activities:

(i) Scaling up the awareness campaigns, the production, marketing and distribution of modern energy efficient cooking stoves;

(ii) To initiate energy policy dialogue in South Central Somalia and Punt land, having successfully enabled the drafting of the energy policy in Somaliland.

(iii) The creation of community electrification schemes in rural areas;

(iv) The development of off-grid Pico-solar PV markets in rural areas;

70 http://daystar.ac.ke/downloads/research/TOR_for_Technical_Feasibility_Study_for_offgridSolarPVsystems.pdf

(v) The procurement, supply and installation of solar powered irrigation systems, as well as solar energy in schools and health facilities;

(vi) The facilitation of youth led renewable energy enterprises.

Figure 3-7 Charcoal being exported from the coast of Somalia. Source: Abdurrahman, 2015.

In its ambitious targets, the SET project seeks to engage governments in Puntland, Somaliland, and South Central Somalia in the creation of enabling policy and regulatory framework and support the country in the integration of clean off the grid technology options in their energy provisioning plans. The expected results from this project are: [71]

i. To engage at least 10 dealers in the distribution and marketing of Lighting Africa certified products.

ii. To train and equip 70 technicians, making them able to offer after sale services;

iii. To enable 10,000 households to acquire modern off grid solar lighting systems;

iv. To reach at least 1.5 million people in the sensitization and awareness campaigns about off grid lighting systems, and their benefits;

Figure 3-8 Installed automatic gauging station in Togga Waheen. Source: SWALIM, 2012.

[71] http://www.daystar.ac.ke/downloads/research/ToR_MarketAssessment_Energy_Products.pdf

The formulation of the National Disaster Management Policy presents an opportunity for saving lives and property in the event of disasters, thereby safeguarding the local economies. It is the first and most important national disaster management initiative. It aims to improve community preparedness and resilience in the face of emergencies and disasters, in order to significantly protect lives and property. It also establishes the required policy and legislative framework for disaster management and response within the relevant government agencies, increasing disaster risk governance at all levels of government, incorporating disaster risk reduction into the NDP and equally importantly, investing in disaster preparedness, early warning systems and better and recovery measures.[72]

[72] http://adesoafrica.org/what-we-do/blogs/the-formation-of-the-somali-national-disaster-management-policy-/

CHAPTER TREE

NATIONAL INVENTORY OF GREENHOUSE GASES FOR SOMALIA

CHAPTER THREE

NATIONAL GHG INVENTORY FOR SOMALIA

3.1. Background Information

In response to the risk of global climate change; the United Nations Framework Convention on Climate Change (UNFCCC) established on 21st March 1994, provides an intergovernmental platform for tackling the challenge of global warming and the impacts of the resulting changes. The parties to the Convention are required to submit national communications reports on implementation of the Convention to the Conference of the Parties (COP). The core elements of the national communications to UNFCCC for non-Annex I Parties is the information on emissions and removals of greenhouse gases (GHGs). The Greenhouse Gas (GHG) inventory is thus an essential part of national communications of countries that are Party to the United Nations Framework Convention on Climate Change (UNFCCC).

Somalia has been a Party to the UNFCCC since December 2009, as a non-Annex 1 country and ratified the Kyoto Protocol in July 2010. The first enabling activity was carried out to develop the National Adaptation Programme of Action (NAPA) with GEF support and through a partnership between UNDP and the Ministry of National Resources. The overarching goal of the NAPA was to make the Somali people more resilient to climate change, in the highly vulnerable economy that is dependent on subsistence agriculture and livestock rearing and further undermined by the heterogeneity of clan-based conflicts. The NAPA was submitted to the UNFCCC in June 2013.

This chapter describes the methods, activity data, emission factors and conversion factors that were used to develop the national inventory based on the IPCC 2006 Inventory Software. The IPCC 2006 Guidelines were used principally for the selection of methods and default emission factors and conversion values applied in the inventory process. Additional methods or emission factors 2006 guidelines were also used to improve the GHG estimates. This Chapter on GHG Inventory for this INC was prepared to not only fulfill Somalia's reporting obligation to the UNFCCC but also support formulation of policies, sustainable development and green growth strategies. The inventory preparation process was focused to enable the country to undertake assessments and update a national Greenhouse Gas (GHG) inventory, establish a GHG database management system, and carry out analysis of emission/removal trends to better inform policy, growth and development strategies, NDCs and MRV systems.

3.2. Preparation of National GHG Inventory for Somalia

The development of the National Green House Gas (GHG) inventory system was initiated to include all institutional, legal and procedural arrangements made within a Party included in UNFCCC, for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases. The GHG inventory system will support the country regularly to estimate anthropogenic GHG emissions by sources and removals; facilitate national review of information submitted and assist in improving the quality of the national communications. Somalia through the Federal Directorate of the Environment; mandated with the development of a GHG inventory plans to enhance the capacity of the Inventory sector players to carry out the GHG Inventory and archive activity efficiently.

The GHG Inventory prepared in this Initial National Communication covers the main areas of human activities which include: Energy (including transport), Land-Use Change and Forestry (LUCF), Agriculture, and Waste including the Memo Items as prescribed in the Convention. The anthropogenic activities falling within the industrial processes and product use were considered insignificant. The main gases considered for the national inventory preparation include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The precursor emissions which include nitrogen oxides (NO_x), carbon monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOC) were also considered. However, the emissions of other gases such as hydro fluorocarbons (HFCs) per fluorocarbons (PFCs) and sulphur hexafluoride (SF_6) were considered negligible.

The compilation of the GHG inventory utilized the IPCC 2006 Inventory Software to develop emissions standalone Microsoft access database, distributed database for activity data and online databases for both emissions and activity data sharing and visualization. This was targeted to enhance technical capacity, improve data/information collection, analysis and support the country to meet an obligation to meet her obligations.

The system is also aimed at enhancing sustainability in implementing the GHG Inventory compilations and data safeguards. The compilation of the GHG inventory has the additional benefit of improving national statistics and increasing awareness about climate change among stakeholders and improves the knowledge of the carbon trajectory.

3.2.1. Stakeholder Participation

During the inventory process a series of workshops were carried out to engage the national stakeholders in the preparation of the Somalia GHG Inventory. This was implemented as one of the enabling activities for the preparation of the Initial National Communication (INC) under the United Nations Framework Climate Change Convention (UNFCCC). The participation of stakeholders was meant to enhance ownership of the national emissions/removals within the larger picture of global emissions. In addition the participation provided the required impetus and knowledge base against which the country can initiate future emissions emission reductions. Furthered the stakeholders played the pivotal role of activity data collection, reviewing and assessment of the final results. The inventory preparation was focused on identifying the principal sources/sinks, quantitatively estimate GHG emissions and the associated trends from different sectors in the country and enhance decision-making.

3.2.2. Institutional Arrangements for Inventory Preparation

The Office of the Prime Minister is the principle institution responsible for all matters regarding climate change including the preparation of the National Communications for the Federal Republic of Somalia. The Federal directorate of Environment under the Office of the Prime Minister is the institution that is mandated to carry out the coordination of the national GHG inventory. The country has three teams working on the preparation of the national GHG inventory namely; the Puntland State GHG Inventory team, the Somaliland GHG Inventory team, the South and Central GHG Inventory team with participants drawn from Gal Mudug State, Hirshabelle State, South West State, Jubaland State and Federal Ministries.

GHG inventory compilation is coordinated among the teams with members drawn from the key institution on matters of climate change and development at the national regional levels. The teams are divided into various GHG Inventory sectors based on the institutional mandates and stakeholder's interests with Sectoral team leaders drawn from the lead agencies for energy, Transport, agriculture, livestock, waste and LULUCF sectors. The identification of the primary organizations central to the GHG Inventory management system and the necessary expertise was done by the Project management Unit and in the stakeholders' workshops forum.

3.2.3. Data Collection and Storage

The collection of data and information is still a huge challenge when compiling the GHG inventory. The stakeholder participation enabled gathering and assessing information required for the implementation of the National GHG Inventory for Somalia. The thematic sector information in recently published literature on the national communications to the UNFCCC and other climate change reports, and data providers at a national, regional and global scale was also verified during the workshop sessions.

The most data is available for Somaliland and Puntland but most regional states in Central and Southern Somalia have neither repository nor any formal/systematic documentation of activity data. The available data and information collected from the regional and aggregated for national reporting. However, the huge data gap were filled with information from organizations working closely with the Federal Government of Somalia which include UNDP, UNCEF, FAO-SWALIM, ICPAC, FSNAU, UNEP and UNFPA. It is also difficult to perform a data uncertainty analysis on data that has already been published. The challenge in the compilation of GHG inventories is the availability of accurate activity data which led to application of Tier I methodology in the estimation of emissions.

Data collection and documentation was the responsibility of individual experts in each sector with support from the national and regional representative in the GHG Inventory teams. Data came mostly from government institutions, local and published literature, and policy documents. The CCD is in the process of implementing a data management system that will improve accessibility to activity data. Priority gaps have been identified and the uncertainty associated with the activity data used has been described to improve the accuracy of the National GHG Inventory for Somalia in the future.

3.2.4. Coordination of the GHG Inventory System

Figure 4-1 and 4-2 show the Proposed Data Management Flows and Archiving and proposed National GHG Inventory Institutional arrangements.

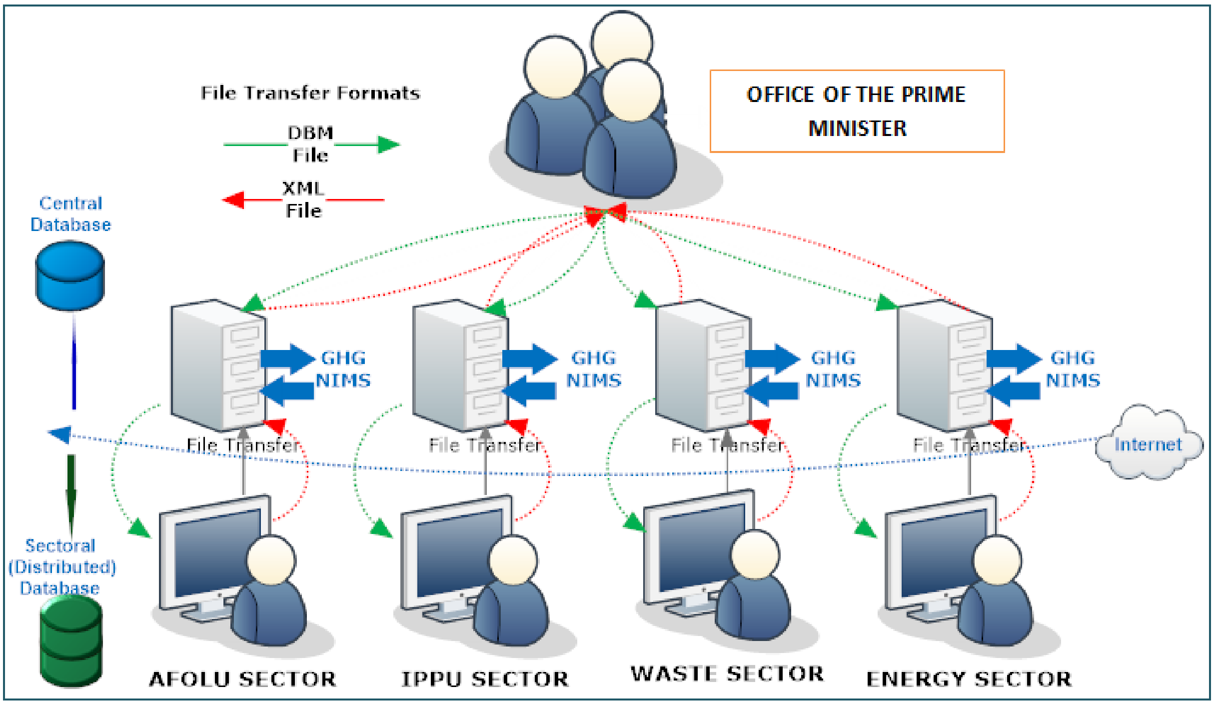
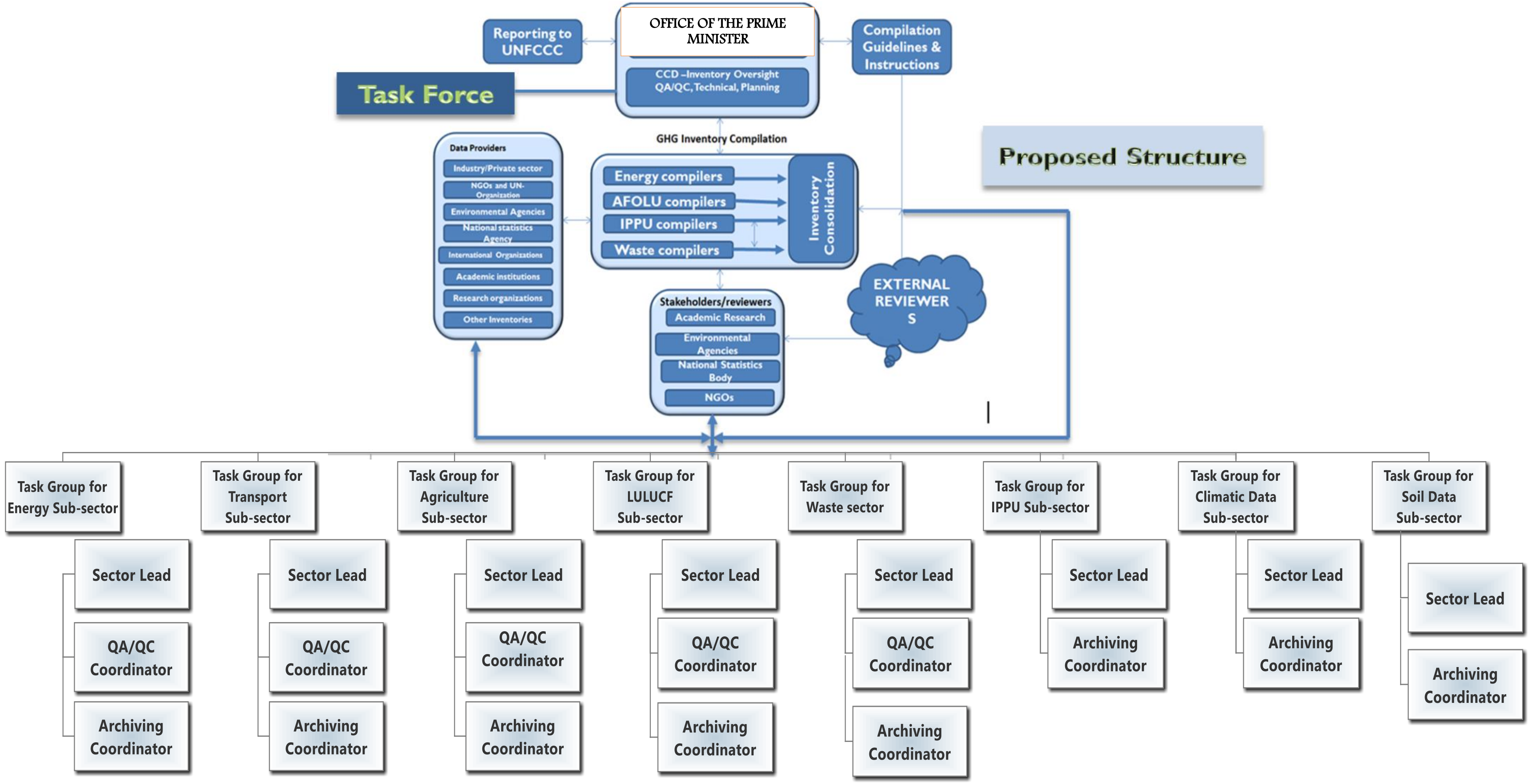


Figure 4-1 Proposed Data Management Flows and Archiving

Figure 4-2 Proposed National GHG Inventory Institutional arrangements



3.3. General Methodology

All countries that are party to the UNFCCC have agreed to apply the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines for compilation and reporting of national greenhouse gas inventories. In addition, the convention encourages the use the GWP from the IPCC Fourth Assessment Report (FAR) as published. The initial inventory of Somalia applied the IPCC 2006 Guidelines and the Global Warming Potentials (GWP) as indicated in the IPCC Fourth assessment report (AR4). There are seven types of GHG emission/removals considered from the different sectors which include Carbon Dioxide (CO2), Methane (CH4), Nitrous Oxide (N2O), Nitrogen Oxides (NOX), Carbon Monoxide (CO), Non- Methane Volatile Organic Compounds (NMVOC) and Sulphur Dioxide (SO2). After data were collected, quality assessments and assurance was done, and the unit conversions were completed and harmonized for entry into the IPCC Inventory software, the GHG emissions were calculated by inventory experts using the following basic principle (IPCC 2006 Guidelines);

Emission = activity data x emission factor …IPCC Equation 3.1

The results from the estimation of emissions were checked by external parties to ensure accuracy and consistency. Emission factors from national sources are the most accurate, but where national activity data are not available the alternative sources were used in accordance to the IPCC 2006 guidelines. The country does not have country specific emission factors leading to application of adjusted default emission factors in a Tier 1 approach. More detailed methodology for each sector and source category are presented in the sections below.

3.3.1. Information on QA/QC Plan

Essential quality control and quality assurance (QC/QA) measures for emissions in agreement with the IPCC requirements for national GHG inventory preparation were carried out to reflect representativeness and completeness. The QC/QA improvement plan on organizing and monitoring measures to improve the quality principles of transparency, consistency, comparability, completeness and accuracy. The QC/QA requirements provided for in the 2006 IPCC Guidelines (Vol. 1, Chapter 6) were applied in the national GHG inventory preparation.

3.3.2. Evaluating Uncertainty

The assessment and reporting of uncertainty is an important element considered in this inventory according to IPCC Guidelines. The analysis of uncertainty is a crucial element of the GHG inventory. It was used to identify approaches for prioritisation of national efforts to reduce future uncertainties and required improvements in the process if inventory preparation. Further the assessment of uncertainty was applied for methodological choices and plans for the future inventories to improve accuracy, minimize biasness and allow for transparent reporting on the presence and level of uncertainty.

3.3.3. Mapping of methods and emission factors

The following table1 shows the level of emission/removal estimation for the inventory

Table 4-1 Level of Emission/removal Estimation

GHG Source and Sink		CO Methods	EF	CH Method	EF	N2 Method	EF	PFC Method	EF	PFC- Method	EF	HF Method	EF
1.	Energy	T1,	D,	D, T1	D,	D, T1	D,						
1.A	Fuel Combustion	T1,	D,	T1,	D,	T1,	D,						
1.A1	Energy Industries	T1	D	T1	D	T1	D						
1.A2	Manufacturing Industries and Construction	T1	D	T1	D	T1	D						
1.A3	Transport	T1,	D,	T1,	D,	T1,	D,						
1.A4	Other Sectors	T1	D	T1	D	T1	D						
1.B	Fugitive Emissions			NE	NE								
1.B1	Solid Fuels			NO	NO								
1.B2	Oil and Natural Gas			NE	NE								
1.B3	Other Emission from Energy Production			NO	NO								
2	Industrial Process	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.A	Mineral Products	NE	NE	NE	NE	NE	NE						
2.B	Chemical Industry	NE	NE	NE	NE	NE	NE						
2.C	Metal Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2.D	Non-Energy Products from Fuels and Solvent Use	NE	NE										
2E	Electronics Industry	NE	NE	NE	NE	NE	NE						
2.F	Product Uses as Substitutes for Ozone Depleting Substances	NE	NE	NE	NE	NE	NE					NE	NE
3	Agriculture, Forestry, and Other Land Use	T1,	D,	T1	D	T1	D						
3.A	Livestock			T1	D								
3.B	Land	T1	D										

GHG Source and Sink		CO Methods	EF	CH Method	EF	N2 Method	EF	PFC Method	EF	PFC- Method	EF	HF Method	EF
3C	Aggregate sources and non-CO2 emissions sources on land	T1	D	T1	D	TI	D						
4	Waste	T1	D	T1	D	T1	D						
4.A	Solid waste disposal			D	D	D	D						
4.B	Biological Treatment of Solid Waste	NE	NE	NE	NE	NE	NE						
4.C	Incineration and Open Burning of Waste	NE D	NE	NE	NE	NE	NE						
4.D	**Wastewater Treatment and Discharge**			**T1**	**D**	**T1**	**D**						

Key: *CS= Country-Specific, PS= Plant-Specific, NE = Not Estimated, NO=Not Occurring, D = Default IPCC methodology and emission factor, EF = Emission Factor, Meth=Methods, T1, T2 - Levels of Tiers*

3.4. Overview of the Energy Sector

The Energy sector activities in Somalia are largely driven by the combustion of fossil fuels used for generating electricity and energy for transportation, Manufacturing and construction, residential and institutional energy use. Emissions arise from these activities by combustion and as fugitive emissions, or escape without combustion. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the GHGs released in the combustion of fuels. Also released in the process are the GHG pre-cursors carbon monoxide (CO), nitrogen oxides (NO_x), and non-methane volatile organic compounds (NMVOC's). There are two ways to estimate CO_2 emissions from fuel combustion: the top-down or reference approach, and the bottom-up or Sectoral approach. Both top-down and bottom-up analyses were carried out for comparison and ideally there was not much of a difference in the emission calculations using the two methods.

3.4.1. Reference or Top-Down Approach

This approach was used to consider the primary level of energy supply and distribution to enable calculations of CO_2 emissions by considering the overall national inventory of fuel supply. This approach utilized the following data and information on fuel quantities for each fuel type utilized in the following activities:

i) Production
ii) Imports
iii) Exports

iv) International bunkers, or the amount of fuel used for international aviation and marine transport
v) Stock change or the variations in the quantity of fuel in stock.

Fuels exports and or fuels used for international bunkers (i.e., aviation or marine transport) were subtracted from the overall apparent consumption and thus are not included in the national GHG emissions inventory. The CO_2 emissions from international bunkers were reported in a separate memo item as recommended by the IPCC guidelines.

3.4.2. Sectoral or Bottom-up Approach

Applying this approach; actual consumption of the specific subsectors was used to estimate emissions. The subsectors are energy industries (power generation or energy production); transportation; manufacturing industries and construction; residential, commercial, and agriculture/forestry; and other non-specified stationery or mobile...

This approach identified the specific Sectoral consumers of fuel; major emitters of energy-related GHGs and thus provides a more detailed inventory of the CO_2 emissions from fuel combustion. Tier 1 approach was used to compute GHG emissions for this inventory where default emission factors were used to estimate emissions since there are no country specific emission data. The following data and information was used to estimate the emissions from fuel consumption values

i) The fuel type
ii) Consumption figures of each fuel type for every sub-category and
iii) The default emission factors and conversion factors for the fuel type from available in tables 3.3 and 3.4 in the IPCC Guidelines Vol. 2- Energy Sector.

The emissions generated were subdivided into CO_2 and Non-CO_2 categories. The inventory compiler has to state the activity data very clearly at is advisable to align it with the IPCC inventory software to facilitate data entry in the system.

3.4.3. Classification of Energy Sector Sources

The IPCC 2006 Guidelines categorization of the sources of emissions in the energy sector was applied. Estimation of emissions was carried out for fuel combustion resulting from activities such as the use of fossil and biomass fuels for Electricity Generation (1.A.1.a.i), the Manufacturing and Construction industry (1.A.2), Transport (1.A.3), Residential (1.A.4.b) and Commercial (1.A.4.a) sectors. Methane and Nitrous oxide emissions result from the combustion of biomass fuels, such as fuel wood were accounted for while the CO_2 emissions resulting from the combustion of biomass were reported as a memo item in the Common Reporting Format (CRF) tables. GHG emissions from the combustion of fuel for all transport activities, such as Road Transportation (1.A.3.b), and Other transportation, were included in the Transport category. Emissions from International Aviation (International Aviation Bunkers) (1.A.3.a.i) and International Navigation Bunker (1.A.3.d.i) activities were reported as a memo item in the CRF tables.

3.4.4. Methodology and Data Sources

The fuel combustion in the subcategories takes place in either stationary or mobile equipment. The emissions are CO_2 and Non-CO_2. The Tier 1 approach is used to compute GHG emissions. It requires the least data when compared with Tier 2 and Tier 3, which will require more resource and more detailed data. For Tier 1 default emission factors are used to estimate emissions, where there is no country specific emission data. The inventory compiler has to state the activity data very clearly at is advisable to align it with the IPCC inventory software to facilitate data entry in the system. The GHG emissions from the stationary combustion were calculated using equation 2.1, Vol2. IPCC 2006

$$Emissions_{GHG,\,fuel} = FuelConsumption_{fuel} \times EmissionFactor_{GHG,\,fuel}$$ …IPCC Equation 3.2

Where

(i) $Emissions_{GHG,fuel}$ = emissions of a given GHG by type of fuel (kg GHG)

(ii) Fuel $Consumption_{fuel}$ = amount of fuel combusted (TJ/Gg)

(iii) Emission Factor $GHG_{,fuel}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ). The total emissions are computed by summing emissions from all fuel types as in 2.2 Vol2. 2006 IPCC.

The default emission factors for stationary combustion in the energy industry are provided Table 2.2, Chapter Volume 2 2006 IPCC Guidelines. A list of these tables in provided in of this report for quick reference. The default emission factors for stationary combustion in the residential and agriculture/forestry/fishing and fish farm category are in Table 2.5 Vl2 2006 IPCC.

Land transport is the dominant means of transport in Somalia including roads, civil aviation and marine/water navigation. The emissions from fuels used in the international transport activities is reported separately as international bunkers and are excluded from the national inventory total. There is inadequate data disaggregation of the data on fuel consumption. Although the data on energy in aviation sector is readily available, the data on marine fuel consumption is required. The disaggregation of data into vehicle type, size, consumption rate and age is also required to improve the inventory to Tier 2 computation of emissions in future. The Equation 3.3 is from IPCC 2003 Vol.2 is applicable for fossil fuel based system

$$\mathbf{Emissions} \approx \sum_{\mathbf{j}} (\mathbf{Fuel_j} \times \mathbf{EF_j})$$

…IPCC equation 3.3

Where:

Emissions	= emissions (kg)
Fuel j	= fuel type j consumed (as represented by fuel sold) in (TJ)
EF j	= emission factor for fuel type j, (kg/TJ)
j	= fuel type

The emissions from fuel are dependent of technology, fuel quality and the type of emission control mechanisms such as use of catalyst-to decrease the rate of N_2O (Table 1.8 Vol2 2006 IPCC)..

3.4.5. Types Fuel Combustion Emissions

The mobile sources are the largest contributors of direct greenhouse gas emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The mobile sources also emit GHG precursors/pollutants such as carbon monoxide (CO), Non-methane Volatile Organic Compounds (NMVOCs), sulphur dioxide (SO_2), particulate matter (PM) and oxides of nitrate (NO_x).

3.4.5.1. Carbon Dioxide (CO2) Emissions

The estimated emissions of CO_2 were computed on the basis of the amount and type of fuel combusted and its carbon content. Due to limited availability of data the Tier 1 approach was used to calculate CO_2 emissions. The equation used for calculation is from IPCC 2006 Guidelines. Tier 1 is used in calculation.

$$\mathbf{Emissions} \approx \sum_{a} (\mathbf{Fuel_a} \times \mathbf{EF_a})$$

...IPCC equation 3.4

Where:

(i) Emission = Emissions of CO_2 (kg)

(ii) $Fuel_a$ = fuel sold (TJ)

(iii) EF_a = emission factor (kg/TJ). This is equal to the carbon content of the fuel multiplied by 44/12.

(iv) a = type of fuel (e.g. petrol, diesel, natural gas, LPG etc)

(v) The CO_2 emission factor takes account of all the carbon in the fuel including that emitted as CO_2, CH_4, CO, NMVOC and particulate matter.

3.4.5.2. Non CO2 Emissions

The emissions of CH_4 and N_2O depend on vehicle technology, fuel and operating characteristics. The calculation was based on the fuel sold since it is not possible to estimate fuel consumption by vehicle type. It was assumed that there is no control of the emission. The calculation of the emission was done using equation 3.2.3 is from IPCC 2006 Guideline.

$$\mathbf{Emissions} \approx \sum_{a} (\mathbf{Fuel_a} \times \mathbf{EF_a})$$

...IPCC equation 3.5

When fuel such as gasoline, diesel, wood/wood-waste, charcoal, and other biomass fuels are combusted in either stationary or mobile equipment, apart from CO_2, the following non- CO_2 gases are emitted: Nitrogen oxides (NOx), Carbon monoxide (CO), and Non-methane volatile organic compounds (NMVOC). Emission factors for different source categories differ due to differences in combustion technologies applied in the different source categories. The default factors presented for Tier 1 apply to technologies without emission controls; the emission factors for non CO_2 combustion are obtained from the EMEP/CORRINEAR.

3.4.5.3. Methane

Biomass based fuels such as fuel wood; charcoal, agricultural residues, agricultural waste and municipal waste combustion are the major contributor to CH_4 emissions. Charcoal production process is the major source of fugitive emissions. The contribution of fuel combustion to global emissions of methane is minor and the uncertainty is high. Methane is produced in small quantities from fuel combustion due to incomplete combustion of hydrocarbons in fuel. The CH_4 emissions from mobile sources are a function of the methane content of the motor fuel. The defaults emission factor for CH_4 was used in the estimation of emissions.

The general method for estimating CH_4 can be described as follows

$$\mathbf{Emissions(CH_4) \approx EF_{ab} \times Activity_{ab}}$$ …equation 3.6

Where:

EF	= Emission Factor (kg/TJ);
Activity	= Energy Input (TJ);
a	= Fuel type; and
b	= Sector-activity.

3.4.5.4. Nitrogen Oxides NO_X

Nitrogen oxides are indirect greenhouse gases. They have effect on the environment for their role in forming ozone (O_3), as well for their direct acidification effects. Fuel combustion activities are the most significant anthropogenic source of NO_x. Within fuel combustion, the most important sources are the energy industries and mobile sources. The emissions from mobile sources such as equipment used in transport subcategory are a function of the air-fuel mix and combustion temperatures, as well as pollution control equipment.

The general approach for estimating NO_X

$$\mathbf{Emissions(NOx) \approx EF_{ab} \times Activity_{ab}}$$ …equation 3.7

Where:

EF	= Emission Factor (kg/TJ);
Activity	= Energy Input (TJ);
A	= Fuel type; and
b	= Sector-activity.

3.4.5.5. Carbon Monoxide (CO)

Carbon monoxide is one of the indirect greenhouse gases. Most of CO emissions from fuel combustion come from motor vehicles. It is an intermediate product of the combustion process and in particular under stoichiometric combustion conditions. The emissions from mobile sources are a function of the efficiency of combustion and post combustion emission controls. The general method for estimating CO is described as:

$$\mathbf{Emissions(CO) \approx EF_{ab} \times Activity_{ab}}$$ …Equation 3.8

Where:

EF	= Emission Factor (kg/TJ);
Activity	= Energy Input (TJ);
a	= Fuel type; and
b	= Sector-activity.

3.4.5.6. Non-Methane Volatile Organic Compounds (NMVOC)

These products of combustion are indirect greenhouse gases. The major sources are from fuel combustion activities are mobile and residential combustion. They are products of incomplete combustion. The emission of NMVOC decreases in large combustion plants and increasing plant efficiency. The general equation used for estimating NMVOC can be described as:

$$\text{Emissions(NMVOC)} \approx EF_{ab} \times Activity_{ab}$$ …Equation 3.9

Where:

EF	= Emission Factor (kg/TJ);
Activity	= Energy Input (TJ);
a	= Fuel type; and
b	= Sector-activity.

3.4.5.7. Sulphur dioxide (SO2)

SO_2 is not a "greenhouse gas" but its presence in the atmosphere influence climate. Sulphur dioxide reacts with a variety of photo-chemically produced oxidants to form sulphate aerosols. Burning of fossil fuels which contain sulphur is harmful to the environment. The emissions of sulphur oxides (SO_x) are directly related to the sulphur content of the fuel. The Sulphur dioxide (SO_2) default (uncontrolled emission factors in kg/TJ is in Table 1.12, Appendix 1. The general equation used for estimating Sulphur dioxide (SO_2) can be described as:

$$\text{Emissions}(SO_2) \approx EF_{ab} \times Activity_{ab}$$ …Equation 3.10

Where:

EF	= Emission Factor (kg/TJ);
Activity	= Energy Input (TJ);
a	= Fuel type; and
b	= Sector-activity.

The SO_2 emission factors were estimated using IPCCC 2006 guideline and reference manual page 1.43 as stated in equation 2.8.

$$EF\left[\frac{kg}{TJ}\right] = 2 * \frac{s}{100} * \frac{1}{Q} * 10^6 * \left(\frac{100-r}{100}\right) * \left(\frac{100-n}{100}\right)$$ …Equation 3.11

Where:

EF	= Emission Factor (kg/TJ);
S	= [kg/kg];
2	= SO_2/S[kg/kg]
s	= Sulphur content in fuel [%];
r	= Retention of sulphur in ash [%];
Q	= Net calorific value [TJ/kt];
10^6	= (Unit) conversion factor; and
n	= Efficiency of abatement technology and/or reduction efficiency [%]

3.4.6. Emission Factors

The following table 2 shows a summary of IPCC 1996 and 2006 guidelines default carbon emission factors and conversions factors used in the estimation of emissions from the energy sector alongside country specific adjustments

Table 4-2: Calorific conversions and Carbon Emission Factors for Fuels

Fuel	Calorific Value (TJ/1000 tonne)	Carbon Émission Factor (t C/TJ)
Crue Oïl	42.08[73]	20.15
Gazoline	44.8	18.9
Jet Kérosène	44.59	19.5
Kérosène	44.75	19.6
Diesel Oïl	43.33	20.2
Residual Fuel Oïl	40.19	21.1
LPG	47.31	17.2
Bitumen	40.19	22
Lubricants	40.19	20
Refinery Feedstocks	44.8	20
Other Oïl	40.19	20
Sub-bituminous Coal	25.75	26.2
Solid Biomass	22.46[74]	29.9
Fuel Wood	19.2	29.9
Charcoal	21.1	29.9
Agricultural Residues	15.4	29.9

Table 4-3 shows the default conversion coefficients for the fraction of carbon oxidized for different fuels.

Table 4-3: Default Emission Coefficients Fraction of Carbon Oxidized[75]

Fuel	Fraction of Carbon Oxidised
Coal	0.98
Oil and Oil Products	0.99
Gas (including LPG)	0.995
Biomass	0.98

Table 4-4: Default Methane Emission Factors for various energy sectors (Kg/TJ)

Sector		Coal	Diesel / Kerosene	Gasoline	Wood	Charcoal	Other Biomass
Energy Industries		1	3	3	30	200	30
Manufacturing Industries and Construction		10	2	2	30	200	30
Transport	Aviation		0.5	0.5			
	Road		5	20			
	Railways		5				
	Navigation		5				
Commercial / Institutional		10	10	10	300	200	300
Residential		300	10	10	300	200	300
Agriculture / Forestry / Fishing	Stationary		5	5			
	Mobile		5	5			

Table 4-5: Default Nitrous Oxide Emission Factors for various energy sectors (Kg/TJ)

Sector	Coal	Diesel / Kerosene	Gasoline	Wood	Charcoal	Other Biomass
Energy Industries	1.4	0.6	0.6	4	4	4
Manufacturing Industries	1.4	0.6	0.6	4	4	4

[73] IPCC 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories Table 2.4

[74] Source: 1 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories; Energy Reference Manual. Table 1-1 and Table 1-3.

[75] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories; Energy Reference Manual. Table 1-6.

and Construction							
Transport	Aviation		0.6	0.6			
	Road		0.6	0.6			
	Railways		0.6				
	Navigation		0.6				
Commercial / Institutional		1.4	0.6	0.6	4	1	4
Residential		1.4	0.6	0.6	4	1	4
Agriculture / Forestry / Fishing	Stationary		0.6	0.6	4	1	4
	Mobile		0.6	0.6			

Table 4-6: Default Nitrogen Oxides Emission Factors for various energy sectors (Kg/TJ)

Sector		Coal	Diesel / Kerosene	Gasoline	Wood	Charcoal	Other Biomass
Energy Industries		300	200	200	100	100	100
Manufacturing Industries and Construction		300	200	200	100	100	100
Transport	Aviation		300	300			
	Road		800	600			
	Railways		1200				
	Navigation		1500				
Commercial / Institutional		100	100	100	100	100	100
Residential		100	100	100	100	100	100
Agriculture / Forestry / Fishing	Stationary		100	100	100	100	100
	Mobile		1200				

Table 4-7: Default Carbon Monoxide Emission Factors for various energy sectors (Kg/TJ)

Sector		Coal	Diesel / Kerosene	Gasoline	Wood	Charcoal	Other Biomass
Energy Industries		20	15	15	1000	1000	1000
Manufacturing Industries and Construction		150	10	10	1000	4000	1000
Transport	Aviation		100	100			
	Road		1000	8000			
	Railways		1000				
	Navigation		1000				
Commercial / Institutional		2000	20	20	5000	7000	5000
Residential		2000	20	20	5000	7000	5000
Agriculture / Forestry / Fishing	Stationary		20	20	5000	7000	5000
	Mobile		1000				

Table 4-8: Default Non-Methane Volatile Organic Compounds Emission Factors for various energy sectors (Kg/TJ)

Sector	Coal	Diesel / Kerosene	Gasoline	Wood	Charcoal	Other Biomass
Energy Industries	5	5	5	50	100	50

Manufacturing Industries and Construction		20	5	5	50	100	50
Transport	Aviation		59	50			
	Road		200	1500			
	Railways		200				
	Navigation		200				
Commercial / Institutional		200	5	5	600	100	600
Residential		200	5	5	600	100	600
Agriculture / Forestry / Fishing	Stationary		5	5	600	100	600
	Mobile		200				

The following assumptions[76] were made regarding fuel sulphur content of different fuels are presented in Table 4-9.

Table 4-9: Default Sulphur Dioxide Content for various fuels (%S)

Fuel	Sulfuré Content (%S)
Gasoline	0.1%
Jet Kerosene	0.05%
Kerosene	0.05%
Diesel Oil	0.05% (2)
Residual Fuel Oil	0.5%
Sub-bituminous coal	0.5%
Solid Biomass	0.2%

The sulphur retention in ash for coal is assumed to be 5% and negligible (0%) for all other fuels.

3.4.7. Trends for Aggregated GHG emissions

3.4.7.1. Emission trends by gas

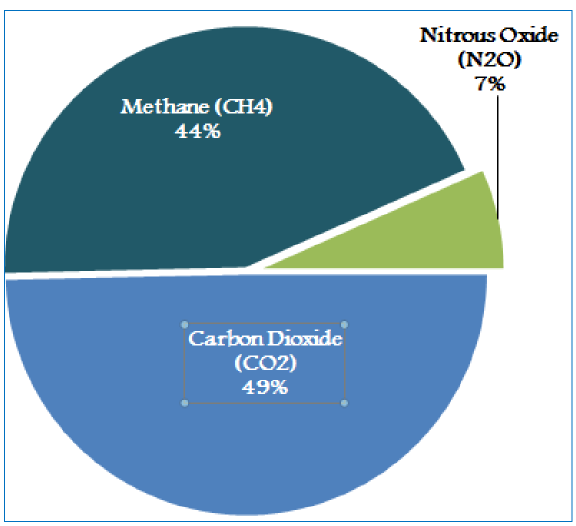


Figure 4-3; Proportion of Energy Emissions (in Gg) by Gas in year 2015

[76] GPGAUM-Corr.2001.01; IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

Somalia's Energy sector emissions profile is similar to that of least developed countries. Carbon dioxide (CO2) and methane are the largest contributors to Somalia's GHG emissions, accounting for 49% and 44% respectively in 2015. The majority of the CO_2 emissions result from the combustion of fuels for transport and manufacturing/construction while most of methane is resulting from the utilization biomass energy resources. Nitrous oxide (N2O) emissions arise from activities such as transport and other combustion of fuel accounted for 7% of Somalia's emissions in 2015. The figure 4 below shows the trend of emissions gas for the energy sector.

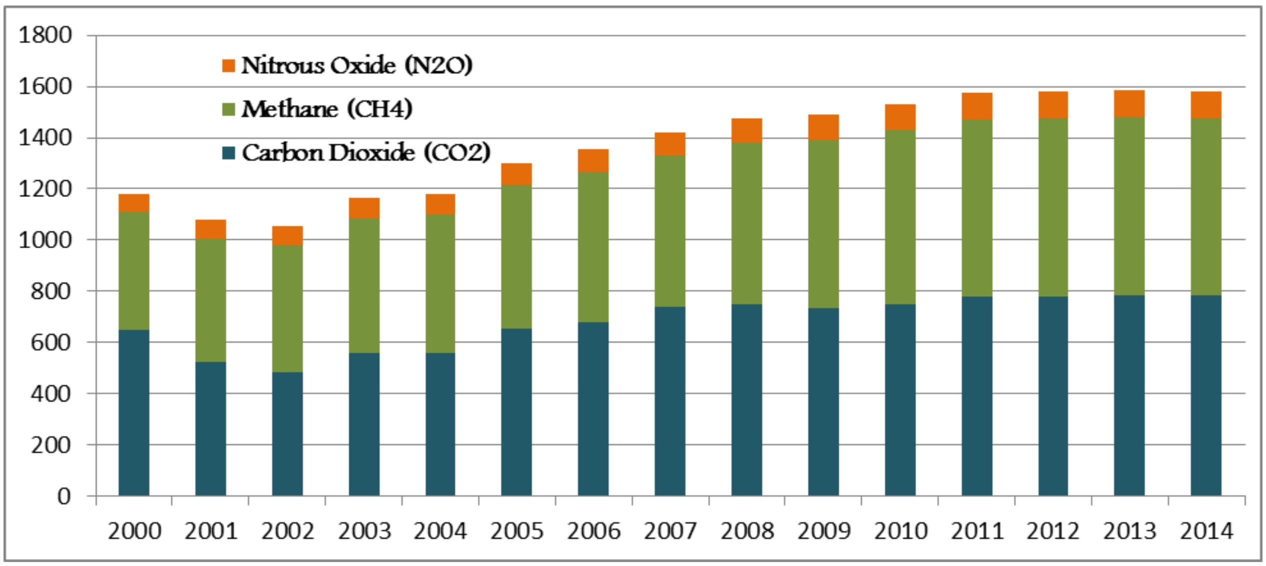


Figure 4-4 the trends of emissions (in Gg) by gas

3.4.7.2. Carbon dioxide

Most of the estimated emissions of CO_2 are resulting from the transport sector as shown in Figure 5. The other sectors including commercial and residential, and manufacturing industry produce almost equal CO_2 emissions with least emissions from the energy generation. It is indicated that in the year 2oo1 to 2004; CO_2 emissions from the other sectors and manufacturing and construction was construction greatly reduced due to conflict related factors.

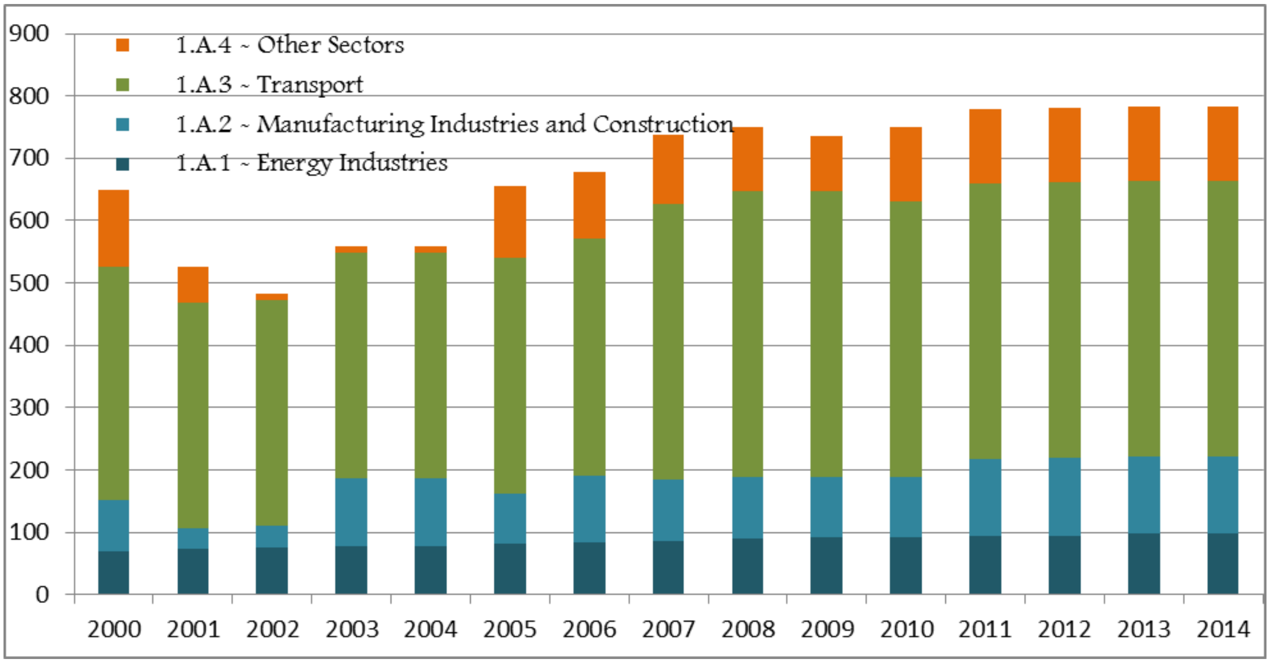


Figure 4-5; Carbon Dioxide Emission (in Gg) from the Energy Sector

3.4.7.3. Methane

Most of the estimated Methane emissions are resulting from the other sectors including commercial and residential, due to over dependency on the biomass energy sources as shown in Figure 6. Due to limited availability of data the Tier 1 approach was used calculates Methane emissions.

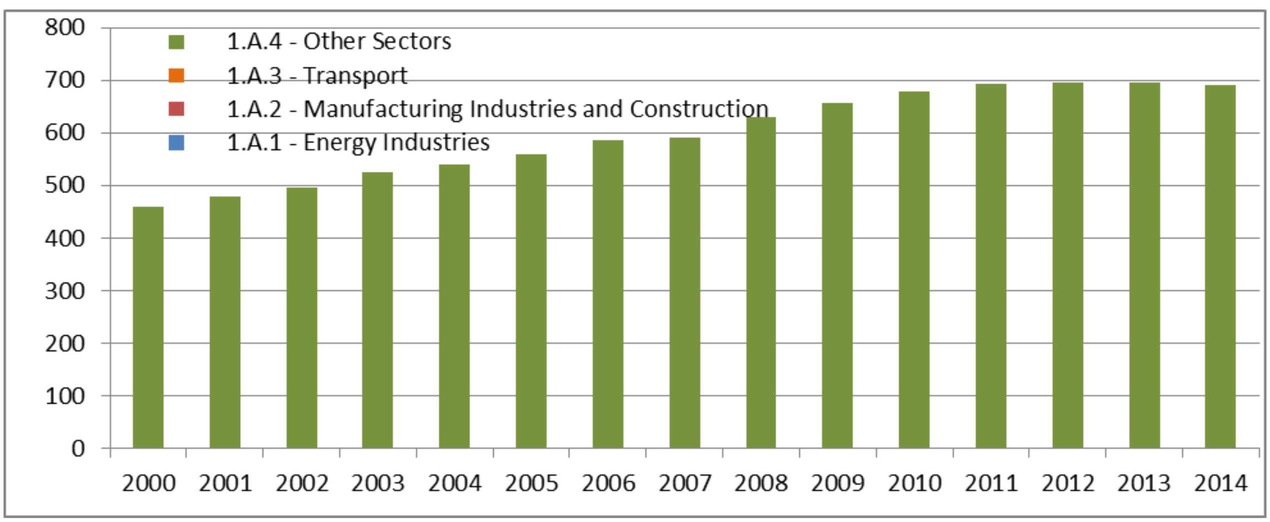


Figure 4-6 Methane Emissions (in Gg) from the Energy Sector

3.4.7.4. Nitrous oxide

As shown in figure7 below most of the estimated Nitrous Oxide emissions are resulting from the combustion of Biomass energy as used in the commercial and residential, and some from the transport sector. There are also significant nitrous oxide emissions from the manufacturing and construction sector. Due to limited availability of data the Tier 1 approach were used to calculate nitrous oxide emissions.

Figure 4-7 Nitrous Oxide Emissions (in Gg) from the Energy Sector

3.4.7.5. Emission trends specified by source category

Figure 8 below shows the transport sector and the other sectors contribution most of the emissions in the energy sector.

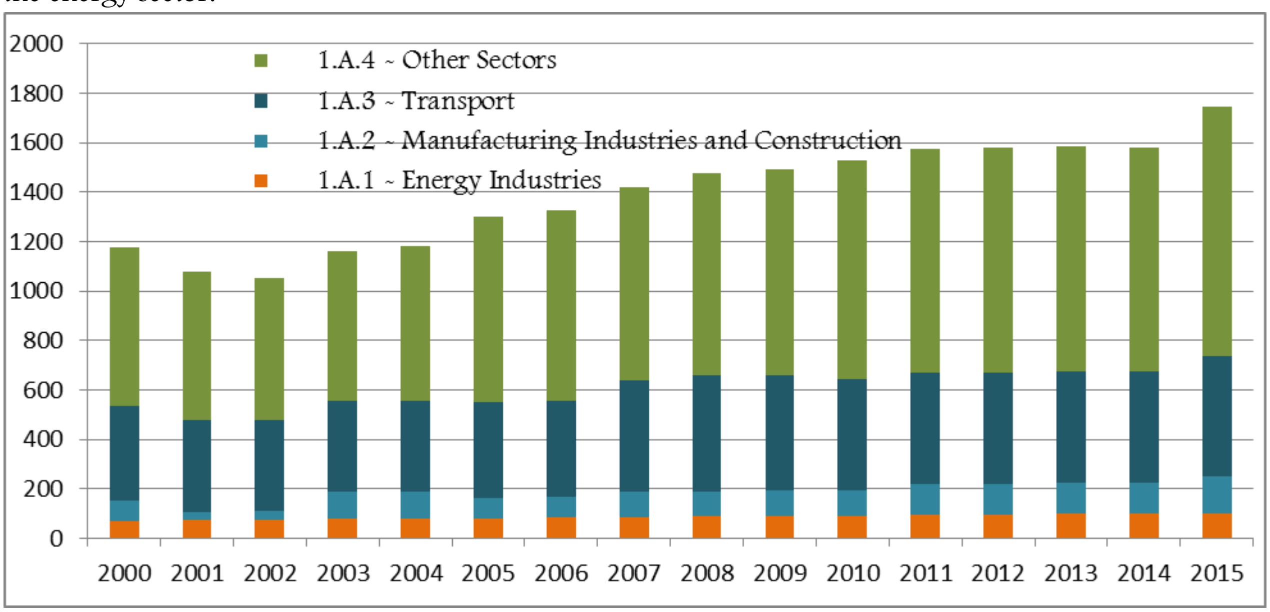


Figure 4-8 Trend of emissions (in Gg) source category

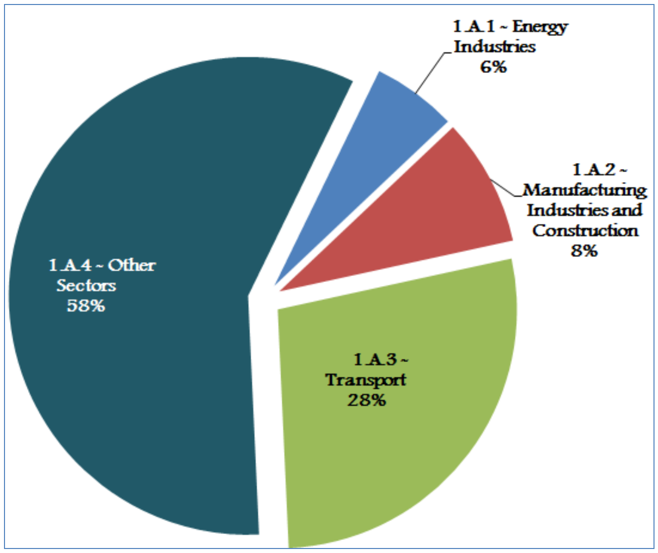


Figure 4-9 shows percentage contribution of emissions by source categories in the energy sector.

The other sector mostly residential generates most of the emissions in the energy sector accounting for 58% total GHG emissions. This is followed by transport at 28%, Manufacturing industries and construction at 8% and Energy industries at 6% of the total energy sector emissions in the year 2015. The other sectors source category includes residential, commercial, institutional and agriculture/forestry/fishing. Figure10 shows the BUA projected emissions form the energy sector, indicating that the other sectors including residential subsector will continue to be the major source of emissions followed by transport

.

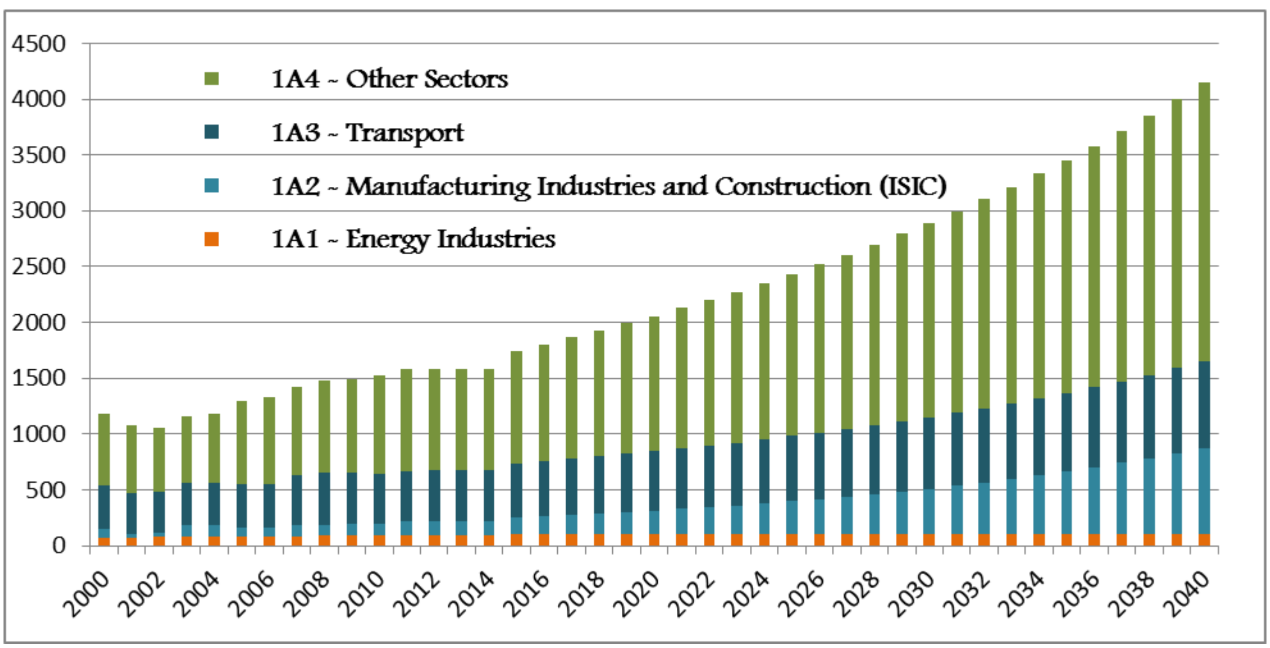


Figure 4-10 Projected Energy Emissions (in Gg)

Table 4-10GHG Emissions (in Gg) from the Energy Sector

Year	1 - Energy	1A - Fuel Combustion Activities	1A1 - Energy Industries	1A2 - Manufacturing Industries and Construction (ISIC)	1A3 - Transport	1A4 - Other Sectors
2000	1178.17	1178.17	69.89	82.39	382.02	643.88
2001	1078.51	1078.51	72.96	33.63	369.90	602.02
2002	1053.61	1053.61	76.60	33.63	369.90	573.48
2003	1162.80	1162.80	78.28	109.29	369.90	605.34
2004	1180.85	1180.85	78.28	109.29	369.90	623.38
2005	1299.09	1299.09	81.07	82.39	386.11	749.53
2006	1327.00	1327.00	83.87	83.48	386.11	773.55
2007	1418.55	1418.55	86.94	99.20	450.55	781.86
2008	1475.55	1475.55	90.58	99.20	466.75	819.03
2009	1489.93	1489.93	91.41	99.20	466.75	832.56
2010	1530.11	1530.11	91.41	99.20	450.55	888.95
2011	1576.83	1576.83	93.37	126.10	450.55	906.82
2012	1580.23	1580.23	95.05	126.10	450.55	908.54
2013	1583.03	1583.03	97.84	126.10	450.55	908.54
2014	1578.81	1578.81	97.84	126.10	450.55	904.32
2015	1658.21	1658.21	99.66	151.02	483.53	1011.86

Table 4-11 Projected (BAU[77]) GHG Emissions (in Gg) from the Energy Sector

Year	1 - Energy	1A - Fuel Combustion Activities	1A1 - Energy Industries	1A2 - Manufacturing Industries and Construction (ISIC)	1A3 - Transport	1A4 - Other Sectors
2016	1683.65	1683.65	100.87	161.24	492.70	1049.06
2017	1863.80	1863.80	101.98	172.15	502.05	1087.62
2018	1925.98	1925.98	102.99	183.81	511.58	1127.60
2019	1990.50	1990.50	103.91	196.25	521.29	1169.05
2020	2057.48	2057.48	104.73	209.53	531.18	1212.02
2021	2127.02	2127.02	105.46	223.72	541.27	1256.58
2022	2199.26	2199.26	106.10	238.86	551.54	1302.77
2023	2274.32	2274.32	106.63	255.03	562.00	1350.66
2024	2352.35	2352.35	107.08	272.29	572.67	1400.30
2025	2433.47	2433.47	107.42	290.73	583.54	1451.78
2026	2517.84	2517.84	107.67	310.41	594.61	1505.15
2027	2605.62	2605.62	107.83	331.42	605.90	1560.47

[77] Business as usual Scenario

2028	2696.98	2696.98	107.89	353.85	617.40	1617.84
2029	2792.08	2792.08	107.86	377.81	629.11	1677.31
2030	2891.12	2891.12	107.72	403.38	641.05	1738.96
2031	2994.29	2994.29	107.50	430.69	653.22	1802.89
2032	3101.80	3101.80	107.18	459.84	665.61	1869.16
2033	3213.85	3213.85	106.76	490.97	678.25	1937.87
2034	3330.68	3330.68	106.25	524.21	691.12	2009.11
2035	3452.53	3452.53	105.64	559.69	704.23	2082.96
2036	3579.64	3579.64	104.94	597.58	717.60	2159.53
2037	3712.30	3712.30	104.14	638.03	731.22	2238.91
2038	3850.78	3850.78	103.25	681.22	745.09	2321.21
2039	3995.37	3995.37	102.26	727.33	759.23	2406.54
2040	4146.39	4146.39	101.17	776.57	773.64	2495.00

3.4.7.6. Fugitive Emissions

The process of fuel extraction, transport, storage, and refinery causes the release of GHGs, specifically CH_4, and non-CO_2 gases into the atmosphere. This are called fugitive emissions since they are not resulting from an intended beneficial activity. Most of the emissions are from activities oil/gas activities, and oil refining. At present, fugitive emission are not significant. Somalia has Oil and gas deposits which play an important role in the national energy supply chain and emission trajectory in the near future. Once the country starts commercial drilling of oil, within the upstream and downstream value chain; there will be significant fugitive emissions. Currently the most important source of fugitive emission is production process of charcoal but is not estimated.

3.5. The Agriculture, Forestry and Other Land Use Sector

The AFOLU sector covers the anthropogenic land management activities that generate emissions but not covered under the energy, and waste sectors. It is divided into three subsectors namely; Livestock, Land based emissions (Land use and land use changes), and Aggregate Sources and non-CO2 Emission Sources. The key greenhouse gases of concern are CO_2, N_2O and CH_4. CO_2 fluxes between the atmosphere and ecosystems primarily controlled by uptake through plant photosynthesis and releases via respiration, decomposition and combustion of organic matter. N_2O is primarily emitted from ecosystems as a by-product of nitrification and de-nitrification, while CH_4 is emitted through methanogenesis under anaerobic conditions in soils and manure storage, through enteric fermentation, and during incomplete combustion while burning organic matter. Other gases of interest but not estimated under Tier 1 or using version 2.1 of the IPCC 2006 software are NO_x, NH_3, NMVOC and CO. These gases (from combustion and from soils) are precursors for the formation of greenhouse gases in the atmosphere which is an indirect emission.

According to Desjardins et al. (1993) agricultural soils contribute to GHG in three ways: CO_2 through soil organic matter losses as a result of land use change, CH_4 from anaerobic soils such as rice paddies and N_2O from fertilizer use and intensive cultivation. The IPCC (2006) identifies various pathways through which the input of nitrogen into the soil can result in emissions of N2O which include:

(i) Nitrogen inputs in form of crop residue (nitrogen fixing crops), organic fertilizers (compost, animal manure and sewage sludge) and synthetic nitrogen fertilizers.

(ii) Loss of soil organic matter from mineral soils due to changes in land use

(iii) Drainage or management of organic soil for agricultural purposes (not occurring in Somalia)

(iv) Deposits of animal manure on paddocks, rangelands and pastures

3.5.1. Methodology and Data sources for the Agriculture Sub-sector

This is the sector that produces most of the anthropogenic GHG emissions in Somalia. The sector's main GHGs emissions are from such activities as enteric fermentation, burning of crop residues, agricultural soils, and animal manure. These emissions consist of GHGs such as Carbon monoxide (CO), Nitrous Oxide (N2O), Methane (CH4) and other Nitrogen Oxides (NOx). Activity data from crop, crop residues, soils, fertilizer use, cultivation of flooded rice and savannah burning and livestock was used for purposes of this calculation.

The methods, activity data, emission factors and conversion factors for the national inventory for the agriculture sector covered in this section are primarily drawn from the IPCC 2006 Guidelines while some additional effort has been made to include more default emission factors with some adjustments to suit the national circumstances, activity data or emission factors to improve the GHG emission estimates.

The estimates of emissions from the areas of savannah burned annually, the crops and area where there is a practice of burning crop residues, have a very high level of uncertainty and are generally not significant in Somalia. In addition, crop production and fertilizer application based on data from the Food and Agriculture Organization of the United Nations (FAO) has very high uncertainty and this data should be compared to national statistics to judge its reliability and completeness. Collection of new activity data for these emission sources through surveys or other means can be used to significantly improve the quality of the inventory in the future.

3.5.2. Livestock

The Livestock production activities are known to produce large quantities of Methane (CH_4) emissions from in two broad sections i.e. from enteric fermentation and both CH_4 and nitrous oxide (N_2O) emissions from livestock manure management systems. Methane (CH_4) emissions produced by live animals as a by-product of a digestive process by which carbohydrates are broken down into simple molecules for absorption into the bloodstream is categorized under enteric fermentation, . Ruminant animals (e.g. cattle, goats) are the largest source of methane emission from enteric fermentation with moderate amount of methane produced from non-ruminant animals (e.g. swine (Not occurring in

Somalia), horses). The amount of CH_4 emitted from the animal depends on the type, age, and weight of the animal; the quality and quantity of feed; and the energy expenditure of the animal. Greenhouse gases are also emitted from the management of animal manure. Methane is produced from decomposition of manure under anaerobic conditions, which usually occur in manure stored in large piles. During storage of manure, some nitrogen in manure are oxidized and converted into N_2O.

3.5.2.1. Enteric fermentation

The most important GHG emitted from livestock production activities is Methane (CH4). CH4 is produced as a by-product of digestion in herbivores through a process known as enteric fermentation (Baggot et al., 2006; IPCC, 2006). The key factors determining the amount of methane produced include the type of feed consumed by the animal and its digestive system (Garzia-Apaza et al., 2008). Since Somalia has no country-specific methane emission factors from enteric fermentation and due to lack of activity data to perform enhanced characterization of livestock population, Tier 1 approach was applied in the estimation of emissions. The parameters and the activity data applied are shown in equation 3.11 below which is simply based on livestock population and default emission factor is used. The estimation was done using equation 10.19 of 2006 IPCC here represented as:

$$Emissions = EF_T\left(N_T / 10^6\right)$$ ... Equation 3.11

Where:

- Emissions = Methane (CH_4)emissions from Enteric Fermentation for a defined population (Gg/yr)
- EF_T = Emission factor for the defined livestock population, kg CH_4/ head/yr. Default factors are listed in tables 10.10 and 10.11 Vol.4 2006 IPCC.
- N(T) = the number of head of livestock species / category T in the country
- 10^6 = Conversion factor (to Gg)

3.5.2.2. Manure management

The practices of manure management from collection, storage and application to land were considered in the estimation of emissions. The different stages of storage and treatment of manure produce varying levels of Methane (CH4) and nitrous oxide (N2O). For purposes of this compilation, manure comprised of both the urine and dung excreted by livestock. In addition it was noted that in Somalia, manure is largely uncollected and thus managed on pastureland due to the widely practiced nomadic pastoralism.

3.5.2.3. Estimation of Methane emissions from Manure Management

The method used to estimate methane emission from manure management is similar in form with that used in estimating methane emission from enteric fermentation and is based on equation 10.22 of Vol4, 2006 IPCC presented here as:

$$CH_{4-manure}Emissions = EF_T\left(N_T / 10^6\right)$$ ... Equation 3.12

Where:

i) Emissions = Methane (CH_4)emissions from manure management for a defined population Gg/yr)
ii) EF_T = Emission factor for the defined livestock population, kg CH_4 / head/yr. Temperature is factor to consider while choosing default factors as provided in table 10.14 , 10.15 and table 10.16 of chapter 10, volume 4, 2006 IPCC.
iii) N(T) = the number of head of livestock species / category T in the country
iv) 10^6 = Conversion factor (to Gg)

3.5.2.4. Estimation Direct Nitrous Oxide (N2O) emissions from Manure Management

The term 'manure' is used here collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock. N_2O is produced, directly and indirectly, during the storage and treatment of manure before it is applied to land or otherwise used for feed, fuel, or construction purposes. Under manure management systems, direct N_2O emissions occur via combined nitrification and de-nitrification of nitrogen contained in the manure. Indirect emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia and NO_x. Tier 1 method was applied where the total amount of N excretion from livestock species/categories in each type of manure management system was multiplied by an emission factor for that type of manure management system. Default N excretion values listed in table 10.19, vol4 2006 IPCC guidelines were used together with the corresponding default emission factor listed in table 10.21, vol4 2006 IPCC.

The estimation of direct N_2O emissions from Manure Management in the country was carried out using IPCC equation 10.25 as shown below:

$$\mathbf{N_2O_{D(mm)}} = \left[\sum_{S} \left[\sum_{T} \left(\mathbf{N_{(T)}} \times Nex_{(T)} \times MS_{(T,S)} \right) \right] \times EF_{3(5)} \right] \times \frac{44}{28} \quad \cdots \text{Equation 3.12}$$

Where:

(i) $N_2OD_{(mm)}$ = direct N2O emissions from Manure Management in the country, kg N_2O / yr
(ii) $N_{(T)}$ = number of head of livestock species/category *T* in the country
(iii) $Nex_{(T)}$ = Annual average N excretion per head of species/category *T* in the country, kg N animal-1 yr-1. (this is derived as
(iv) $MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless
(v) $EF_{3(S)}$ = emission factor for direct N_2O emissions from manure management system *S* in the country, kg
(vi) S = manure management system
(vii) T = species/category of livestock
(viii) 44/28 = conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

3.5.2.5. Estimation of Indirect N2O emissions from Manure Management

The emissions estimated represent losses of nitrogen in other forms (e.g., ammonia and NOx) as manure is managed on site. The approach for the estimation of Indirect N_2O emissions for manure management is similar to that of estimating direct emissions. As per the IPCC equation 20.27 (Vol4. 2006 IPCC), fractions of N losses is used instead of the emission factor. Default fractions of N losses from manure management systems due to volatilisation are provided in Table 10.22 Vol. 4, 2006 IPCC.

$$\mathbf{N}_{\mathbf{Volatilization\text{-}MMS}} = \left[\sum_{\mathbf{S}} \left[\sum_{\mathbf{T}} \left(\mathbf{N}_{(\mathbf{T})} \times Nex_{(T)} \times MS_{(T,S)} \right) \times \left(\frac{Frac_{GasMS}}{100} \right)_{(T,S)} \right] \right]$$ …IPCC Equation 10.27

Where:

i) $N_{volatilization\text{-}MMS}$ = amount of manure nitrogen that is lost due to volatilisation of NH_3 and NOx, kg N yr-1
ii) $N_{(T)}$ = number of head of livestock species/category *T* in the country
iii) $Nex_{(T)}$ = annual average N excretion per head of species/category *T* in the country, kg N animal-1 yr-1
iv) $MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless
v) $Frac_{GasMS}$ = percent of managed manure nitrogen for livestock category *T* that volatilises as NH_3 and NOx in the manure management system *S*, %

3.6. Land Based Emissions

Land is a key component of the AFOLU sector and entails emissions and sinks of CO_2 from the carbon pools of biomass (above-ground and below-ground) as well as those from the different categories of soils such as croplands, grasslands, settlements, forestland and other land use categories that are relevant.

The emission/removal estimation from the Land subsector was focused on the greenhouse gas emissions from the Land Use Change and Forestry Sector (LUCF) attributed to anthropogenic activities such as wood fuel/charcoaling, timber harvesting and conversion of forest into other land uses such as agriculture, and settlement. Forests can be a source or sink of carbon depending on the balance between photosynthesis and respiration and the degree to which it is converted into other land uses. In photosynthesis, trees absorb carbon dioxide (CO_2) from the atmosphere and store carbon in their biomass and soil (Brown et. al., 1992; and Trexler et al. 1992). The net carbon uptake or emission of the Land sub-sector is dependent on two basic biophysical processes:

i) Changes in forest/woody carbon stocks due to the net annual biomass growth of existing forest and non-forest stands, and possible biomass regrowth in abandoned lands;
ii) Land use and forest conversion practices which affect the carbon chemistry of the atmosphere via biomass burning, decay, and soil carbon release or uptake.

3.6.1. Land Use Change and Forestry (LUCF)

The primary objective of using the land cover as a parameter 'the land Unit' is to facilitate the inference of biophysical information from land cover for use in estimation of emissions resulting from respective changes and or conversions from one cover or use category to the other. There is no consistent land cover data covering the country for sufficient time series to carry out change detection and calculate percentage land cover for the IPCC Six land use categories. MODIS Land Cover (IGBP) Type I, was thus selected and acquired from the USGS site to fill the land use data gap. Annual land cover maps for years 2001 to 2013 were generated using the MODIS dataset. The 17 MODIS classes were aggregated to the IPCC six land use classes using a decision tree classification algorithm which was applied to all the datasets for 2001 – 2013 as shown in table 14. The Figure 10 below shows the land cover maps for different the years 2001 to 2013.

To estimate the emissions from land, consistent wall to wall land cover data with six IPCC land use classes for Somalia were derived from MODIS and modified using ancillary data from FAO SWALIM and Afri-cover maps. Tier 1 approach was applied due to the inadequacy of data in terms of disaggregation into detailed land use classes and in availability of country specific emission factors. All the five carbon pools of aboveground biomass, belowground biomass, dead wood, Litter and Soil organic matter as presented in Table 4-12 were considered with respect to the tier 1 assumptions that the average transfer rate into dead organic matter (dead wood and litter) is equal to the average transfer rate out of dead organic matter. Tier1 therefore show that the net stock change in dead organic matter is zero when considering conversions. The five pools were the further aggregated into three carbon pools: living biomass, Dead Organic Matter (DOM) and soils as shown in 11.

Table 4-12 Carbon Pools, Source: 2006 IPCC guidelines

Pool		Description
Living Biomass	Aboveground Biomass	All biomass of living vegetation, both woody and herbaceous, above the soil including stems, stumps, branches, bark, seeds, and foliage.
	Belowground biomass	All biomass of live roots. Fine roots of less than 2mm diameter are often excluded because these often cannot be distinguished empirically from soil organic matter or litter.
Dead Organic Matter (DOM)	Dead wood	All non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps, larger than or equal to 10 cm in diameter
	Litter	All non-living biomass with a size greater than the limit for soil organic matter (2 mm) and less than the minimum diameter chosen for dead wood (e.g. 10 cm), lying dead, in various states of decomposition above or within the mineral or organic soil.
Soils	Soil organic matter	Includes organic carbon in mineral soils to a specified depth (suggest 1 m) and applied consistently through the time series2. Live and dead fine roots and DOM within the soil, which are less than the minimum diameter limits (2mm) for roots and DOM, are included with soil organic matter where they cannot be distinguished from it empirically.

3.6.2. Sources of Activity Data

Activity data needed for land use is listed in Table 4-13. Where this data was not available at country level supplementing data downloaded from international sources e.g., FAO, MODIS etc. Some activity data like area of peat extraction was not be applicable in the Somalia. Figure 4-11shows the land cover maps used in the analysis

Table 4-13 Summary of Activity Data

Type of Activity Data	Activity Data Value(s)	Activity Data Units	Remarks
Managed and unmanaged land area remaining unchanged	Area land categories managed and unmanaged	ha	
Land category converted into land category being considered	Area of land category converted	ha yr-1	Land use change analysis
Amount of fuel wood harvested	Sum of fire wood and wood used for charcoal in a year	M^3 or Dry Matter (dm) Tones	FAOSTAT

Amount of wood harvested	Sum of timber harvested in a year	M^3 or Dry Matter (dm) Tones	FAOSTAT
Loss due to disturbance	Biomass loss due to fire, pest and disease	Dm /yr	MODIS Fire products, Land use change analysis
Area of organic soils drained or cultivated	Area organic soils drained or cultivated annually	ha yr-1	Land use change analysis and soil data
Area of flooded	Area flooded annually	ha yr-1	Land cover datasets and change analysis

3.6.3. Emission Factors

Unlike other subsectors, emissions / removals in land use were estimated as a function of activity data and a combination of coefficients known as carbon stock change (CSC). Examples of CSCs are annual growth, root shoot ratio and Biomass Expansion Factor (BEF). Table 4-14 provides a list of reference sources of EF that were applied since the country specific coefficients were not available. Most references were made from volume 4 2006 IPCC guidelines

Table 4-14 Quick reference to emission factors

Type of Factor	Emission or Carbon-Stock Change Factor Value	Emission or Carbon-Stock Change Factor Units	Reference
Annual growth rates	G_W, Varies per land category and sub category	tonnes dry matter (dm)ha^{-1} yr^{-1}	Table 4.9 and Table 4.10
Root to shoot ratio	Varies per land use, management and species (table 4.4)	Dimensionless	Table 4.4
Conversion and expansion factor merchantable volume to total biomass	$BCEF_R$	Ratio	Table 4.5
Carbon fraction (CF) of dry matter	(CF) 0.5 or Table 4.3	Ratio[1]	0.5 or Table 4.3
Fuel wood removed (m^3) as tree parts	FG_{part}	m^3 yr^{-1}	FAO statistics
Basic wood density	D varies per species	tonnes m^{-3}	Tables 4.13 and 4.14
Emission factor for drained nutrient-rich Wetlands organic soils	$EF_{N2O\text{-}NPeatRich}$	(kg N_2O-N ha^{-1} yr^{-1})	Table 4.6
Native (mineral soils) Reference carbon stock	SOC_{ref} Varies per climate and soil combination	T C ha^{-1}	Table 2.3
Mineral soils relative Stock change factor for land-use system	F_{LU}, Varies per land category, last year of inventory period and first year of inventory period	Denoted as $F_{LU(0)}$ for last year and $F_{LU(0-T)}$ for first year	Forest land Table 2.3 Cropland Table 5.5 Grassland Table 6.2 Settlement Chap. 8, Sec. 8.3.3 Other land Chap. 9, Sec. 9.3.3
Mineral soils relative Stock change factor for management regime	F_{MG} Varies per land category, last year of inventory period and first year of inventory period	Denoted as $F_{MG(0)}$ for last year and $F_{MG(0-T)}$ for last year	Forest land Ref Table 2.3 Cropland Table 5.5 Grassland Table 6.2 Settlement Chap. 8, Sec. 8.3.3 Other land Chap. 9, Sec. 9.3.3
Mineral soils relative Stock change factor for C input	F_I Varies per land category, last year of inventory period and first year of inventory period	Denoted as $F_{I(0)}$ for last year and $F_{I(0-T)}$ for first year	Forest land Ref Table 2.3 Cropland Table 5.5 Grassland Table 6.2 Settlement Chap. 8, Sec. 8.3.3 Other land Chap. 9, Sec. 9.3.3
Emission factor lime calcic limestone ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$	Calcic limestone default is 0.12 Dolomite default is 0.13	Dimensionless	2006 IPCC
Emission factor for CO2- C from nutrient rich managed peat soils for peat extraction	$EF_{PeatRich}$	T C ha^{-1} yr^{-1}	Table 7.4

Type of Factor	Emission or Carbon-Stock Change Factor Value	Emission or Carbon-Stock Change Factor Units	Reference
Emission factor for CO2- C from nutrient poor managed peat soils for peat extraction	$EF_{PeatPoor}$	T C ha^{-1} yr^{-1}	Table 7.4
CO2 emission factors for nutrient-rich peat soils	$EF_{CO2PeatRrich}$ T C ha^{-1} yr^{-1}	T ha^{-1} yr^{-1}	Table 7.4
Emission factor for drained nutrient-rich Wetlands organic soils	kg N_2O-N ha^{-1} yr^{-1}	Kg ha^{-1} yr^{-1}	Table 7.6

Table 4-15 Description of the MODIS Land Cover Classes and the Aggregated Six IPCC Land Categories

Code No.	MODIS Land Cover Category	Description	IPCC Land Category Aggregate
1	Evergreen Needle leaf Forests	Lands dominated by woody vegetation with a percentage cover >60 percent and height exceeding 2 meters. Almost all trees remain green all year. Canopy is never without green foliage.	Forestland
2	Evergreen Broadleaf Forests	Lands dominated by woody vegetation with a percentage cover >60 percent and height exceeding 2 meters. Almost all trees and shrubs remain green year round. Canopy is never without green foliage	Forestland
3	Deciduous Needle leaf Forests	Lands dominated by woody vegetation with a percentage cover >60 percent and height exceeding 2 meters. Consists of seasonal needle leaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Forestland
4	Deciduous Broadleaf Forests	Lands dominated by woody vegetation with a percentage cover >60 percent and height exceeding 2 meters. Consists of broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Forestland
5	Mixed Forests	Lands dominated by trees with a percentage cover >60 percent and height exceeding 2 meters. Consists of three communities with interspersed mixtures or mosaics of the other four forest types. None of the forest types exceeds 60% of landscape.	Forestland
6	Closed Shrublands	Lands with woody vegetation less than 2 meters tall and with shrub canopy cover >60 percent. The shrub foliage can be either evergreen or deciduous.	Grasslands
7	Open Shrublands	Lands with woody vegetation less than 2 meters tall and with shrub canopy cover between 10-60 percent. The shrub foliage can be either evergreen or deciduous.	Grasslands
8	Woody Savannahs	Lands with herbaceous and other understory systems and with forest canopy cover between 30-60 percent. The forest cover height exceeds 2 meters.	Forestland
9	Savannahs	Lands with herbaceous and other understory systems and with forest canopy cover between 10-30 percent. The forest cover height exceeds 2 meters.	Grasslands
10	Grasslands	Lands with herbaceous types of cover. Tree and shrub cover is less than 10%.	Grasslands
11	Permanent Wetlands	Lands with a permanent mixture of water and herbaceous or woody vegetation. This is salt, brackish, or fresh water.	Wetlands
12	Croplands	Lands covered with temporary crops followed by harvest and a bare soil period (*e.g.*, single and multiple cropping systems). Note that perennial woody crops will be classified as the appropriate forest or shrub land cover type.	Croplands
13	Built-Up Lands	Land covered by buildings and other man-made structures	Settlements
14	Cropland/	Lands with a mosaic of croplands, forests, Shrublands, and	Croplands

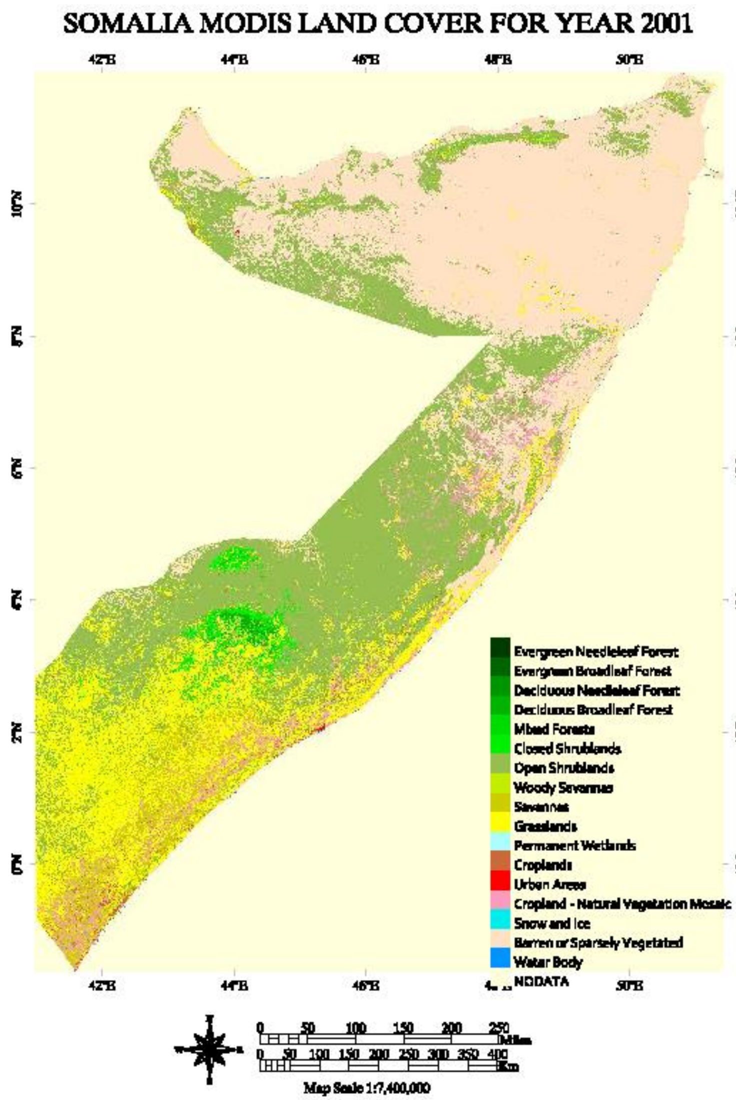
Code No.	MODIS Land Cover Category	Description	IPCC Land Category Aggregate
	Natural Vegetation Mosaics	grasslands in which no one component comprises more than 60 percent of the landscape.	
15	Snow and Ice	Lands under snow/ice cover throughout the year.	Wetlands
16	Barren	Lands with exposed soil, sand, rocks, or snow and never has more than 10 percent vegetated cover during any time of the year	Other lands
17	Water Bodies	Lakes, reservoirs, and rivers. Can be either fresh or salt-water bodies.	Wetlands

It was not possible to get areas for plantation forests, unmanaged grassland and perennial cropland due to inadequate ancillary data available to satisfactorily delineate the classes. The LULUCF section accounts for emissions and removal resulting from Forestland (that displays some human intervention), Cropland, Wetland, Settlements and Other lands.

3.6.4. Combination of soils data and Ecological zones

The Global Ecological Zones and FAO-SWALIM (improved) soil classes as shown in figure 11 were combined using GIS applications to create the IPCC soil classes and climatic zones as required by the GPGs. The soil classes were further combined with land cover land use maps using GIS applications to establish the area of land use categories remaining in the same category for a particular year. The land use changes derived from land use change detection carried out using remote sensing applications were also combined with the soil-climate data. This was done to estimate the land area for land conversions from one land use category to the other.

Figure 4-11; Maps Showing Categories of MODIS Land Cover Type I for the years 2001 to 2013



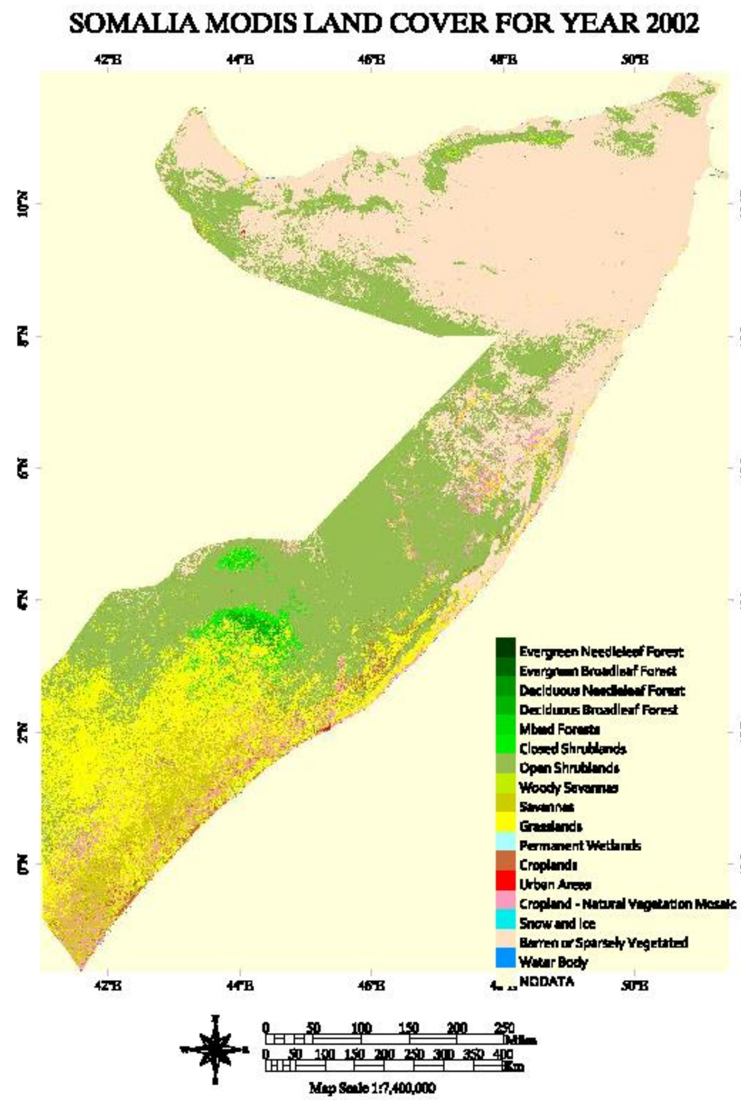
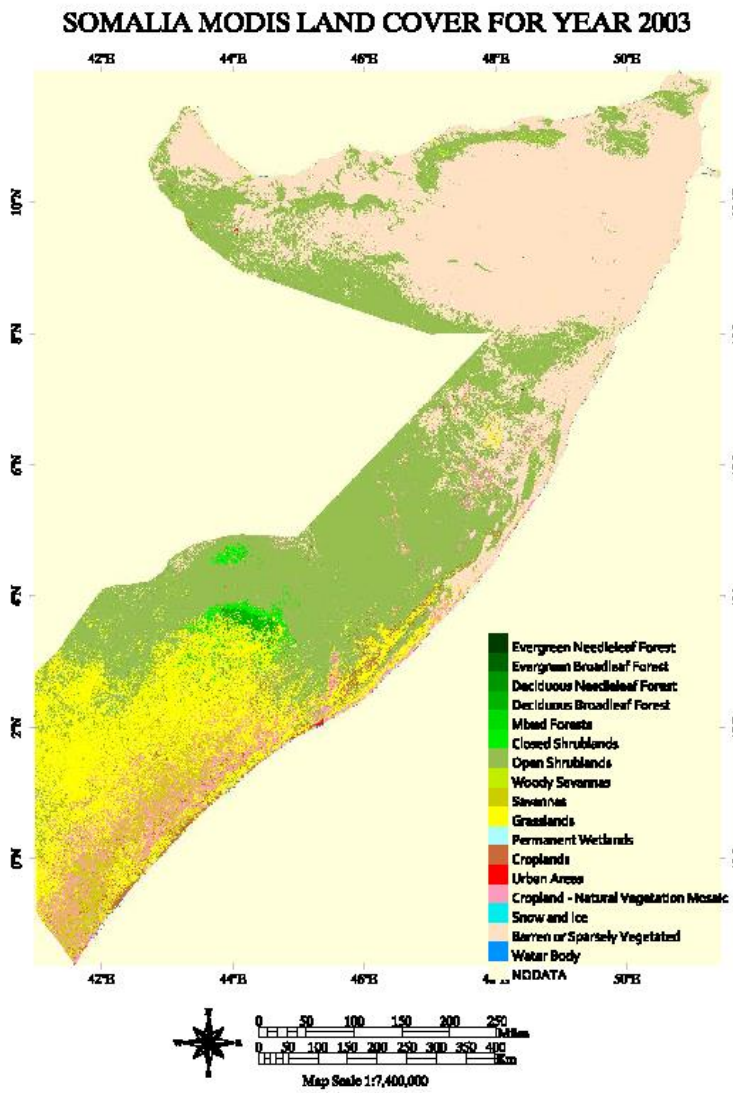


Figure 4-11; Maps Showing Categories of MODIS Land Cover Type I for the years 2001 to 2013



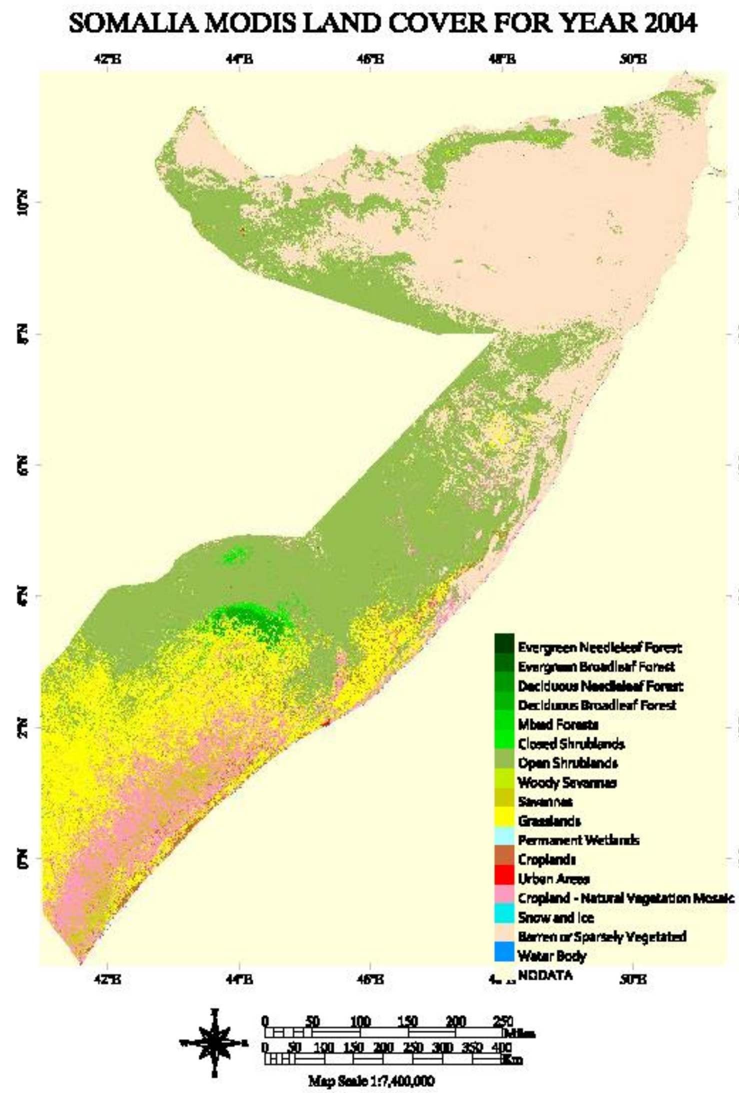
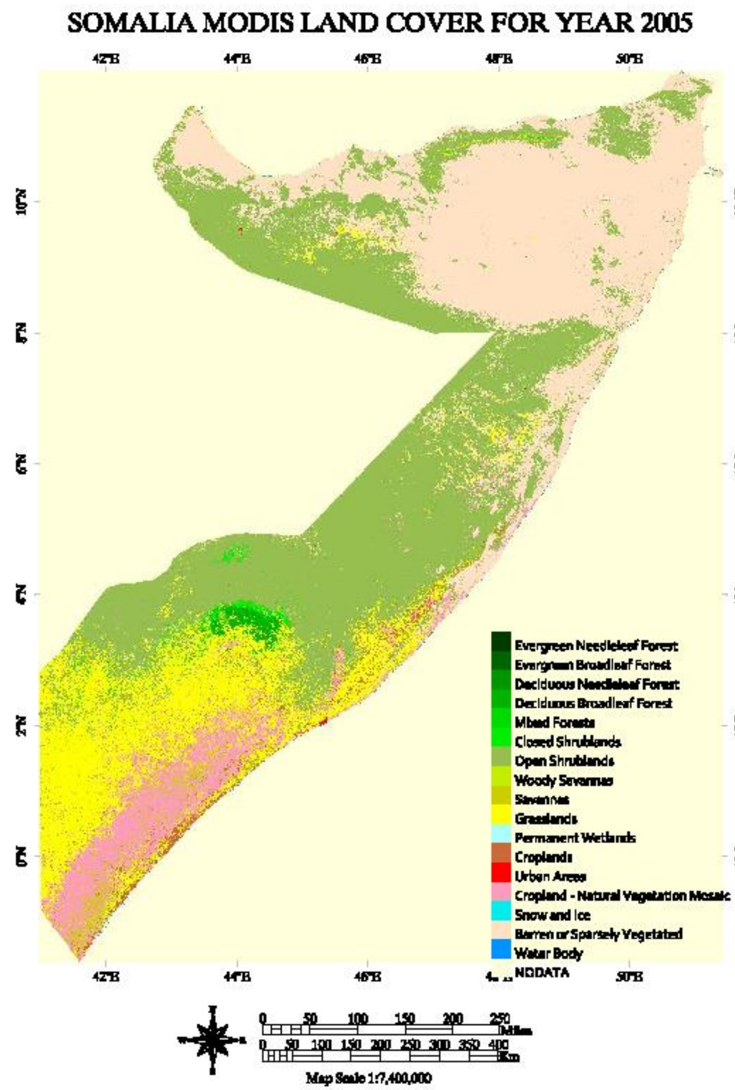


Figure 4-11; Maps Showing Categories of MODIS Land Cover Type I for the years 2001 to 2013



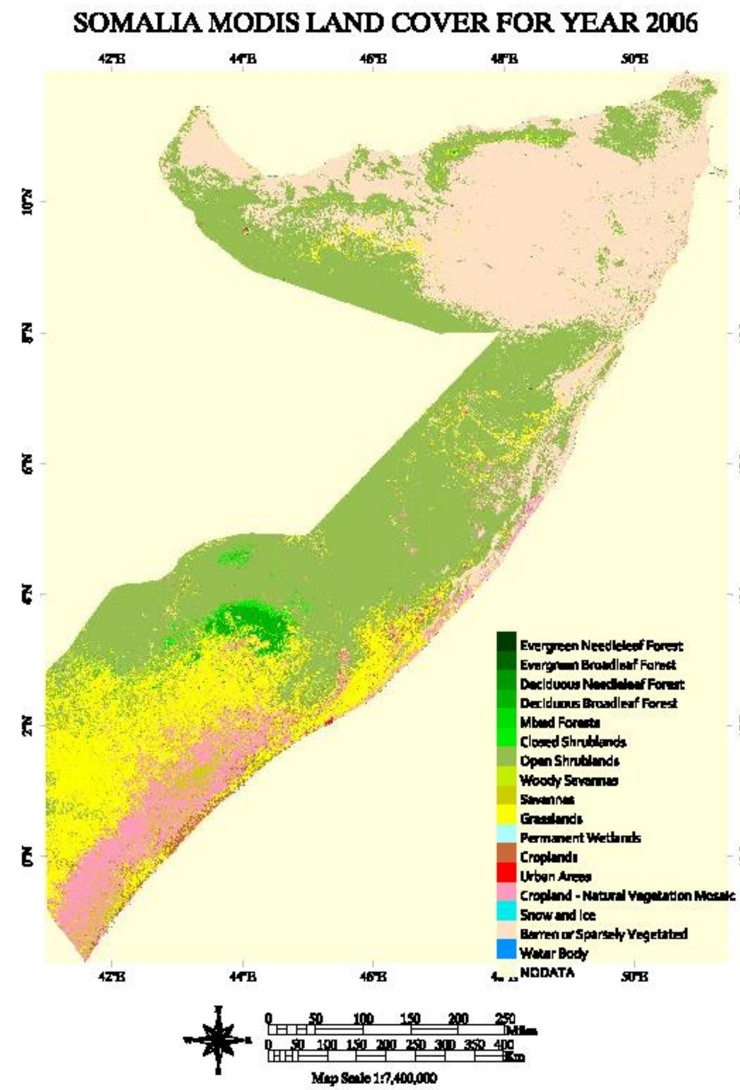
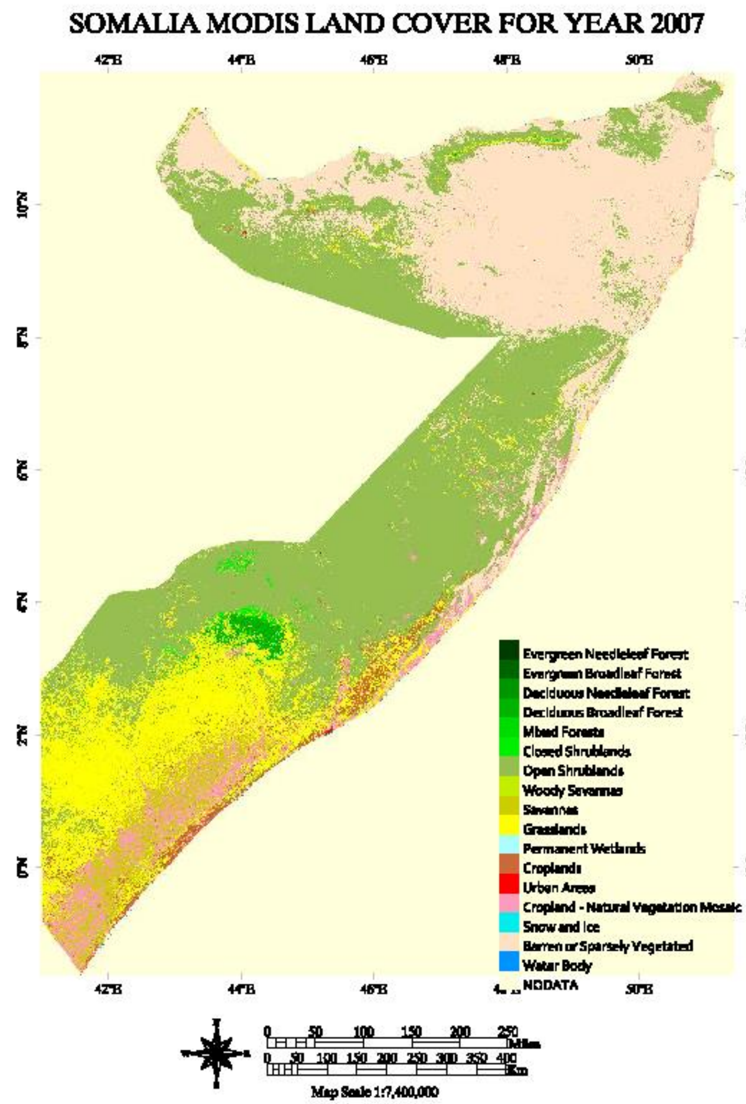


Figure 4-11; Maps Showing Categories of MODIS Land Cover Type I for the years 2001 to 2013



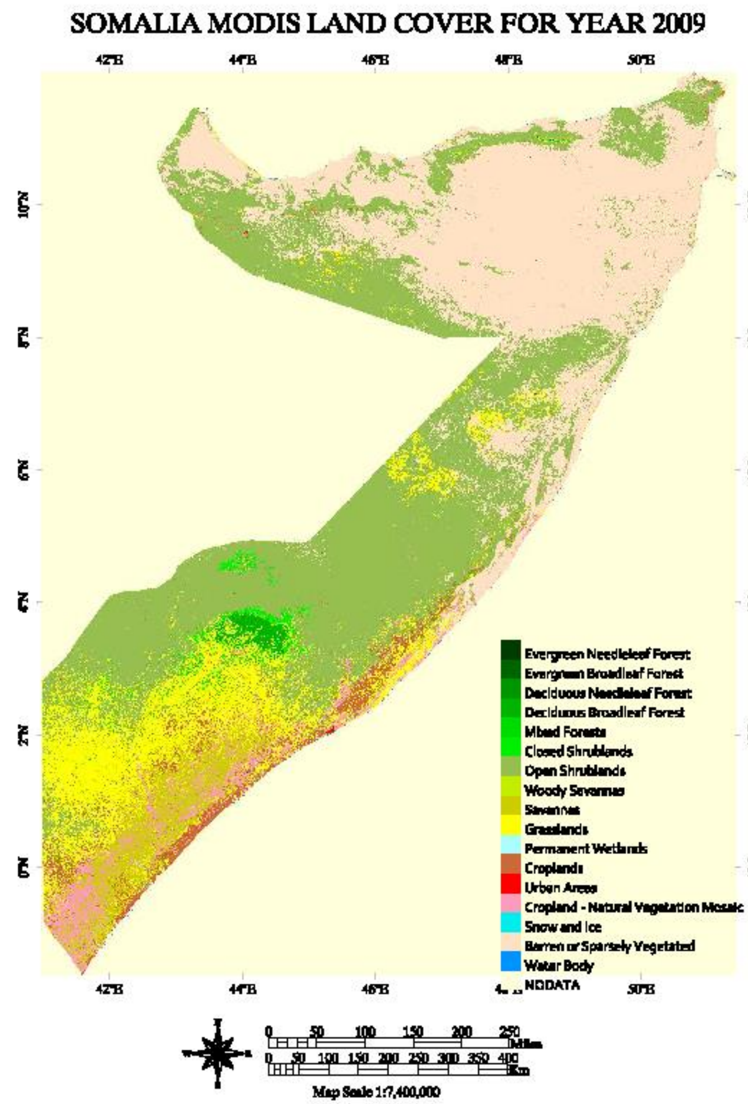
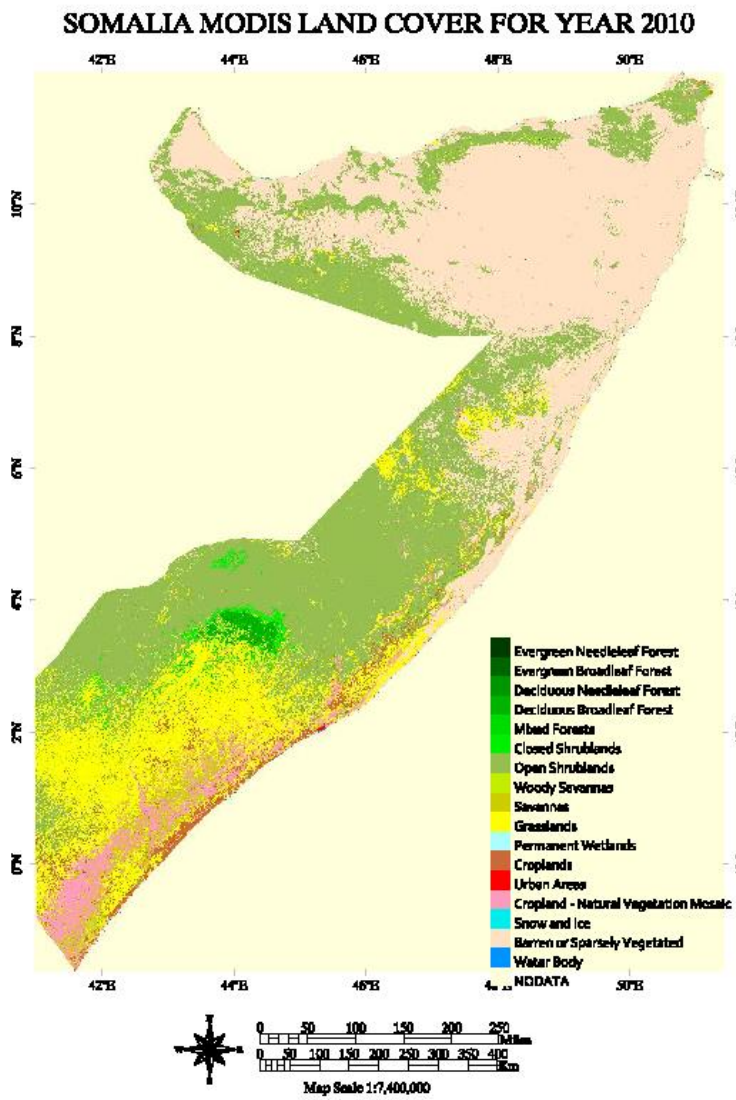


Figure 4-11; Maps Showing Categories of MODIS Land Cover Type I for the years 2001 to 2013



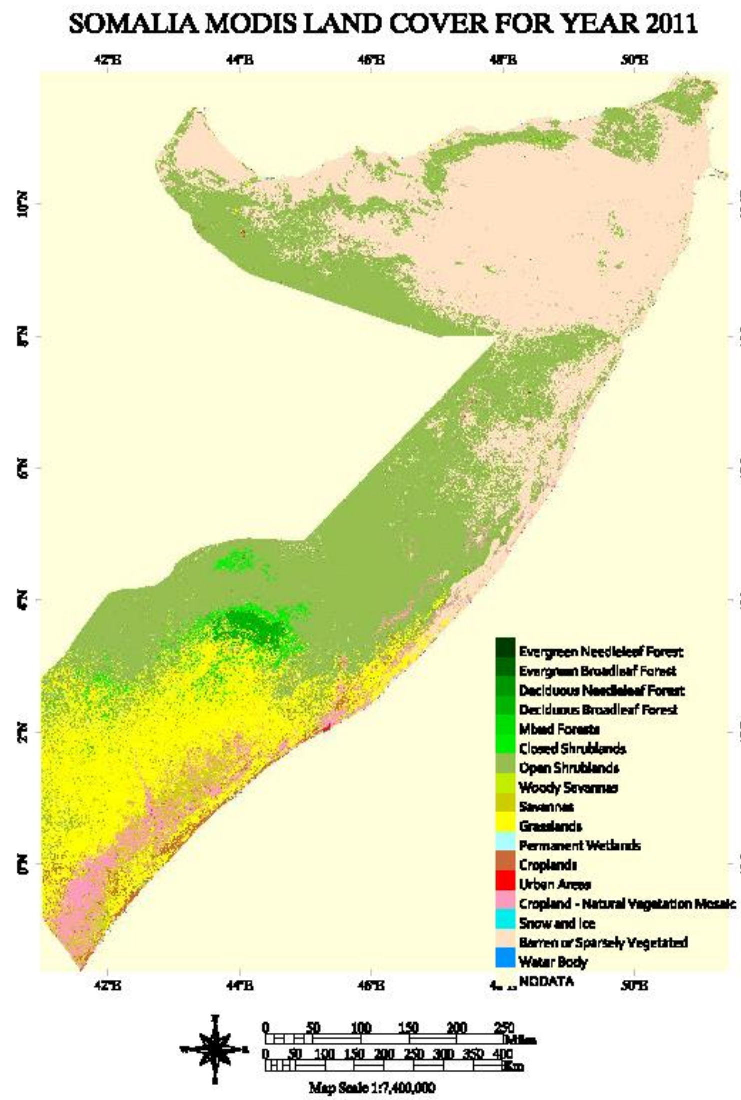
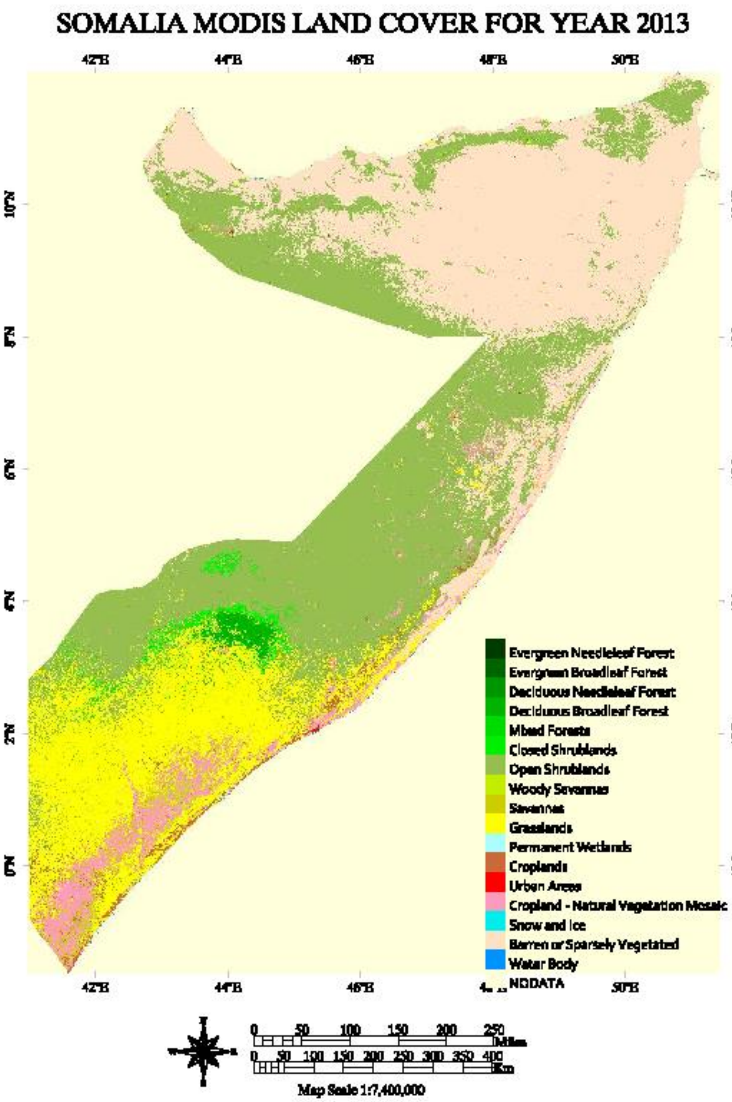


Figure 4-11; Maps Showing Categories of MODIS Land Cover Type I for the years 2001 to 2013



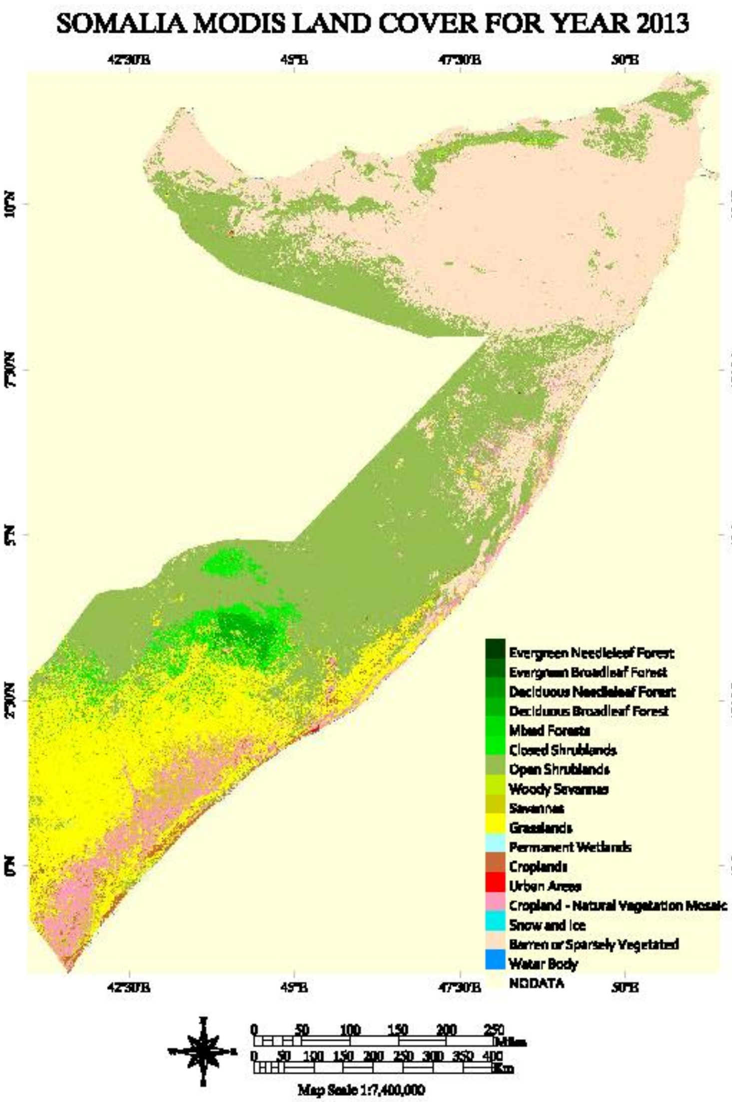


Figure 4-12; Maps Showing the Soils of Somalia Used in the AFOLU SECTOR GHG Inventory Preparation

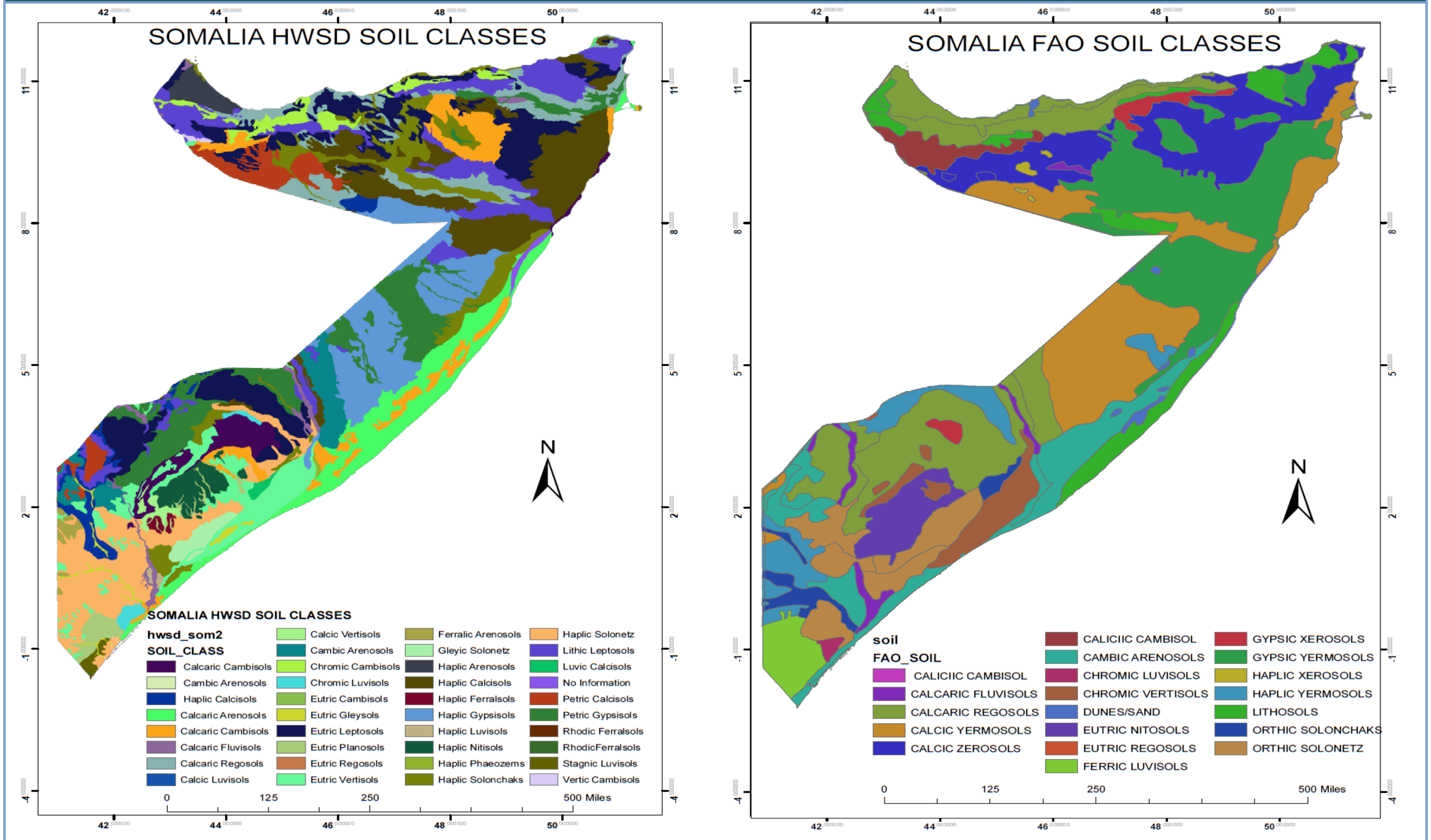
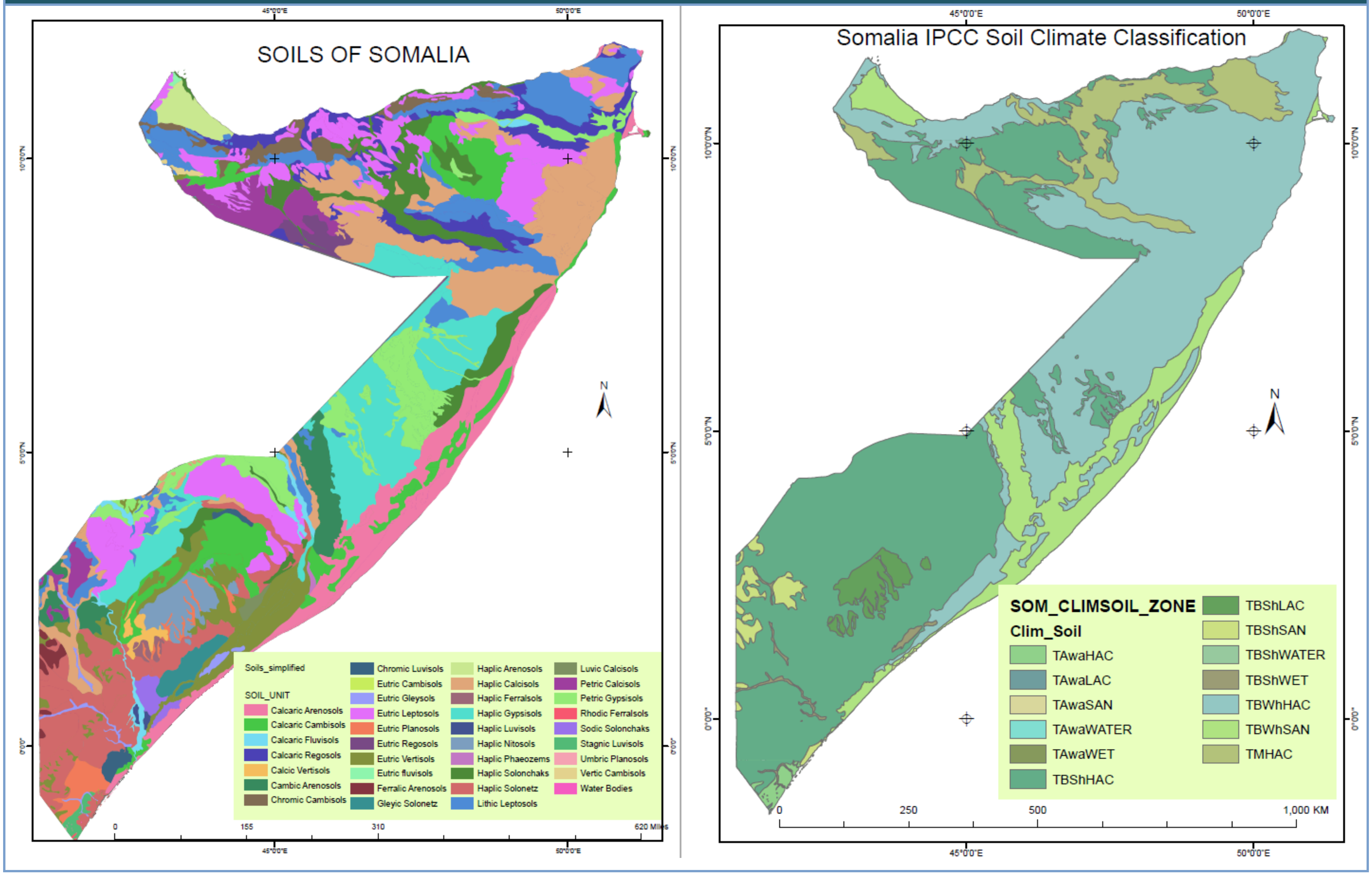


Figure 4-12; Maps Showing the Soils of Somalia Used in the AFOLU SECTOR GHG Inventory Preparation



3.6.5. Aggregated sources and non-CO2 emission sources on land

The emissions from this subcategory are divided into emissions from biomass burning, Liming, Urea Application Direct and indirect N_2O emissions from managed soils and Rice cultivation. Table 15 gives an overview of the activity data used in this section.

Table 4-16 Activity data for Aggregate sources and non CO2 emissions

Type of Activity Data	Activity Data Value(s)	Activity Data Units
Liming	Amount of lime applied	Tons yr-1
Rice cultivation area by type	Area (Ha)	HA
Fertilizer (N) input on managed soils	N in synthetic fertilizers, animal manure, compost, sewage sludge, crop residues, changes in land use / management	Kg N yr-1
Amount of crop residue and managed savannah burnt annually	Area of managed land burnt	ha yr-1

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Table; 4-17 provides a quick reference to relevant tables Vol.4 2006 IPCCC.

Table; 4-17 Emission Factors Aggregate sources and non CO_2 emissions sources

Type of Factor	Emission Factor Value	Emission Factor Units	Reference
Emission factor lime calcic limestone ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$	Calcic limestone default is 0.12 Dolomite default is 0.13	Dimensionless	2006 IPCC
Emission factor for N_2O fertilizer application (direct emission)	kg N2O-N (kgN input)$^{-1}$	Kg	Table 11.1
Emission factor for N_2O managed soils (direct emission)	kg N_2O-N (ha^{-1} yr^{-1})	Kg	Table 11.1
Emission factor for N_2O due to leaching managed soils(Indirect emission)	Fraction of N leached kg N (kg of N additions)$^{-1}$	Kg	Table 11.3
Fraction of synthetic fertilizer N that volatilises (indirect emission)	(kg NH_3-N + NO_x-N) (kg of N applied)$^{-1}$	Kg	Table 11.3
Mass of fuel available for combustion	Varies per land category	Kg dry matter (dm /ha	Table 2.4
Combustion factor	Varies per land category	Dimensionless	Table 2.6
CH_4 emission factor	Varies per land category	g GHG (kg dm burnt)$^{-1}$	Table 2.5
CO emission ratio	Varies per land category	g GHG (kg dm burnt)$^{-1}$	Table 2.5
N_2O emission ratio	Varies per land category	g GHG (kg dm burnt)$^{-1}$	Table 2.5
NO_x ratio	Varies per land category	g GHG (kg dm burnt)$^{-1}$	Table 2.5

3.6.5.1. Direct N2O and Indirect N2O Emissions from Managed Soils

Managed soils are all soils on land, including Forest Land, which is managed. There are two pathways that were considered for estimating emissions of N_2O from anthropogenic N inputs or N mineralization;

(i) a direct pathway (i.e., directly from the soils to which the N is added/released), and

(ii) through two indirect pathways:

a) following volatilization of NH_3 and NO_x from managed soils and from fossil fuel combustion and biomass burning, and the subsequent redisposition of these gases and their products NH_4+ and NO_3- to soils and waters; and

b) After leaching and runoff of N, mainly as NO_3-, from managed soils.

Direct emissions of N_2O from managed soils were estimated separately from indirect emissions N_2O emissions from Managed Soils applying Tier 1 methodology, but a common set of activity data was used, which include;

(i) Total synthetic N fertilizer (in kg N/yr) used in the country..

(ii) Amount of manure nitrogen used as fertilizer corrected for NH_3 and NO_x emissions, and excluding manure produced during grazing (4-5A Supplement).

(iii) Default for N_2O emission from the N inputs These steps are summarized in equation 11.1 (vole 4. 2006 PCC)

The N_2O emissions from atmospheric deposition of N volatilised from managed soil were estimated using equation 11.9 (Vol4. 2006 IPCC) represented here:

3.6.6. Emission trends by gas

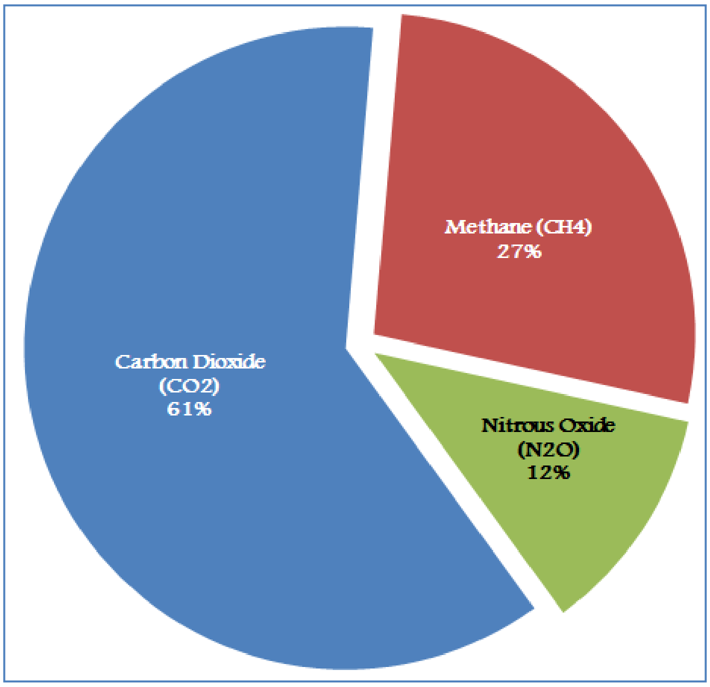

Figure 4-13; Proportion of AFOLU Emissions by Gas in year 2015

In the AFOLU sector emissions profile shows that Carbon dioxide (CO_2) is the major contributor of the total sector emission at 61% while the Methane (CH4) and Nitrous Oxide (N2O) are contributing 27% and 12% to the Somalia's GHG emissions for the AFOLU sectors, in 2015. The majority of the CO_2 emissions result from the LULUCF activities mainly conversions of Forestland to other land uses especially grassland and cropland. The Methane is resulting from the Livestock; both enteric fermentation and manure management. Nitrous oxide (N2O) emissions arise from activities such as manure management, use of synthetic and manure/fertilizers applications on land. The figure 14 below shows the trend of emissions by gas from the AFOLU sector. It is shown that carbon dioxide mainly resulting from land use changes and conversions is steadily increasing. This can generally attributed to the harvesting of wood fuel and charcoaling to meet ever increasing demands for biomass energy both locally and overseas. The methane and nitrous oxide resulting mainly from livestock management activities has remained steady due to livestock controls through the continuous export market to UAE available for Somalia

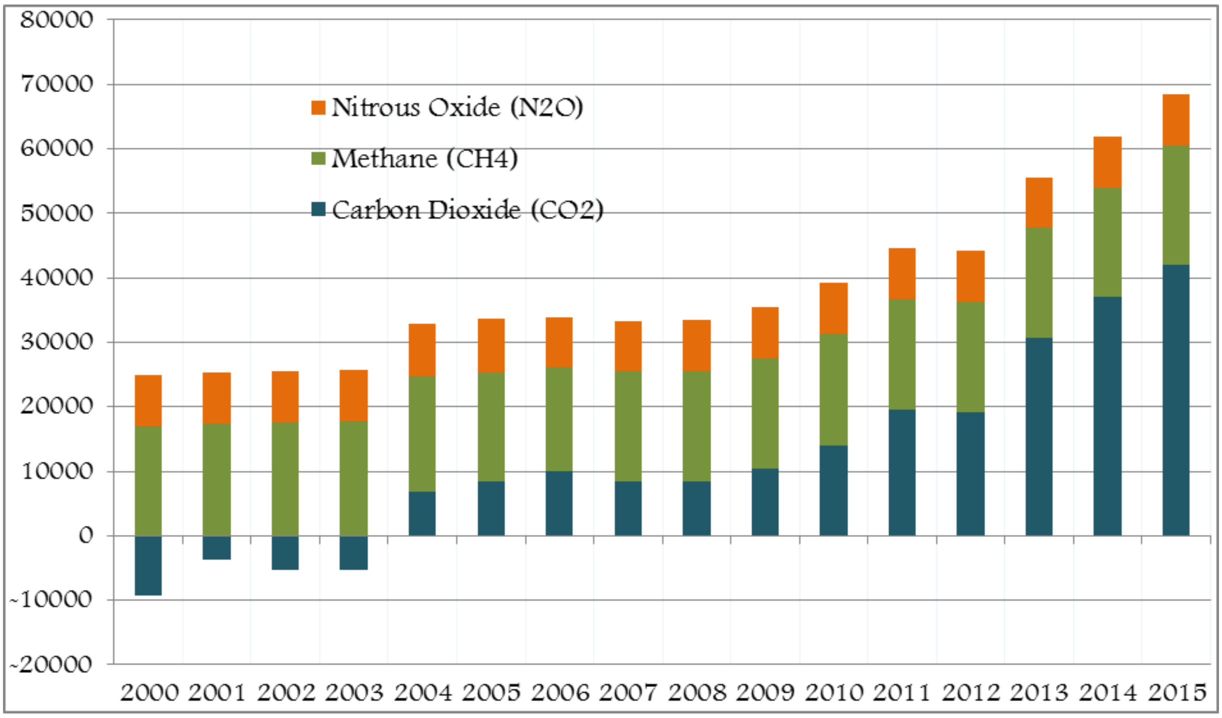

Figure 4-14: The trends of emissions (in Gg) by gas

3.6.6.1. Carbon dioxide

Most of the estimated emissions of CO_2 are resulting from the Forestland, Grasslands and Otherlands accounting for 47%, 27% and 23% of the total CO2 emissions in the AFOLU Sector respectively as shown in Figure15. The forestlands and grassland emission result from charcoaling and overgrazing

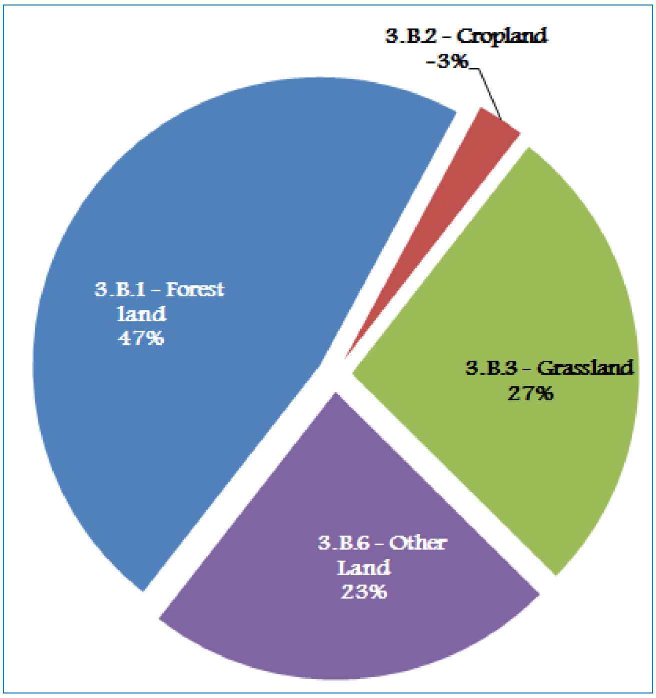

Figure 4-15; Proportion of Carbon Dioxide Emission (in Gg) from the AFOLU Sector

Figure 16 below shows that grassland that have been having a net carbon stock up to year 2009 has since become an emerging source of CO_2 emissions in the AFOLU sector alongside the croplands.

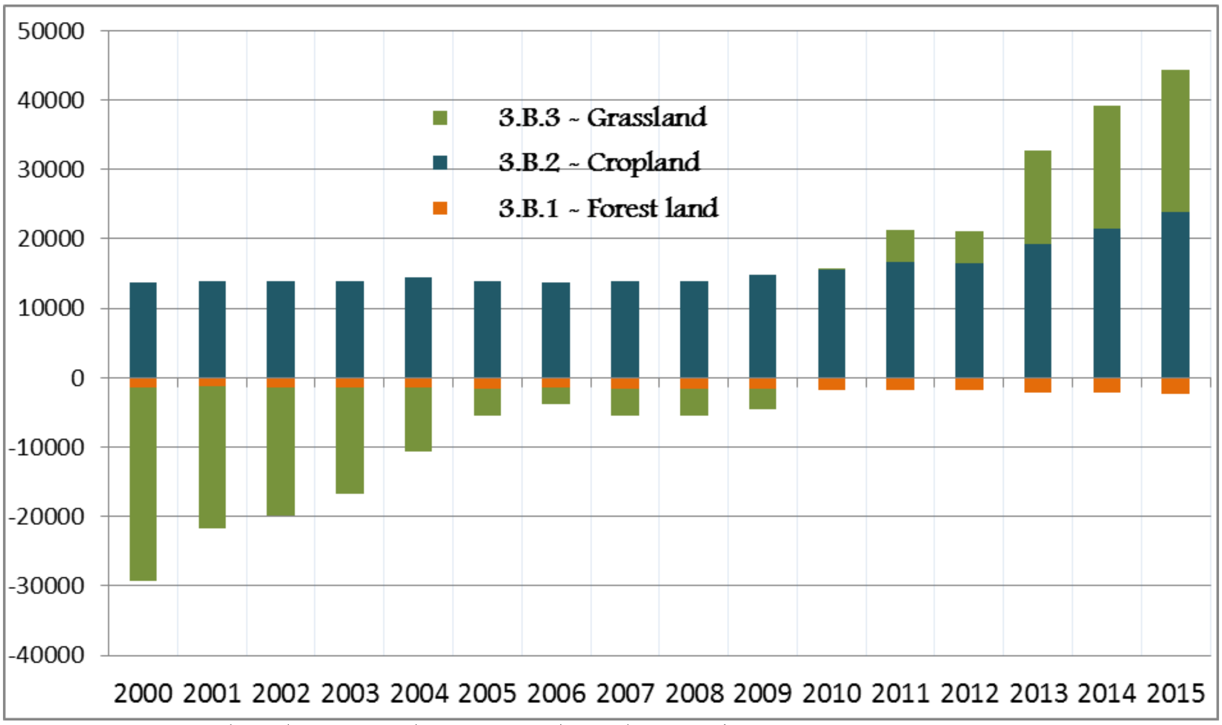

Figure 4-16; Trend Carbon Dioxide Emission (in Gg) from the AFOLU Sector

3.6.6.2. Methane

Most of the estimated Methane emissions are resulting from Enteric Fermentation at 96% while only 4% is resulting from manure management as shown in figure 18. These emissions are purely dependent on the livestock populations and due to limited availability and inadequate disaggregation of data into animal age, type of feed and country specific emission factors; Tier 1 approach was used to estimate methane emissions. Figure 17 below shows steady annual rates of methane and nitrous oxide emission as a result of constant destock of livestock into the export market.

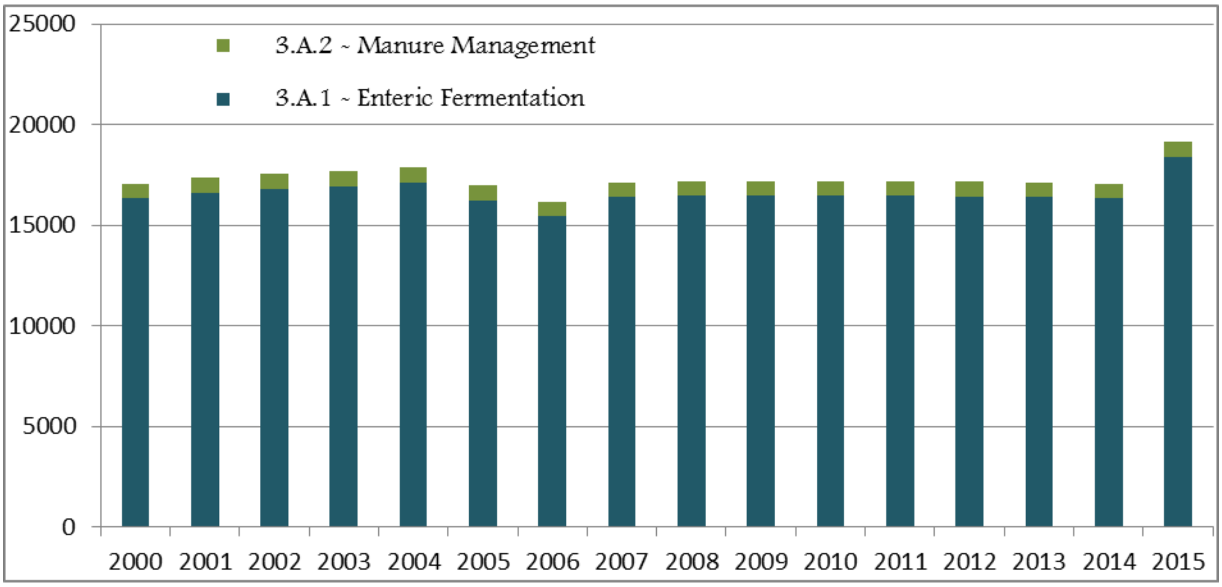

Figure 4-17 The trend Methane emissions(in Gg) by source category

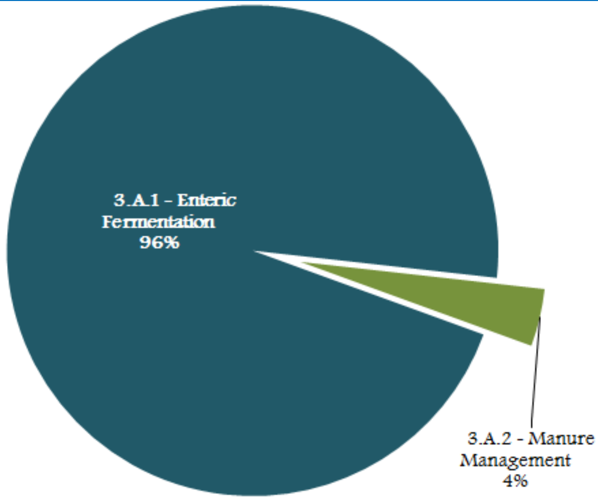

Figure 4-18 Proportion of Methane (in Gg) from AFOLU sector

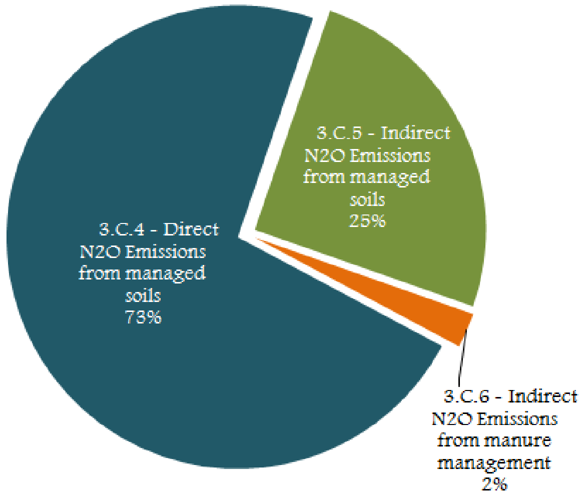

Figure 4-19 Nitrous Oxide Emissions (in Gg) from the Energy Sector

3.6.6.3. Nitrous oxide

As shown in figure 19 most of the estimated Nitrous Oxide emissions are resulting from the direct N2O emissions from managed soils at 73%, indirect N2O emissions from managed soils at 25%, and indirect N2O emissions from managed manure management at 2% of the AFOLU sector nitrous oxide emissions. Figure 20 below shows the

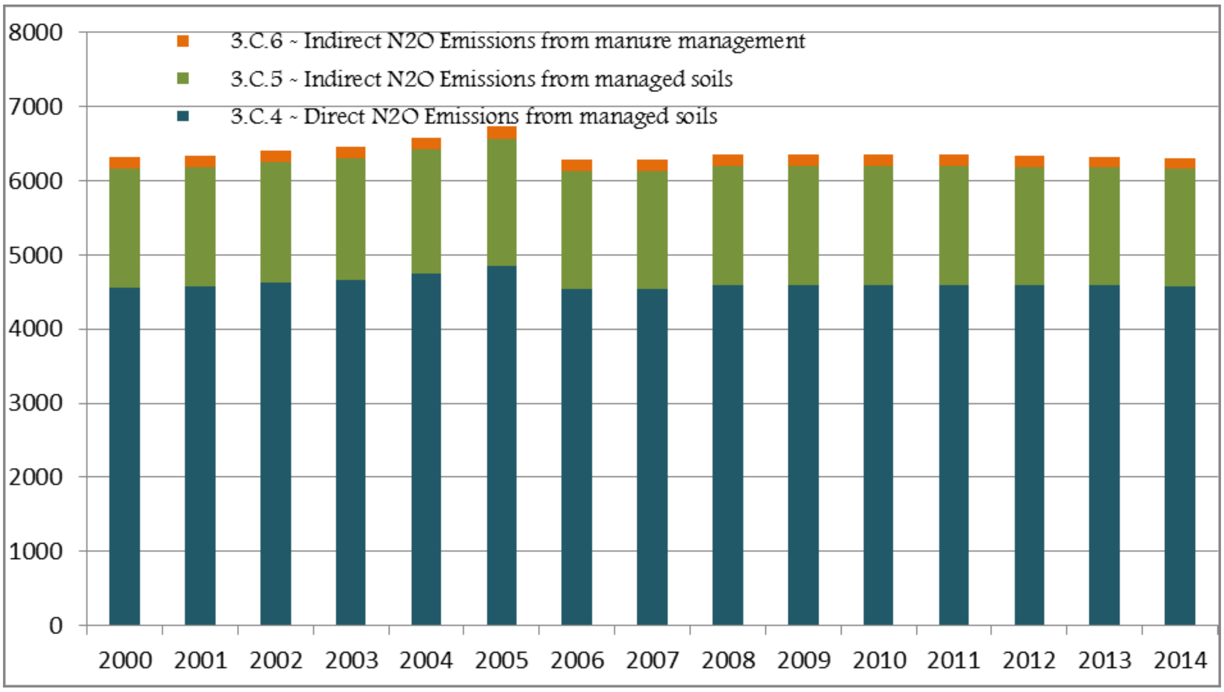

Figure 4-20: The trend Nitrous oxide emissions (in Gg) by source category

3.6.7. The trends of emissions by Source Category

The figure 22 below shows the trends of emissions by source categories in the AFOLU Sector. It is indicated that there is rapid growth in emissions from grassland while the emissions from enteric fermentation remain averagely constant. The growth of emissions is much slower with the livestock section as seen in the trend of enteric fermentation. The figures 21 and 22 below, shows emissions by category in the AFOLU Sector. It is indicated that 43% and 39% of the AFOLU Sector emission results from grassland and enteric fermentation respectively; while enteric fermentation and forestland contribute only 12 and 8% respectively. Direct N_2O emissions from managed soils and indirect N2O emissions from managed soils accounts for 10% and 3% respectively while, forestland carbon stock/removal account for 5% of the total AFOLU sector emissions/removals

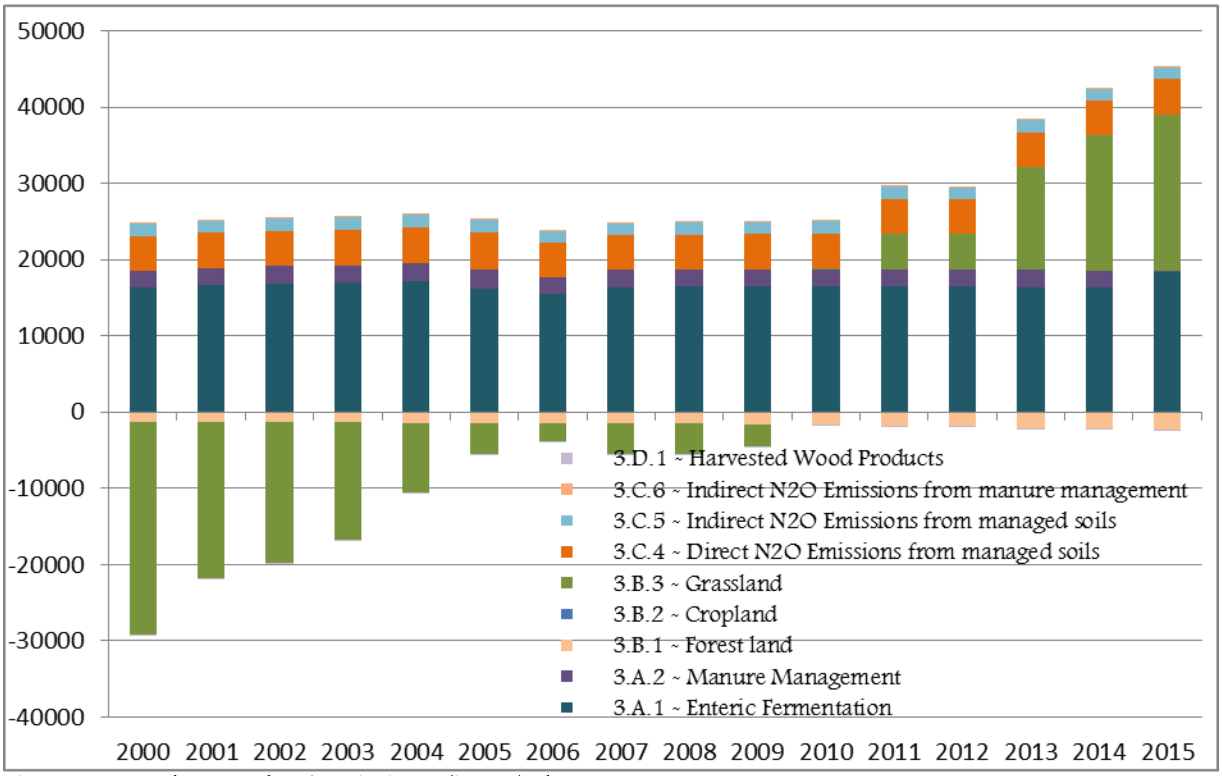

Figure 4-21; the trends of emissions (in Gg) by Source Category

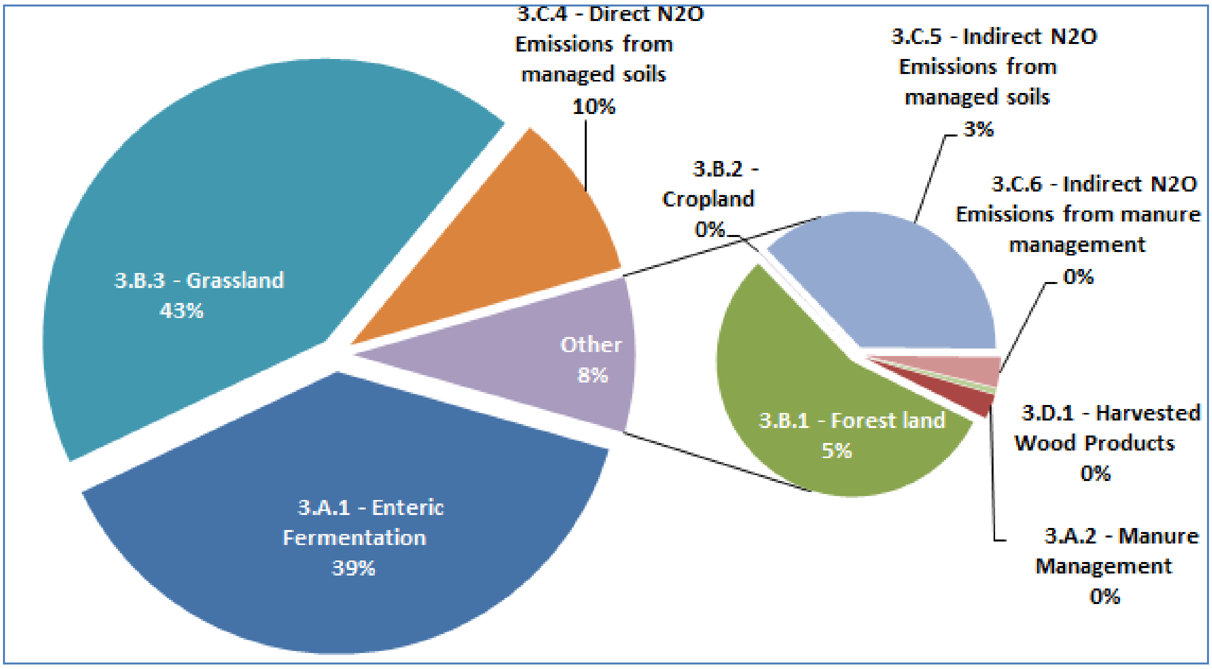

Figure 4-22; Proportion of Emissions (in Gg) by Source Category

Table 4-18 and 4-19 below shows the estimated annual AFOLU emissions (in Gg)

Table 4-18 AFOLU Sector Emissions (in Gg)

	3 - Agriculture, Forestry, and Other Land Use	3.A - Livestock	3.A.1 - Enteric Fermentation	3.A.2 - Manure Management	3.B - Land	3.B.1 - Forest land	3.B.2 - Cropland	3.B.3 - Grassland	3.B.6 - Other Land
2000	15638.86	18575.95	16343.92	2232.02	-9260.84	-1319.36	1.37	-27877.73	-15862.13
2001	21530.82	18903.50	16628.56	2274.94	-3717.44	-1303.04	1.38	-20490.75	-17829.30
2002	20165.01	19120.72	16820.95	2299.77	-5370.04	-1374.01	1.38	-18409.89	-17624.31
2003	20345.95	19250.17	16932.29	2317.88	-5370.04	-1374.01	1.40	-15409.89	2657.99
2004	32819.68	19468.37	17113.06	2355.32	6768.00	-1389.51	1.44	-9214.81	-20321.21
2005	33760.73	18651.29	16251.00	2400.28	8382.28	-1536.74	1.38	-3897.62	5197.59
2006	33868.53	17679.97	15432.74	2247.23	9905.89	-1478.94	1.37	-2322.20	-23940.47
2007	33327.82	18662.87	16415.29	2247.58	8382.28	-1536.74	1.39	-3897.62	-26144.31
2008	33445.42	18712.54	16454.32	2258.22	8382.28	-1536.74	1.38	-3897.62	-26144.31
2009	35393.51	18723.84	16466.11	2257.73	10313.19	-1681.93	1.48	-2795.75	-31222.00
2010	39140.80	18723.27	16467.88	2255.38	14060.25	-1696.91	1.56	128.35	-34108.07
2011	44515.85	18710.82	16459.65	2251.17	19452.03	-1863.42	1.67	4625.23	-37230.04
2012	44228.40	18686.50	16441.40	2245.10	19198.27	-1863.44	1.64	4625.23	-37230.04
2013	55614.31	18661.85	16412.98	2248.87	30623.29	-2129.07	1.93	13463.01	-44181.65
2014	61865.75	18602.19	16374.82	2227.37	36953.93	-2215.73	2.15	17685.63	-48011.29

Table 4-19; AFOLU Sector Emissions (in Gg) (Cont'd)

Year	3.C - Aggregate sources and non-CO2 emissions sources on land	3.C.4 - Direct N2O Emissions from managed soils	3.C.5 - Indirect N2O Emissions from managed soils	3.C.6 - Indirect N2O Emissions from manure management	3.D - Other	3.D.1 - Harvested Wood Products
2000	6323.76	4559.73	1612.29	151.74	-25.99	-25.99
2001	6344.76	4577.46	1612.41	154.89	-21.84	-21.84
2002	6414.33	4627.91	1629.86	156.57	-21.80	-21.80
2003	6465.82	4664.51	1643.44	157.87	-18.57	-18.57
2004	6583.32	4747.06	1675.35	160.90	-20.73	-20.73
2005	6727.16	4849.94	1712.74	164.48	-21.56	-21.56
2006	6282.67	4539.49	1590.31	152.87	-23.53	-23.53
2007	6282.67	4539.49	1590.31	152.87	-21.77	-21.77
2008	6350.60	4588.37	1607.70	154.53	-46.38	-46.38
2009	6356.48	4594.73	1607.23	154.52	-37.49	-37.49
2010	6357.28	4597.62	1605.29	154.37	-30.18	-30.18
2011	6353.00	4597.05	1601.87	154.08	-31.21	-31.21
2012	6343.63	4593.00	1596.98	153.64	-31.04	-31.04
2013	6329.17	4585.48	1590.62	153.08	-39.77	-39.77
2014	6309.63	4574.49	1582.77	152.37	-40.11	-40.11

Figure 4-23 shows the BUA projected emissions form the AFOLU sector, indicating that the Grassland source category will continue to be the major source of emissions. This shows that mitigation measure should focus on the grassland areas

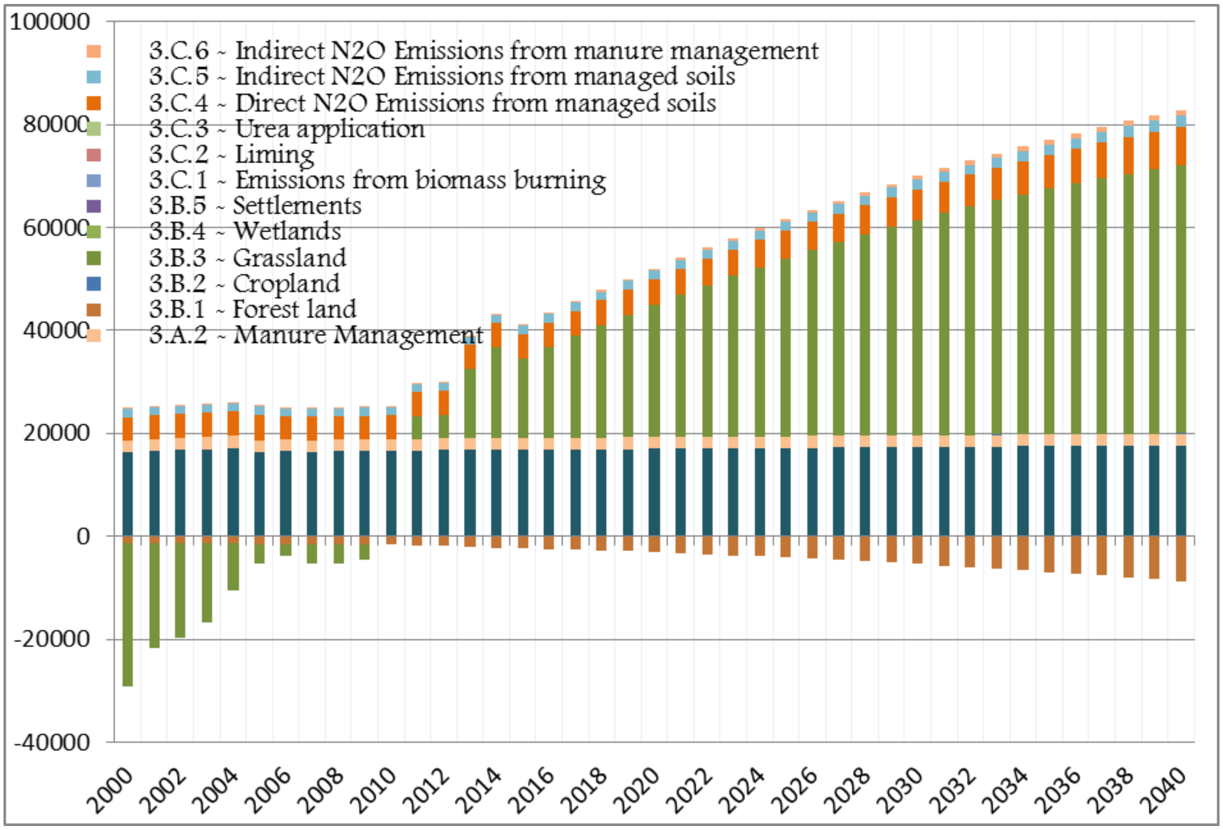

Figure 4-23; Projected Emissions (in Gg) from Aggregate Sources and Non-CO2 emissions Sources on Land in the AFOLU Sector

Table 4-20 projected Emissions (in Gg) from the AFOLU Sector

	2016	2020	2025	2035	2040
3 - Agriculture, Forestry, and Other Land Use	65764.81	85291.46	147743.94	186275.10	229676.22
3.A - Livestock	19098.64	19234.84	19406.39	19754.19	19930.55
3.A.1 - Enteric Fermentation	16837.86	16973.11	17143.69	17490.02	17665.79
3.A.2 - Manure Management	2260.77	2261.73	2262.70	2264.17	2264.76
3.B - Land	144409.76	228093.04	360810.44	524764.84	946384.64
3.B.1 - Forest land	-2459.34	-3118.65	-4156.45	-6944.22	-8694.18
3.B.2 - Cropland	2.36	3.16	4.49	8.23	10.63
3.B.3 - Grassland	17660.81	25748.66	34539.92	47727.30	52123.42
3.C - Aggregate sources and non-CO2 emissions sources on land	6192.87	5989.96	5649.72	4680.56	4051.64
3.C.4 - Direct N2O Emissions from managed soils	4760.08	4986.56	5394.73	6627.97	7453.05
3.C.5 - Indirect N2O Emissions from managed soils	1610.70	1654.17	1741.53	2026.33	2223.76
3.C.6 - Indirect N2O Emissions	317.95	403.93	537.08	888.91	1107.60

from manure management					

3.7. GHG Inventory for the Waste Sector

3.7.1. Overview of the Waste Sector

The methods, activity data, emission factors and coefficients that were used to develop the national inventory for the waste sector are described in this section. The methods and default values are primarily drawn from the Revised 1996 IPCC Guidelines with additional alternative methods or emission factors from IPCC good practice guidance or 2006 guidance to improve the GHG estimates. Complete data sets mainly population for the period between 1994 and 2015 are provided in this document. The activity dataset can be used to adjust the baseline to develop emission trends for all the years between 1994 and 2015 and Business As Usual projection to 2040. In some cases adjustments in emission factors or coefficients for this time period are also identified. The primary areas where future work can be done to complete and reduce uncertainties, address data gaps and improve the overall quality of the inventory are related to estimating both domestic and industrial solid waste and wastewater generation. Collection of this information through national surveys that determine amounts generated but also the type of disposal or treatment could significantly improve the quality of the inventory.

The GHG emissions from the waste sector result from the anthropogenic activates which include treatment and disposal of wastes. This section covers descriptions on the sources of methane, carbon dioxide and nitrous oxide emissions resulting from the decay and treatment processes of organic matter under anaerobic and or aerobic management conditions at solid waste disposal sites open burning of solid waste. The nitrous oxide emissions result from the decomposition of human waste, and anaerobic treatment and discharge of domestic wastewater in liquid and solid phases (sludge). The emissions of methane results from solid waste disposal decomposition of human waste, and anaerobic treatment and discharge of domestic and industrial wastewater in liquid and solid phases (sludge).

The carbon dioxide emissions from treated and or disposed biomass are reported in the memo items. In addition the biogenic CO_2 emissions reported elsewhere are not included in the waste sector inventory emissions for instance the annual crops. This is because the absorption of CO_2 by the harvested vegetation is not estimated and thus the inclusion of these emissions in the Waste Sector would result in an imbalance. Also, CO_2 emissions from wood and wood products are reported in the Land Use, Land-use Change and Forestry (LULUCF) Sector. In contrast, CH4 emissions from anaerobic decomposition of wastes are included in inventory totals as part of the Waste Sector emissions.

The generation of waste poses great environmental and health risks and releases greenhouse gases in the atmosphere. There is a significant CH_4 and N_2O emission from waste as a result of anaerobic decomposition of the organic matter in wastes, and N_2O which is emitted as a byproduct of the chemical processes in the human waste. The GHG inventory of the Waste Sector has four subsectors:

1. Methane (CH_4) from Solid Waste Disposal (4A); the main sources include managed[78] (4A1), unmanaged (4A2) and uncategorized (4A3) disposal sites
2. Methane (CH_4) and Nitrous Oxide (N_2O) from biological Treatment of Solid Waste (4B)[79]
3. Carbon Dioxide CO_2,Methane (CH_4) and Nitrous Oxide (N2O) from the Incineration[80] and Open Burning of Waste (4C)
4. Methane (CH_4) Wastewater Treatment and Discharge (4D); the main sources include; Industrial Wastewater Treatment and discharge (4D2)[81], and) from Domestic Wastewater Treatment and discharge (4D1)

3.7.2. Classification of Waste Activities under IPCC 2006 Guidelines

Based on IPCC 2006 guideline, the following source categories were covered in the waste sector: Solid Waste Disposal (4A), Open burning (4C) and Wastewater Treatment and Discharge (4D). Each major source category was divided into sub-categories that enabled allowed the inventory to take into account different waste attributes and waste management characteristics and approaches.

3.7.3. Solid Waste Disposal (4A)

Solid waste generation was closely linked to population as surrogate data, urbanization and the standard of living. CH4 and non-fossil CO2 were the main gases associated with solid waste disposal through biological decomposition. Based on the type of management at the disposal site, the solid waste disposal activities were further divided into sub-categories unmanaged waste disposal sites (4.A2) and uncategorized waste disposal sites (4.A3). The main data input were population, waste generation per capita, solid waste streams, annual total waste generation, and fractions of waste disposed-off by different means. Methane emissions from solid waste deposited in different site (dumpsites) were estimated for in the inventory.

3.7.4. Incineration and Open Burning of Solid Waste (4C)

Disposal of solid waste through incineration (4C.1) and open burning (4.C2).were considered to produce CO2, CH4 and N2O emissions. However, emissions estimations were carried out for open burning of municipal solid waste. Due to inadequate collection and documentation waste incineration activity data, the respective estimations were not carried out.

[78] -not occurring in Somalia
[79] -not occurring in Somalia
[80] -not estimated due to inadequate activity data in Somalia
[81] -not estimated due to insignificancy of the industry sector in Somalia

3.7.5. Wastewater Treatment and Discharge (4D)

Methane and Nitrous Oxide were considered the main gases from wastewater treatment and discharge was divided into domestic wastewater treatment and discharge (4D.1). Emissions from 4.D1 are as a result of the different means of disposal and treatment of sewage.

3.7.6. Solid Wastes Generation

3.7.6.1. Source category description

The solid waste is generated from households, commercial areas, municipalities, and industries. The solid waste generation and treatment information is scanty and or not available in Somalia. This is mainly due to low awareness and inadequate systems for data collection and archiving. The generation of waste was associated with population and socio economic development. The production of solid waste was estimated using the methodology provided in the IPCC 2006 guidelines where it is considered proportional with the growth of a population and was extrapolated for every year.

Waste management has changed much over the last decade in the aspect of waste minimization and recycling/reuse, policies to reduce the amount of waste generated, alternative waste management practices and landfill gas recovery. In Somalia there are no sanitary Landfills, but the existing designated dumpsites are operated by the regional governments.

3.7.6.2. Estimation of Emissions from Solid Waste Disposal Sites (SWDS)

The first order decay (FOD) method was applied to estimate CH4 emissions from SWDS with the assumption that degradable organic component (DOC) decays slowly throughout a few decades (IPCC, 2006). It was also assumed that the prevailing conditions remain largely constant resulting into production of methane proportional to the amount of carbon remaining in the waste. Thus, more methane is released during the first few years after deposition because more degradable organic carbon is available for bacterial decay.

The IPCC 2006 Inventory Software was used to calculate methane emissions from solid waste disposal sites. This software employs the First Order Decay Method (FOD) as opposed to a Mass Balance Approach to calculate CH_4 emissions. Projected historical population data from year 1994 was applied. The following parameters were used in the calculation:

i) population,

ii) waste per capita generation rate(kg/cap/year), mostly default values were used

iii) percentage of waste that goes to different disposal sites, mostly default values were used

iv) percent composition of wastes that goes to the disposal sites, mostly default values were used

v) Gross Domestic Product (GDP),

vi) percent of solid waste that goes to solid waste disposal sites, and

It was assumed that there is no methane recovery as at 2015. These data was acquired from the various government agencies involved in waste management and statistical data collection, management and reporting.

3.7.6.3. Input MSW Waste Activity Data

The activity data required carry out estimation of emissions include population (in millions) from 1994 -2015. The population data was used as a proxy in the following equation

$At = A0e^{kt}$

Where:

A_t is the population at time t,

A_0 is the known population,

k is the growth rate, and t is the time in years.

The other activity data used include

i. Waste generation per capita (kg/cap/year) or kg/cap/day, multiplied by 365 to obtain the annual waste per capita generation.
ii. Fraction of MSW (by weight) that is disposed solid waste disposal sites.
iii. Initial assumption, that the garbage collection efficiency is equated to the fraction of MSW that is disposed to SWDS.
iv. The composition of wastes that goes to SWDS according to the following categories: Food, Garden, Paper, Wood, Textile, Nappies, and Plastics and other inert. The waste composition should be expressed in % by weight.

3.7.7. Estimation of Emissions from Domestic Wastewater Treatment and Discharge

The treatment of Domestic Wastewater Treatment and Discharge generates significant amount of CH_4 from the breakdown of the dissolved organic matter. The main factor that is used to determine the CH4 generation potential of the system is the Biochemical Oxygen Demand (BOD) which indicates the level of aerobically biodegradable carbon in the wastewater.

The following data were used to estimate CH_4 emissions from the handling of Domestic Wastewater Treatment and Discharge:

i) urban population,
ii) Degradable Organic Component (DOC) in kg BOD/1000 persons/year,
iii) fraction of DOC removed as sludge,
iv) Fraction of wastewater treated by handling systems,
v) Fraction of sludge treated by handling systems, and
vi) CH4 recovered (nil)

3.7.7.1. Data Collection

Waste management activity data collection is still inadequate. There is no systematic activity data collection for this sector in the country. Wastes are generated from the day to day human activities as human population grow the quantities of the different categories of waste generated also increase proportionately. The wastes generation is more pronounced in urban centres where there is concentration of human population and human activities. Africa's per capita solid waste generation is estimated at around 290kg/cap/year (Vol 5IPCC 2006).

3.7.8. Methodological issues and data sources

The methodological choices and assumptions applied on the activity data, emission factors used in the Waste sector are adopted from 2006 IPCC guidelines and GPG. These documents provided guidance on data collection, methodological choices and the use of relevant assumptions in consistently and transparently.

3.7.9. Trends for Aggregated GHG emissions

The volumes and complexity of waste that Somalia is experiencing are constantly increasing due to economic growth and urbanization. The proliferation of waste poses serious risks to ecosystems and human health. Approximately 0.56 kg/person/day of waste is generated comprising mainly of vegetable/ organic matter (83.6%) and waste paper (7.9%). Other waste materials include plastic waste (3.2%), waste metals (0.3%) and glass/ cullet materials (0.1%) and other miscellaneous materials (3.9%) that constitute enamels, broken pots, and containers that are neither plastic or metals. The waste sector has been noted to contribute rising quantities of GHG into the atmosphere

3.7.9.1. Emission trends by gas

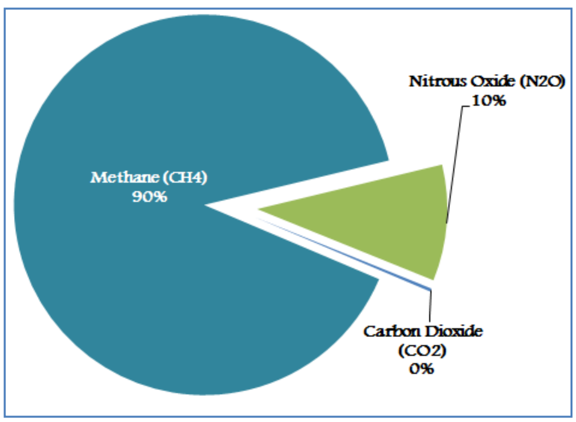

Figure 4-24; Proportion of Waste Emissions by Gas in year 2015

As indicated in figure 24, Methane and Nitrous Oxide are the largest contributors to Somalia's GHG emissions, accounting for 90% and 10% respectively in 2015 in the waste sector. The majority of the Methane emissions result from solid waste management and wastewater treatment and discharge. The Nitrous oxide (N_2O) emissions arise from activities related to wastewater treatment and discharge in 2015. Carbon dioxide forms only less than 1% of the emissions from waste sector resulting from open burning of waste. The figure 25 below shows the trend of emissions gas for the waste sector.

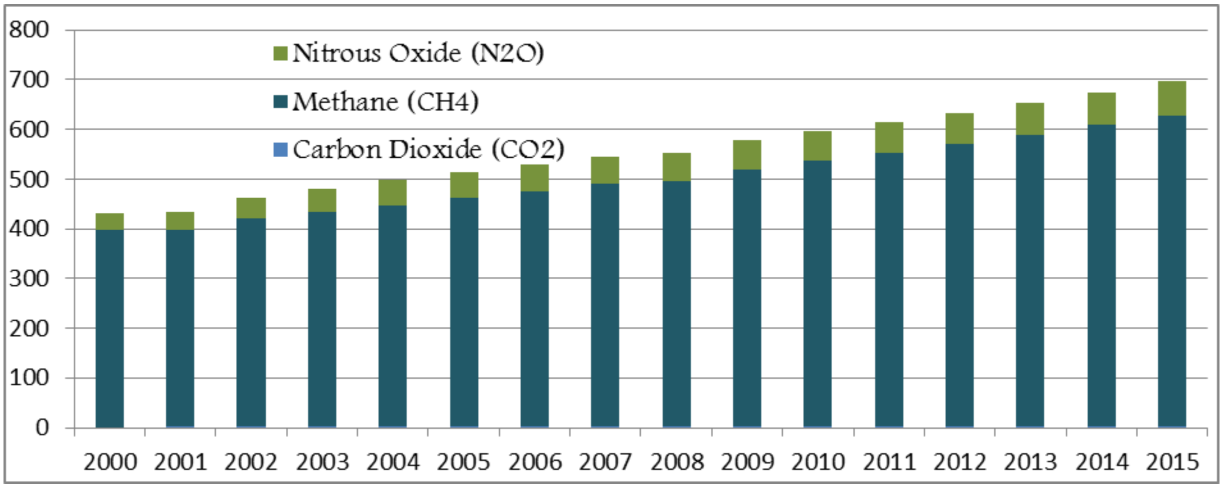

Figure 4-25 the trends of emissions (in Gg) by gas

3.7.9.2. Emission trends specified by source category

The wastewater treatment and discharge activities generates most of the emissions in the waste sector accounting for 61% of total GHG emissions of Somalia from the Waste sector in the year 2015. The Figure 29 shows that the Solid Waste disposal activities accounts for 39% while the incineration and open burning of waste accounts for less than1% of total GHG emissions of Somalia from the Waste sector in 2015

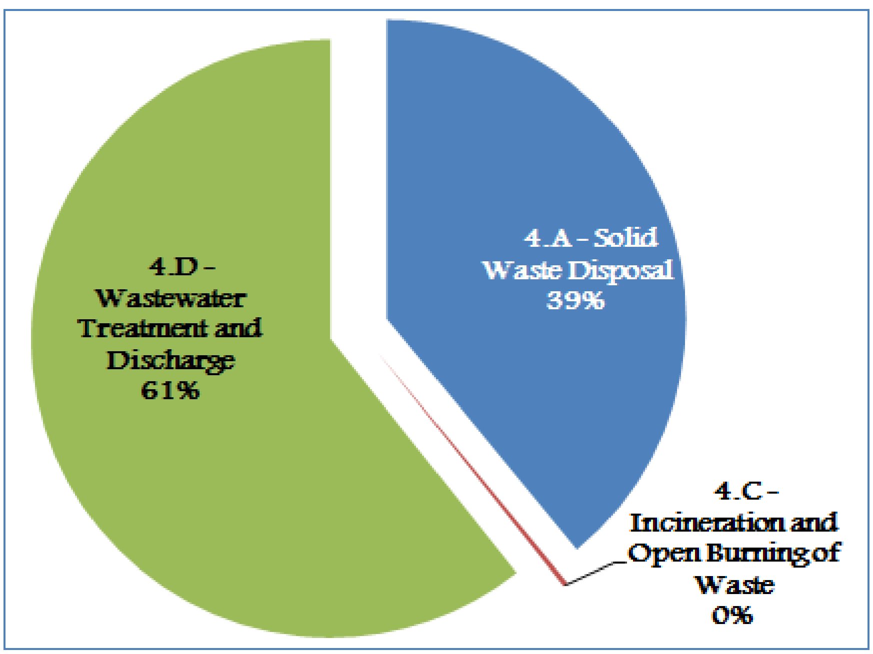

Figure 4-26 Percentage contributions of emissions from waste sub sectors

Table 21 below shows waste sector emissions in CO_2 equivalent values while figure 27 shows the trend of emissions by source categories of the waste sector. Table 22 shows the BUA projection of emissions form the waste sector.

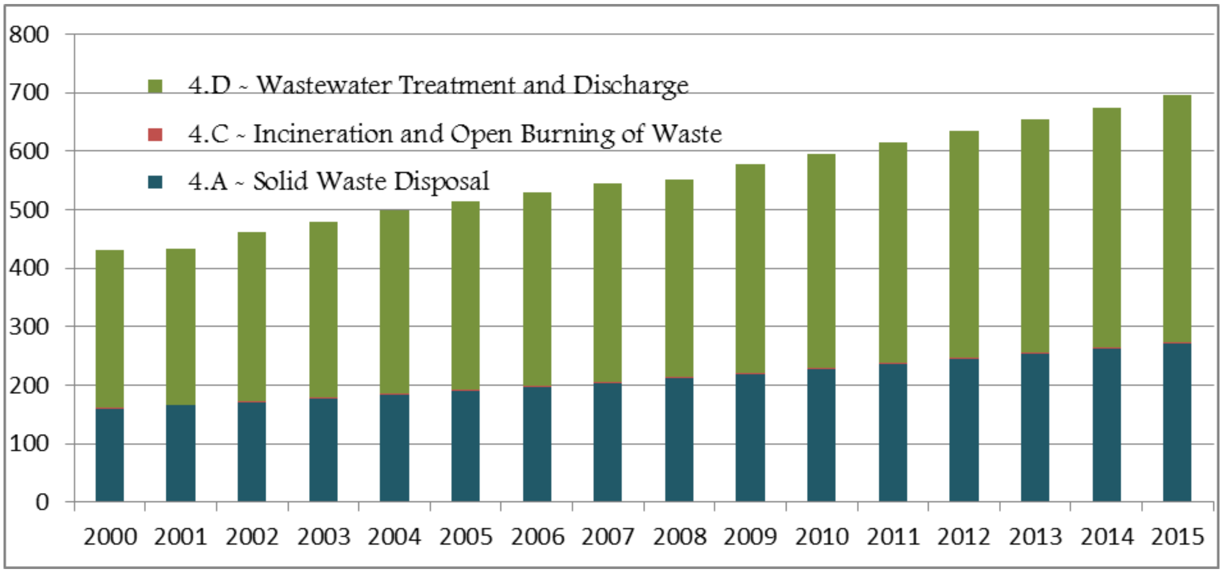

Figure 4-27 Total Emissions (in Gg) from the Waste Sector

Table 4-21 GHG Emissions (in Gg) from the Waste Sector

Year	4 - Waste	4.A - Solid Waste Disposal	4.C - Incineration and Open Burning of Waste	4.D - Wastewater Treatment and Discharge
2000	430.68	160.07	1.31	269.31
2001	433.21	165.50	1.35	266.36
2002	462.05	171.26	1.39	289.40
2003	480.09	177.30	1.42	301.37
2004	498.65	183.63	1.46	313.57
2005	513.54	190.22	1.50	321.82
2006	528.84	197.09	1.54	330.21
2007	544.46	204.25	1.58	338.63
2008	552.01	211.70	1.62	338.69
2009	577.67	219.43	1.66	356.58
2010	595.43	227.46	1.70	366.28
2011	614.09	235.77	1.74	376.58
2012	633.64	244.36	1.78	387.50
2013	654.01	253.25	1.82	398.94
2014	675.03	262.45	1.86	410.72
2015	696.69	271.99	1.91	422.79

Figure 28 shows the BUA projected emissions from the waste sector, indicating that wastewater treatment and discharge will continue to be the major source of emissions.

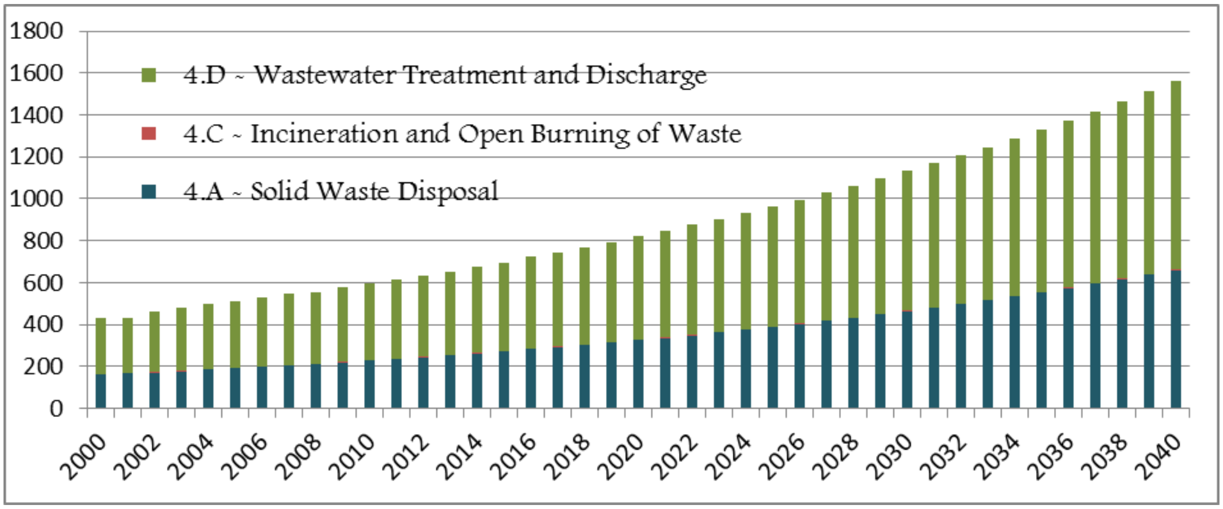

Figure 4-28 Projected (BAU) Emissions (in Gg) for the Wastes Sector

Table 4-22; Projected Emission (BAU) Emissions (in Gg) for the Waste Sector

Year	4 - Waste	4.A - Solid Waste Disposal	4.C - Incineration and Open Burning of Waste	4.D - Wastewater Treatment and Discharge
2016	721.5067	281.517	1.964018	438.0256
2017	745.0243	291.6904	2.013536	451.3204
2018	769.3143	302.2314	2.064302	465.0186
2019	794.4023	313.1533	2.116348	479.1326
2020	820.3147	324.4699	2.169707	493.675
2021	847.0787	336.1955	2.224411	508.6588
2022	874.7227	348.3448	2.280494	524.0974
2023	903.2757	360.9332	2.337991	540.0045
2024	932.7678	373.9765	2.396938	556.3944
2025	963.2303	387.4911	2.457371	573.2818
2026	994.6952	401.4941	2.519328	590.6818
2027	1027.196	416.0031	2.582847	608.6099
2028	1060.767	431.0365	2.647967	627.0821
2029	1095.443	446.6132	2.714729	646.115
2030	1131.261	462.7527	2.783174	665.7255
2031	1168.26	479.4755	2.853345	685.9313
2032	1206.478	496.8026	2.925286	706.7503
2033	1245.956	514.7559	2.99904	728.2013
2034	1286.736	533.358	3.074653	750.3033
2035	1328.861	552.6323	3.152173	773.0761
2036	1372.375	572.6031	3.231648	796.5401
2037	1417.325	593.2956	3.313126	820.7163
2038	1463.759	614.736	3.396658	845.6262
2039	1511.726	636.9511	3.482297	871.2923
2040	1561.276	659.969	3.570095	897.7373

YEAR	4 - Waste	4.A - Solid Waste Disposal	4.C - Incineration and Open Burning of Waste	4.D - Wastewater Treatment and Discharge
1994	683.95	94.05	7.22	582.68

YEAR	4 - Waste	4.A - Solid Waste Disposal	4.C - Incineration and Open Burning of Waste	4.D - Wastewater Treatment and Discharge
2000	965.09	204.74	8.77	751.59
2005	1225.88	265.35	10.30	950.23
2010	1449.52	331.58	11.97	1105.97
2015	1746.20	491.43	13.51	1242.20
2020	2026.74	589.81	15.64	1422.03
2025	2316.83	728.21	17.68	1572.17
2030	2616.46	881.87	19.84	1716.60
2035	2925.64	1050.78	22.13	1855.31
2040	3244.36	1234.94	24.56	1988.29

3.7.10. Uncertainties

The total protein consumption is estimated to have an uncertainty of ±20. The uncertainty in the nitrous oxide emission factors are estimated to ±30%. Resulting in a combined uncertainty of emission factors and coefficients is estimated to be ±36%.

3.7.11. Time-series consistency

Temporal effects can be related to changes in the amounts of human sewage generated and how it is treated. In this case temporal effects are solely based on changes in population, changes in sanitation and access to improved sanitation facility, in addition to the variation in protein consumption by the populations with respect to time and economic growth.

3.7.12. Source-specific planned improvements and recommendations

Improvements are required in comprehensive data collection on the type of treatment in place for human sewage and the proportion of social classes utilizing given sanitation facilities. Nitrous oxide emissions may vary depending on if the human sewage is treated at a facility, applied to land, buried or incinerated. There is need to involve the regional states that are mandated to manage waste with support from the federal government.

CHAPTER FOUR

ANALYSIS OF MITIGATION OPTIONS FOR THE FEDERAL REPUBLIC OF SOMALIA

CHAPTER FOUR

ANALYSIS OF MITIGATION OPTIONS FOR FEDERAL REPUBLIC OF SOMALIA

4.1. Introduction

This section presents summaries of policies and measures, and efforts to facilitate Climate Change Mitigation in the Federal Republic of Somalia. As a Non-Annex I Country, Federal Republic of Somalia does not have any commitments under the UNFCCC to reduce GHG emissions but under article 4.1(b) is required to formulate, implement, publish and regularly update national programmes containing measures to mitigate climate change. Mitigation is one of the activities that could be implemented by all counties in without respected to their development, in order to reduce the emission and other effects of climate change. Mitigation in this case refers to efforts to reduce/prevent emission of greenhouse gases (GHGs) or to enhance their removal from the atmosphere by sinks.

This chapter address three sections the first sections addresses mitigation assessment in the key sectors, such energy, transport and AFOLU. The second sections gives the over view of the activities accrued by Mitigation in Federal Republic of Somalia efforts to facilitate mitigation in climate change in the sectors which contributes significantly to the climate change. The last section provides the govern efforts to translate mitigation measures into actions with support of international community.

The emission from Somalia is very low compared to other countries. The main sources of emissions are 62927.95 Gg. Somalia is willing to contribute towards the reduction of emissions of GHG as it was stated in the NDC. There is a need to decrease the amount of greenhouse gases released to the atmosphere both national and international level by reducing on the emissions generated due to human activities (anthropogenic) and secondly, to absorb the greenhouse gases from the atmosphere (carbon sequestration).

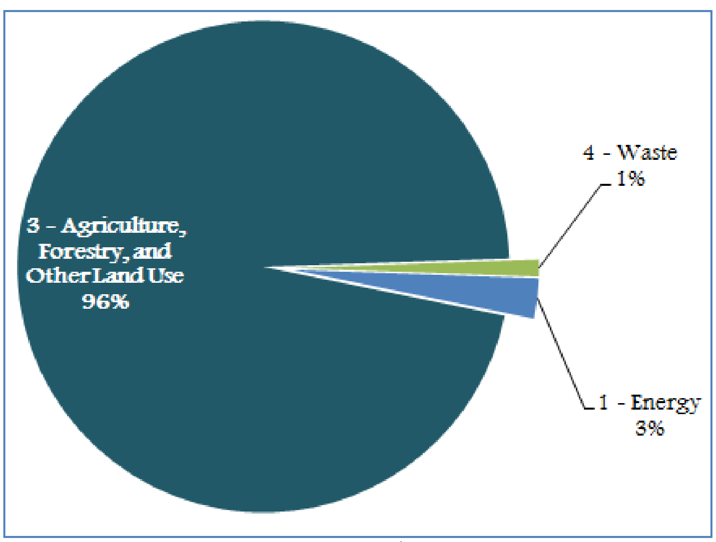

Figure 5-1 Proportion of Sectoral Emissions

Somalia is not obliged under the Climate Change Convention to reduce its greenhouse gas (GHG) emissions. Somalia's contribution (62.92 Mt CO2e as at 2015) to the total global GHG emissions is marginal, representing less than 0.12 percent of total global emissions in 2015. Of the 62.92 Mt CO2e in 2015, about 96 percent of GHG emissions came from the AFOLU while the Energy and Waste contribute 3 percent and 1 percent respectively and the IPPU sector is not considered significant.

4.2. Sectoral Mitigation Assessment

The computed emission for 2000-2015 was used as the bases for projection of emissions in all sectors. The emission trends reveal that energy and AFOLU are the fastest growth sectors. Federal Republic of Somalia is planning to put more emphasis in these sectors. The main areas of interest are energy generation and transport; land use change and forestry. The figuresn1-3 below show the mitigation potential assessments

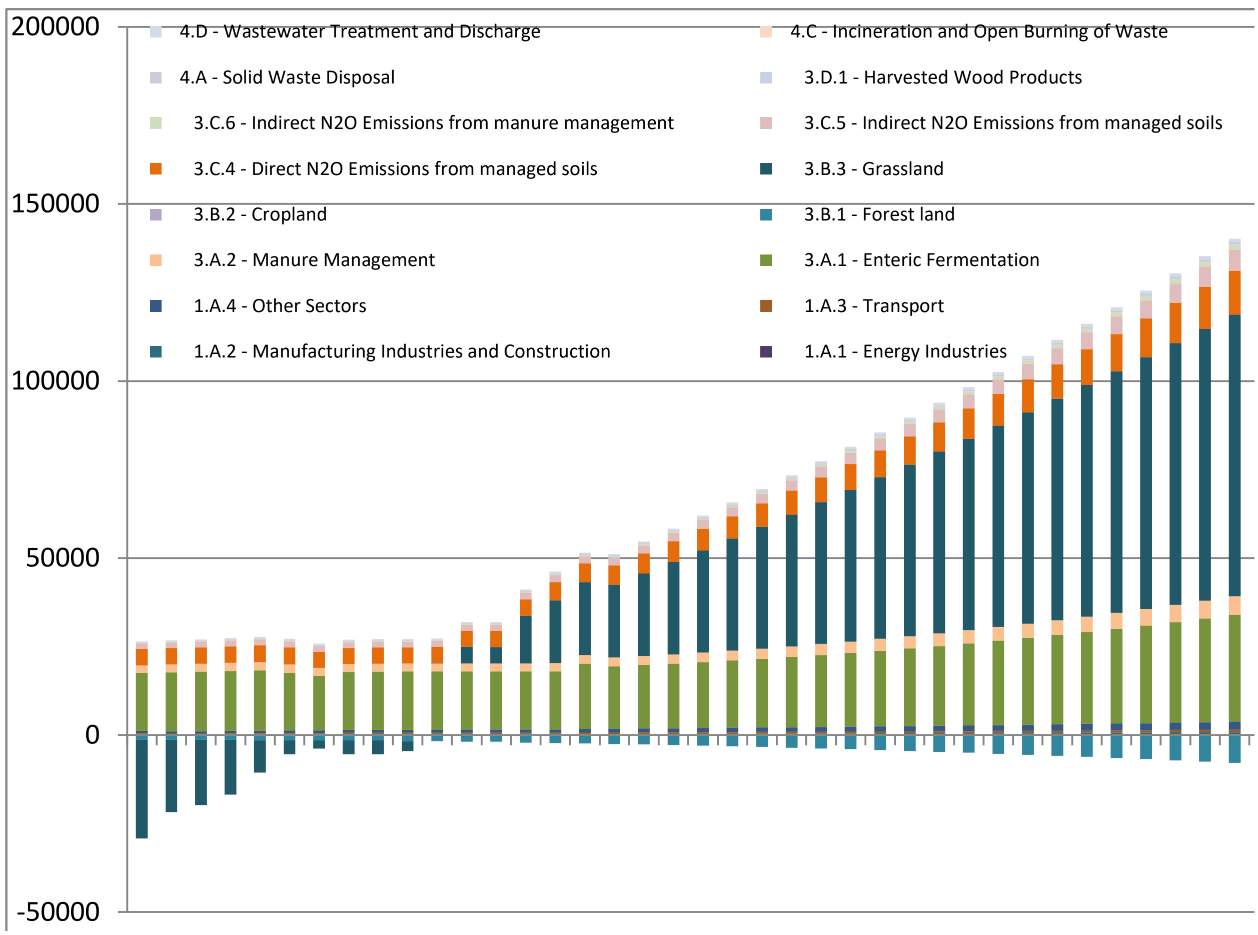

Figure 5-2 Projected GHG Emissions (by Source) 2000-2040

4.3. Mitigation Scenario Development

Three mitigation scenarios are developed for the First National Communication namely; Business as Usual, that is where the current pattern of emissions are not altered. It assumes that greenhouse gas emissions shall increase proportionally to increases in energy consumption. Since greenhouse gases emissions are directly dependent on energy generation and consumption. Moderate Scenario is where the government use its own resources to implement mitigation measures, and Enhanced Scenario that is where the government with assistance from the international community, through bilateral assistance, carbon financing and multilateral assistance carry out comprehensive mitigation sets of actions in the key sectors which contributes significantly to the national GHG emissions. It will involve high investments in all major sectors. The initial data used in this study is based on the information from the base year study 2000 to 2015, thereafter projection was made after every five years to 2030. The following are the scenario target option for Somalia

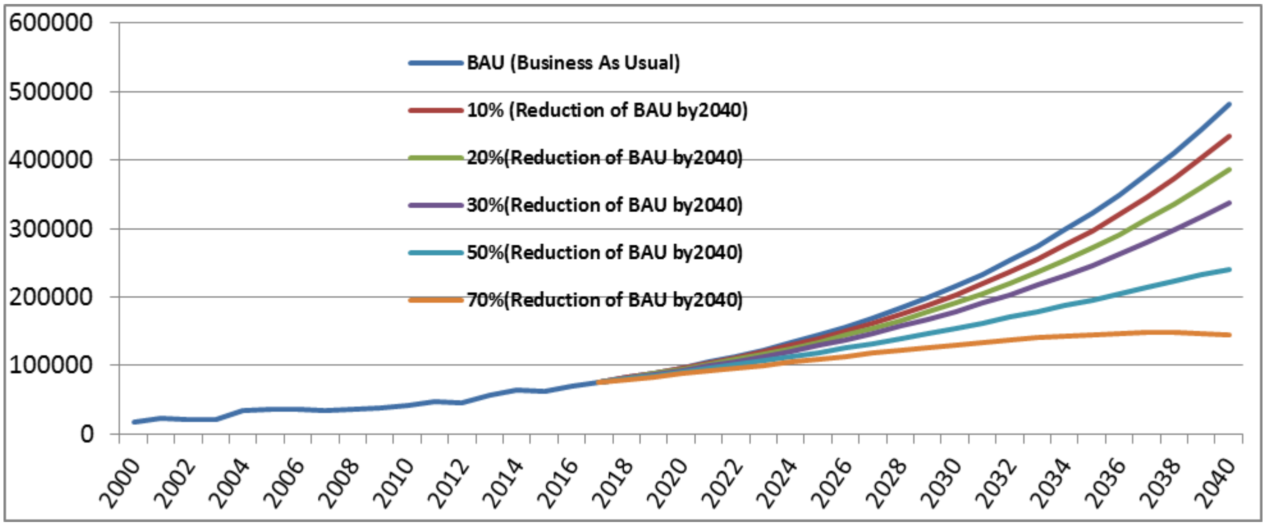

Figure 5-3 Projected GHG Emissions with BAU and proposed Abatement Scenarios for 2000-2040

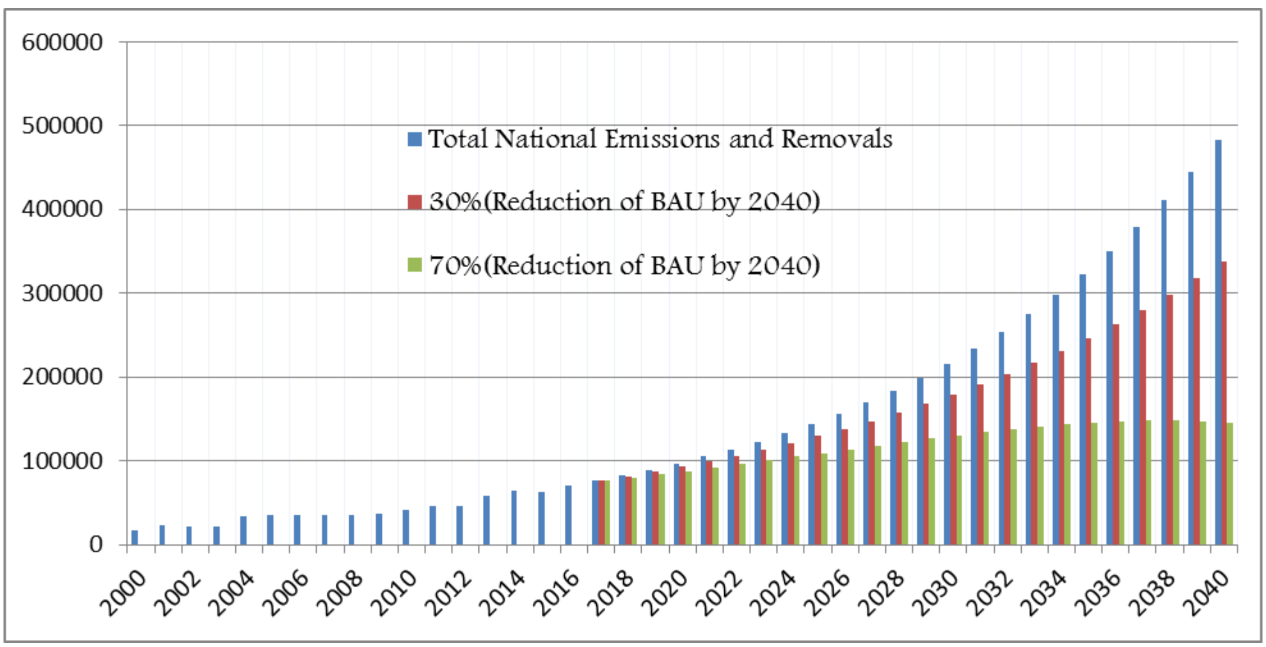

Figure 5-4 Emission Reduction Targets

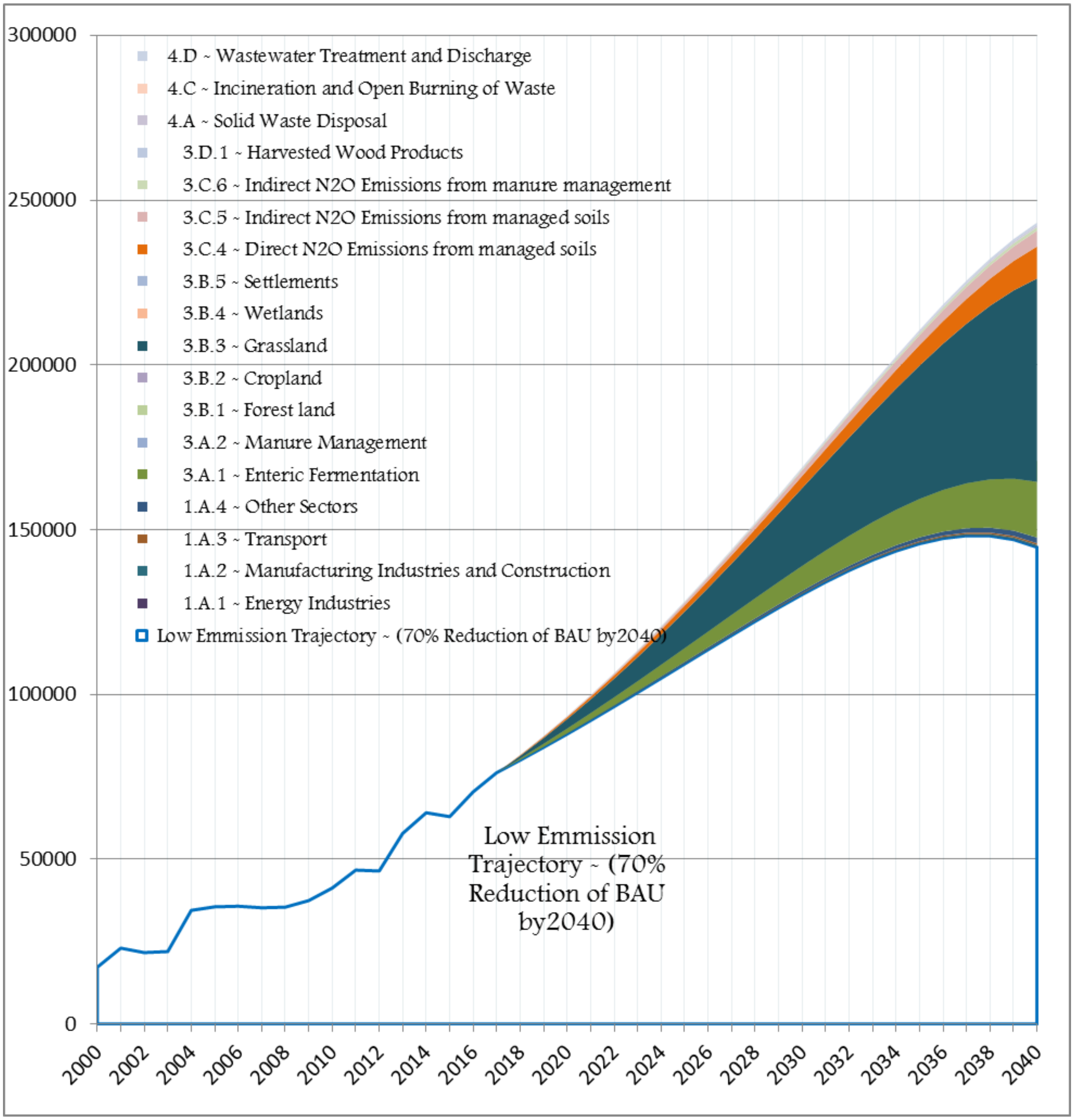

Figure 5-5 the proposed Low Emission Trajectory - (70% Reduction of BAU by2040)

Somalia is highly dependent on Biomass and thermal sources of energy that leads to high emissions of GHG in the energy. However the country endowed with potential of wind, solar, wave and tide in the mostly in the northern region, while limited hydropower resources exists in the Sothern part of the country. These sources of renewable energy can be used to generate electricity to mitigate emission during energy generation. The sources of emission per sector are as follows; Households, Transport (air, land and sea), Energy Sector (energy generation by industry, thermal plants, and solid fuel production), Agriculture (soil, crop, animal husbandry and fisheries), Industry. The mitigation actions in Somalia can be carried depending on the sector and consideration.

4.3.1. Energy Sector Analysis

Energy generation and consumption has been increasing since 2000, which is the normal trend for underdeveloped and developing countries. There is inadequate information about imports of petroleum products in the Somalia that may be because imported are dominated by the private sector. Even the data given by different publications are not consistent. It was not possible to use to use reference approach in computation of the emissions like being practiced in most countries. The information based on the publication about energy sector sometime can vary widely.

The most notable increase energy is in the area of electricity generation where most of it comes from thermal generators, accounting for 97% of the total generation with limited supply from hydropower and of late solar and wind energy sources. Biomass energy constitutes more than 90% of the total energy demand in Somalia. Moreover, charcoal production and use is on the increase with the same applying to wood fuel. There is a general discrepancy in data collection on the petroleum related fuels import and consumption. This can be seen in the report by AFREC 2015, showing that the consumption of oil has been on the increase since 2000 and projected to increase up to 2015, although the imports dropped to very low levels up to almost by 50% and yet there is no local production of fossil fuel. There no tally of data from other regions with other publications. To improve on this situation on the quality of data, the FRS should publish official energy statistic

In 2014, the imports of oil in the Somaliland region were 21.6 kt while in 2015 were 196 kt. In comparison to the data reported by AFREC 2017, the imports were 130 and 133 kt, respectively. In spite of that, there is a growing trend in the fuel consumption after 2010 (AFREC 2017). Owing to the limited information on the disaggregation of oil, this study considered surrogate data from Somaliland region for the estimation of the activity data. The data given from various publications, in the absence of the Somali Government official data, was used to make projections up to the year 2040.

4.3.2. Energy Sector Situational Analysis

Biomass is the leading form of energy in the Federal Republic of Somalia (FRS) followed by petroleum fuels and electricity. Currently, there is available published energy statistical data for FRS Puntland and Somaliland. It is reported (ADRA 2009) that wood fuel is commonly used in rural households while charcoal is used in the urban households mainly for cooking as the other sources of energy such as electricity are expensive. Furthermore, both charcoal and firewood are used in the commercial sector. There was no official data for biomass consumption in 2000 from all the regions of FRS. However, the World Bank reports an estimated consumption of 9,228 thousand cubic meters which translates to 7,198 kt which might have taken into account the fuel wood use in the charcoal production processes.

In this study, data from the Somaliland region was used as the basis for estimation of the fuel wood consumption in the FRS.

It is estimated that firewood consumption in Somaliland was 344 kg per household per month (ADRA, 2009). Moreover, it is assumed that the life style in the FRS is similar to that of the Somaliland region giving an overall wood fuel consumption pattern. The average household size for FRS is 5.9 (UNFPA, 2014). The UNFPA study was used to estimate the total population and other demographic data for FRS in the year 2000. The overall firewood consumption for an estimated population of 8,601,830 was approximately 3,840 kt. In addition, it is estimated that 24% (ADRA, 2009) of the wood used in the commercial sector translates to about 922 kt. The amount of charcoal produced in 2000 was 651 kt (AFREC, 2017) with some of it consumed in the household and commercial sectors while the rest was exported to the Middle East. This in agreement with the reported figure by the World Bank. Charcoal is very popular in the urban areas where 97% of the households depend on it for cooking (ADRA, 2009). It is estimated that households consume about 72 kg of charcoal per month (ADRA, 2009) amounting to an estimated 421 kt. On average, the charcoal consumption in the commercial sector is estimated at 10% of the charcoal consumed in the urban households (Drigo, 2008). The estimated consumption of charcoal in the commercial sector is about 46 kt.

4.3.2.1. Petroleum

Oil is used in the transport and industrial sectors for the production of electricity and for other uses such as households. There is a very high uncertainty in the data reported from the different publications regarding oil importation and consumption in the FRS. In the present study, information on the petroleum consumption was based mainly on the energy statistical data from the Somaliland and Puntland regions.

In the year 2000, 240 kt of oil was imported compared to a consumption of 168 kt (AFREC, 2017). However, it should be noted that there was no disaggregation of the fuels i.e. diesel, petrol, and aviation. The oil consumption in the transport and industrial sectors was estimated at 115 and 28 kt, respectively (AFREC 2017). It is assumed that the electricity generation accounted for the oil consumption in the industrial sector. In contrast, Kerosene is used mostly for lighting and limited use for cooking in the households. Furthermore, the petroleum imports from Puntland and Somaliland were 24.8 and 55.3 kt, respectively. Thus, the total imports from the two regions were 90.1 kt, representing about 50% of the oil consumption or 30% of the total petroleum imports.

Most of the electricity is generated from thermal generators amounting to 235 GWh (AFREC 2015). Further estimates indicate that diesel consumption varied between 2.5 to 3 kWh per liter depending on the efficiency of the generator. This translated from 0.33 to 0.4 liters per kWh which is equivalent to 287 to 348 g/kWh. In the present study, 300 g/kWh of diesel consumption was taken as a conservative estimate. The amount of fuel used in electricity generation was 70.5 kt. This could be attributed to the higher rate of independence of the thermal generator. Thermal power is projected to increase from installed capacity of 100 MW in 2014 to 246 MW in 2040.

The FDR has a plan to expand electricity generation and distribution system in the country. The installed capacity will increase from 85 MW to about 150 MW in 2025. MW in 2025. The contribution of renewable power will be about 40–50MWp of renewable energy mainly solar energy. Other sources such as wind and hydro will also contribute to the electricity demand. It implied that the installed capacity will increase by about 7.0 per annum over the first next ten years then by 5.5%. The installed capacity is projected to increase to about 270 MW by 2030 and 453 MW in 2040. It implies that thermal power contribution will be about 53% in 2040.

Kerosene is used for lighting in households which are not electrified in both the urban and rural areas. Most notably, it also finds limited application for cooking purposes in the urban households, which is 5% of the households (ADRA, 2009). The per capita kerosene consumption in the urban households was estimated at 84 liters per month, while in the rural households is at 2 liters per year (ADRA, 2009). The total consumption of kerosene in the urban and rural households was estimated at 10.4 and 8.9 kt, respectively. LPG is mostly used in the institutions located within the urban areas. Further estimations indicate that about 90% of LPG is used in the institutions while 10% is used in the households (ADRA, 2009). The consumption of LPG in the commercial and household sectors was 466 and 46.6 tonnes, respectively.

4.3.3. Energy Equipment and Infrastructure

The energy devices used in the household sector are generally of a low efficiency. It is reported that only 2% of the households use energy saving stoves while the rest ~ 98% use traditional stoves for their cooking applications. The commercial sector boosts of a higher penetration of efficient cooking stoves. According to ADRA, 2009, the 14% of the commercial sector uses improved stoves while the rest use metallic stoves. Charcoal production and trade are one of the main economic activities for the generation of incomes at the community level. The activity is conducted using inefficient kilns leading to high input energy costs and emissions to the environment.

Most of the generators for electricity are out dated and poorly maintained. There are few new ones and others previously used in the Middle East. It is also noted that the electricity transmission network is poor coupled with high losses. On the other hand, the roads and associated infrastructure are not well maintained. A proper road infrastructure is lacking in most of the towns and cities in Somalia. Most vehicles not well maintained leading to an increase in fuel consumption and emissions within the transport sector. The quality of fuel is questionable, since there is control on the quality of fuel by national standards bureau.

4.3.4. Sectoral Energy Demand.

As the Somalia develops the energy consumption will increased. The drivers of the energy consumption are rate of population growth rates, the urbanization and growth in GDP. The per capita energy consumption is one of the indicators for national development. Somalia like most of the least developed countries has very rate of commercial energy absorption.

4.3.4.1. Energy Generation

The main source of fuels used in the energy generation in Somalia is diesel and charcoal. There is increasing demand of electricity but is mostly used for the basic needs. The tariff is very high. In the BAU Scenario, emission from the diesel generators will increase from 227.1 CO2eq in 2000 to 884.8 CO2eq in 2040. The generators are characterized by low efficiency and poor transmission and distribution lines. Most of charcoal is produced using traditional kilns which in most cases are not efficient. The emission is projected to increase from 2503.59 in 2000 to 35 CO2eq in 2040.

4.3.4.2. Households

Population growth rate is the main driver for biomass energy consumption in the household. In the BAU Scenario, the emissions from the biomass use in the rural areas and charcoal use in the households will increase from 6951.3 and 1606.2 Gg CO2 eq. to 13,547.8 and 7854.29 Gg CO2 eq in the year 2000 and 2040, respectively. Furthermore the emissions from Kerosene and LPG use in the households will increase from 62.28 and 0.14 Gg CO2 eq. to 266.07 to 0.68 Gg CO2 eq. in the year 2000 and 2040, respectively.

4.3.4.3. Commercial Sector

In the BAU Scenario, biomass use in the commercial sector will lead to an increment in the emissions from 1390.3 Gg CO2 eq. in 2000 to 2709.6 Gg CO2 eq. in the year 2040.Furthermore, the emissions from the use of charcoal in the commercial sector are projected to increase from 67.8 Gg CO2 eq. in the year 2000 to 331.73 Gg CO2 eq. in the year 2040.

4.3.4.4. Transport Sector

Transport plays a great role in the national development in transportation of goods and services. Road Transport is the dominant form of transport in Somalia. There are several local airline companies operation with in Somalia and international companies. The state of the roads needs improvement. There many possible mitigation options for Somalia in the transport sector. The present state of the transport infrastructure is not adequate for smooth flow for goods and services. Improved infrastructure both in the cities, towns and main roads will reduce on the emissions. The uses of the old vehicles which are not well maintained also add to the emissions of GHG. In Somalia all the bulk goods are transported by road.

The diesel emissions from the transport sector will increase from 193.31 Gg CO_2 eq. in 2000 to 1128.45 Gg CO_2 eq. in 2040. The petrol emissions from the transport sector will increase from 236.91 Gg CO_2 eq. in 2000 to 916.51Gg CO_2 eq. in 2040. The aviation fuels use will lead to an increment in the emissions within the transport sector from 50.68 Gg CO_2 eq. in 2000 to 257.24 Gg CO_2 eq. in 2040

Table 5-1 Summary of the Energy Situation in 2000

Sector/activity	Fuel	Quantity	CO_2 Gg	Gg CH_4	Gg N_2O	Gg CO_2 eq.
Biomass use in Rural	wood	3840 kt	6,450.7	17.3	0.2	6951.3
Commercial sector	wood	768 kt	1290.1	3.5	0.0	1390.3

Charcoal production	Charcoal	651 kt	2,187.4	11.7	0.08	2503.6
Charcoal in Households	Charcoal	456 kt	1,533.6	2.74	0.01	1606.2
Charcoal in commercial	Charcoal	46 kt	64.7	0.12	0.00	67.8
Kerosene use in rural and urban	kerosene	19.2 kt	6191	0.009	0.001	62.28
LPG use mostly urban	LPG	46 ton	0.14	0.000	0.000	0.14
Electricity generation	Diesel	70.5 kt	226	0.009	0.00	227.1
Transport	Diesel	60 kt	192.65	0.01	0.0	193.31
Transport	Petrol	74.4 kt	230.99	0.11	0.01	236.91
Transport	Aviation	15.8 kt	50.39	0.0	0.0	50.68

Table 5-1 shows the overall emissions from the different sectors and activities for the year 2000. As can be seen, the biomass use in the rural areas and commercial sectors accounts for the largest share of the total emissions amounting to 6951.3 and 1390.3 Gg CO2 eq, respectively. This is followed by emissions from the charcoal production and consumption activities in the household and commercial sectors amounting to 2503.6 and 1673.8, Gg CO2 eq respectively. LPG use in the urban areas had the least emissions as a result of the limited use of petroleum products for cooking applications due to the high costs of this energy source.

Table 5-2 Summary of the Energy Situation in 2015

Sector/activity	Fuel	Quantity	CO_2 Gg	Gg CH_4	Gg N_2O	GgCO_2 eq.
Biomass use in Rural	wood	5142 kt	8638.3	23.1	0.3	9308.7
Commercial sector	wood	1028 kt	1727.7	4.6	0.1	1861.7
Charcoal production	Charcoal	1245 kt	4183.2	22.41	0.15	4797.97
Charcoal in Households	Charcoal	828 kt	2781.97	4.97	0.02	2911.1
Charcoal in commercial	Charcoal	83 kt	117.4	0.21	0.0	122.95
Kerosene use in rural and urban	kerosene	40.6 kt	130	0.018	0.001	131.293
LPG use mostly urban	LPG	85 ton	0.25	0.00002	0.00	0.25
Electricity generation	Diesel	114.9 kt	369	0.015	0.003	370.2
Transport	Diesel	101 kt	324.29	0.01	0.0	325.4
Transport	Petrol	127 kt	394.31	0.19	0.02	404.43
Transport	Aviation	26.9 kt	85.64	0.00	0.00	86.37

Table 5-2 shows the overall emissions from the different sectors and activities for the year 2015. As can be seen, the biomass use in the rural areas and commercial sectors accounts for the largest share of the total emissions amounting to 9308.7 and 1861.7 Gg CO2 eq, respectively. This is followed by emissions from the charcoal production and consumption activities in the household and commercial sectors amounting to 4797.97 and 3034.05 Gg CO2 eq, respectively. LPG use in the urban areas had the least emissions as a result of the limited use of petroleum products for cooking applications.

Table 5-3 Summary of the Projected Energy Situation in 2030

Sector/activity	Fuel	Quantity	CO_2 Gg	Gg CH_4	Gg N_2O	Gg CO_2 eq.
Biomass use in Rural	wood	6521 kt	10955.4	29.3	0.4	11805.6
Commercial sector	wood	1304 kt	2629.3	7.0	0.1	2833.4
Charcoal production	Charcoal	1956 kt	6570.5	35.2	0.23	7520.46
Charcoal in Households	Charcoal	1502 kt	4652.17	8.31	0.04	4868.08
Charcoal in commercial	Charcoal	150 kt	196.32	0.35	0.00	205.61
Kerosene use in rural and urban	kerosene	44.2 kt	198.49	0.028	0.002	199.678
LPG use mostly urban	LPG	154 ton	0.46	0.00004	0.00	0.46
Electricity generation	Diesel	196.9 kt	632	0.026	0.005	634.4

Transport	Diesel	213	683.86	0.03	0.01	686.20
Transport	Petrol	218.9	679.61	0.32	0.03	697.05
Transport	Aviation	48.8	0.16	0.00	0.00	0.16

Table 5-3 shows the overall emissions from the different sectors and activities projected for the year 2030. As can be seen, the biomass use in the rural areas and commercial sectors will account for the largest share of the total emissions amounting to 11805.6 and 2833.4 Gg CO_2 eq, respectively. This is followed by emissions from the charcoal production and consumption activities in the household and commercial sectors amounting to 7520.46 and 5073.69 Gg CO_2 eq, respectively. LPG use in the urban areas will have the least emissions as a result of the limited use of petroleum products for cooking applications.

Table 5-4 Summary of the Projected Energy Situation in 2040

Sector/activity	Fuel	Quantity	CO_2 Gg	Gg CH_4	Gg N_2O	Gg CO_2 eq.
Biomass use in Rural	wood	7483 kt	12,572.2	33.7	0.4	13,547.8
Commercial sector	wood	1497 kt	2,514	6.7	0.1	2709.6
Charcoal production	Charcoal	2437 kt	8187.6	43.85	0.29	9371.35
Charcoal in Households	Charcoal	2234 kt	7505.93	13.40	0.07	7854.29
Charcoal in commercial	Charcoal	223 kt	316.75	0.57	0.0	331.73
Kerosene use in rural and urban	kerosene	52 kt	265.03	0.037	0.02	266.07
LPG use mostly urban	LPG	228 ton	0.68	0.00005	0.00	0.68
Electricity generation	Diesel	274.6 kt	827	0.036	0.007	884.8
Transport	Diesel	350.3 kt	11,224.59	0.05	0.01	1128.45
Transport	Petrol	287.8 kt	893.58	0.43	0.04	916.51
Transport	Aviation	80.2 kt	255.07	0.00	0.01	257.24

Table 5-4 shows the projected overall emissions from the different sectors and activities for the year 2040. As can be seen, it is expected that the biomass use in the rural areas and commercial sectors will account for the largest share of the total emissions in these sectors amounting to 13,547.8 and 2709.6 Gg CO_2 eq, respectively. Furthermore, the biomass use for charcoal production will account for 9,371.35 Gg CO_2 eq. of the total emissions followed by the charcoal consumption activities in the household and commercial sectors amounting to 7854.29 and 331.73 Gg CO_2 eq respectively. The emission from thermal generator will reach 884.8 Gg in 2040. LPG use in the urban areas will constitute the least emissions as a result of the limited use of petroleum products for cooking applications since they are an expensive source of energy.

4.4. Mitigation Analysis

Somalia like most of the least developed countries the emissions will increase as the country develop, but the best approach now is to choose low carbon development path. The Federal Republic of Somalia has many forms of energy resources used in the different sectors. Regardless of the type of energy resource, the Federal Republic of Somalia has very low energy efficiency, resulting in the high energy consumption. Most of the energy is used in the household sector. Biomass is the dominant source of the energy in the FRS. The emissions from the combustion of the biomass in the commercial and household sectors are considered to be biogenetic. Therefore, it is reported as a memo item which applies to combustion of wood and charcoal. There are high emissions of methane during the production of charcoal. Methane is one of the three main greenhouse gases to be reported. In most countries the emissions of the anthropogenic gases are concentrated in the urban areas.

The main source of anthropogenic emissions is from transport sector. Petrol and diesel are the main sources of fuels used in the transport sector. There are several ways to mitigate emissions from the transport sector. Possible options include the improved road infrastructure and well maintained vehicles. The second most important source of emissions is from the electricity generation sector using diesel generators. Most the generator sets are old and power transmission lines are poorly maintained. All these lead to high energy losses in the distribution network and hence high energy consumption. Generally, improving the efficiency of the energy industry, such as diesel generators and improved charcoal production technology will be one of the mitigation options to start with. While at the end use, the improvement of efficiency of the end use devises such stoves for wood and charcoal will be a good mitigation option. In this study it is assumed that the mitigation actions started in 2015. The overall emissions in the energy sector are projected to decrease from the Business as Usual Scenario to under the Mitigation Scenario.

4.4.1. Energy Sector

Hydropower potential is mainly found the southern region of Somalia. It is located far from major load centres in Somalia. It was initially used for irrigation and electricity generation. The old plant needs rehabilitation. There is potential sites for larger scale hydropower plant upstream Jubba River. The FRS can maximize its hydropower resources by putting in place measures to protect water resources.

a) The FRS should develop an integrated study on development of hydropower especially in the southern region of the country.
b) Develop the water resource inventory and identify potential threats to water resources
c) Put in place measures to protect water resources from uncontrolled exploitation
d) Increase the efficiency of water supply and introduce a system of water demand management.
e) Establish institutions that will be responsible for measurement and control system for water resources management and a unified system for hydrological data management

4.4.1.1. Energy Industries Mitigation

4.4.1.1.1. Charcoal Production

Charcoal production is one of the most important activities in the FRS energy industry. Charcoal is a very popular fuel in the urban households. About 97% of the households use charcoal for cooking. It is cheaper than the other alternatives such as kerosene, LPG, and electricity. Furthermore, a large quantity of charcoal is exported to the Middle East. The emissions from charcoal production increased from 2,503.6 Gg CO_2eq in 2000 and are projected to reach to 9,354.3 CO_2eq in 2040. The methane emissions released to the atmosphere increased from 11.7 Gg in 2000 and are projected reach to 43.15 Gg by the year 2040. The mitigation of options will be to use efficient technologies such as Casamance and Adams kilns, which have average efficiencies of 25-35%. The other option is to use alternative fuels to charcoal such LPG as discussed later. In this study conservative figures of 28% and 12% are considered for the improved charcoal kiln and traditional kiln, respectively.

Mitigation actions expected to start with the gradual penetration of efficient kilns from year 2020. The target could be the introduction of efficient charcoal kilns which are projected to reach a penetration of 35% by the year 2040. The emissions from charcoal production will reduce to 5,256 Gg CO2eq. Briquettes are one of the promising alternatives to charcoal. They can be made using low cost appropriate technologies for paralyzing and compression using starch as the main binder.

4.4.1.1.2. Electricity Generation.

There is a heavy dependence on thermal power for electricity generation and as the result, Somalia has one of the highest tariffs in the world yet it is one of the least developed countries with low incomes. Apart from the high expenses associated with the rising cost of fuel, electricity generation using thermal energy contributes to the anthropogenic emissions. The FRS has a plan to expand the power generation and distribution systems to boost the economy. Electricity availability at a fair tariff is key to industrial and social development. The mitigation measures will be in place so that the use of thermal generators will be reduced to about 30% of the installed capacity by 2040, and thus about 90 MW installed capacity. Mitigation activities centered on solar energy, wind energy and hydropower will reduce the emissions from 884.6 CO2eq in Base Case Scenario to 370 CO2eq under Mitigation Scenario. Consequently, the emissions will be reduced by 58% from BAU Scenario.

The use of solar and wind energy are some of the best mitigation options available in this sector. Hydropower is also a good candidate but the location is not favorable because of its distance from the current load centres. With improving political stability in the country, the number of load centres will increase in the Central and Southern Somalia. Large scale solar plants are viable in the cities and other urban centers. Solar –wind integrated systems are also a very good option for the urban setting and cities. The vast wind resources will be enough for both internal use and for export to the neighboring countries. These are capital intensive ventures which can only be achieved with the international assistance from development partners and other financial mechanisms such as carbon financing.

The most obvious mitigation options are to improve on the maintenance practice and improvement of the transmission lines to reduce the losses. The installation of renewable energy systems is in progress. There was installation of a Solar –Wind Integrated system in the Puntland region in 2016. More installations are still expected to follow under the government programme to increase access to power supply nationwide. There are other sources of energy such as tide and waves. These are not applicable in the near foreseeable future. Somalia has reserves of fossil fuels such as coal, natural and oil resources. These fuels may be used in future.

4.4.1.1.3. Households

Biomass is most important fuel in both the urban and rural households. A high dependence on charcoal for cooking in the households leads to an increasing rate of deforestation. It is expected that the use of efficient cook stoves will reduce emissions in the household sector. The efficiency of charcoal metal stoves and improved stoves is estimated at 18% and 30%, respectively. The government can put in place plans to increase the penetration of improved charcoal stoves from 2% in 2000 to 30% in 2040. This will result in the emission reduction from 6920 CO_2eq to 4532 CO2eq in 2040. That is reduction of about 35% from the BAU scenario.

Firewood is a very popular fuel in the rural areas because it is cheap. The increasing population as projected in the near future implies that the charcoal may not be free. There is very limited information about the use of efficient fire stoves in the rural households. The government can promote the use of efficient wood fuel stoves to be used in the rural households. The efficiency of three stone fire stoves is estimated at 10% while the improved wood stove the efficiency is estimated at 30% The Somalia government can design and implement a national programme to promote the efficient wood fuel stoves, which will reduce the emissions from 13547 CO2eq in the BAU Scenario to 9605 CO2eq under Mitigation Scenario, thus a reduction of about 29% by the 2040.

Apart from biomass use, households also depend on LPG for their thermal energy needs. LPG use is common in households with high income. Unlike the other forms of energy, the use of LPG is expected to increase since it is one of the substitutes to charcoal in the urban households. The emissions from LPG are expected to increase. This will depend on the government policy such as reduced taxation and targets on charcoal substitutions with other fuels. The emissions will increase from 13.23 CO2eq in 2000 to 13.23 CO2eq in year 2040.

Use of biogas at household level can reduce fuel wood and charcoal in this sector. It should be noted that for biogas to function successfully, water availability in the vicinity is very important. Operation of biogas plant at household level is labour intensive. It can be very costly to construct biogas digester.

Due to the low level of industrialization, most of the electricity is consumed by the household sector. It is mostly used for lighting, due to the high tariff and it cannot be used for cooking. It is not possible to estimate the electricity use in the households because the supply and distribution is done by the private sector. The use of energy saving bulbs, promotion of solar energy for households and lowering taxes on solar energy equipment, will result in lower emissions generated by the generators. Most of the kerosene is mostly used in the rural and non-electrified households. There is a difficulty in obtaining data on imports.

4.4.1.1.4. Commercial Sector

The commercial sector in Somalia also relies on wood fuel and charcoal for their thermal energy needs. The private sector is keen on using energy saving devices because they have more disposable income. The estimated efficiencies of the metallic stoves and improved stoves are 20 % and 35%, respectively.

The penetration of the efficient stoves for charcoal is projected to increase from 14% in 2015 to 50% in 2040.

The resulting emissions are projected to decrease from 305.8 CO_2eq to 155.6 CO_2eq which is 49%. There is information on the current use of efficient fuelwood. It is estimated that 2% of the commercial sector uses efficient wood stoves, and is projected to reach 35% in 2040. The estimated efficiency of wood and improved stoves is 15% and 35%, respectively. The emissions will reduce from 3251 CO_2eq in 2015 to 2140 CO_2eq in 2040. That reduction is due to the mitigations which will be 34% over the BAU Scenario.

The use of LPG is dominated by the commercial sector involving restaurants, hotels and schools for laboratory based activities. It is estimated that 90% of LPG is used in the commercial sector and it is estimated to increase at a rate of 4.6% in the foreseeable future. The emissions in the commercial sector will increase about three folds, thus from 0.25 CO_2eq in 2015 to 0.73 CO_2eq in to 2040. There is limited information about electricity use in the commercial sector. Water for household and agricultural needs can be pumped using wind and solar energy is possible sources of electricity for water pumping and electricity generation. This will be a viable mitigation options in water pumping instead of use of petrol and diesel engines which emits GHG.

4.4.1.1.5. Transport Sector

Road Transport is the dominant form of transport in Somalia. There are several local airline companies in operation within Somalia and internationally. The state of the roads needs improvement. There are many possible mitigation options for Somalia in the transport sector. These mitigation options will be applied in combination which will lead to an overall reduction in the greenhouse gas emissions. The mitigation actions will include but not limited to; improving the efficiency of vehicles through regular maintenance and servicing, improving and maintenance of the transport infrastructure such as proper drainage and road furniture.

Since most of the vehicles are found in the urban areas, there are some mitigation options which are specific to the urban areas. The driving practice can lead to the reduction in the fuel consumption and hence emission reduction in transport sector more so in the urban areas where most the vehicles are found. In the long term, planning of the settlement in the urban areas has to be well organized. That will reduce in the distances traveled by city and town dwellers. Some of the cities in Africa are planning for mass transit systems such as bus rapid transport to reduce on the congestions and traffic jams. Somalia has a vast land which is cultivatable mostly in the southern part of the country. Crops such as sugarcane can be grown and ethanol can produced from the molasses.

When these mitigation actions are taken in combination, the overall emissions from diesel fuel in transport sector are projected to reduce by 916.51 CO_2eq in BAU to 522.41 CO_2eq in the Mitigation Scenario. Thus a reduction of 43%. There will be a similar reduction in the use of petrol in the transport sector. The emissions from petrol fuel in transport sector are projected to reduce by 1128 CO_2eq in BAU to 643.21 CO_2eq in the Mitigation Scenario. Thus reduction of 43%.

Biodiesel can be produced from crops and plant oil which are not edible, such as custer seed, jatropha and corton, so that it will not compete with food crops. Biodiesel can be operated in any diesel engine with little or no modification to the engine or the fuel system. It can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. The emission from diesel engines is a major exhaust pollutant, both unburned hydrocarbons and nitrogen oxides. The use of biodiesel results in a substantial reduction of unburned hydrocarbons. In the areas where there are vast marginal lands can be used for growing energy crops.

4.4.2. Energy Sector Abatement Options

The Federal Republic of Somalia has many forms energy resources used in different sectors. Regardless of the type of energy resource, the Federal Republic of Somalia has very low energy efficiency, resulting in high energy consumption Most of energy is used in the household sector. Biomass is dominant source of the energy. The emission from the combustion of the biomass in the industrial and household sector is considered to be biogenetic so it is reported as a memo item, this apply to combustion of wood and charcoal. However, during the production of charcoal, there is high emission of methane. It is one of the three main greenhouse gases to be reported. There are several ways to mitigate emission from the charcoal production. In the IPCC 2006, charcoal production is considered as energy generation from solid.

In the Business as usual Scenario, Somalia residential and commercial is 1011.85 Gg annually. The emissions is 687.59 Gg of methane expressed as $C0_{2\ eq}$. The efficiency of the local kilns is 10-15%. It estimated that a growth rate of demand is about 4% per annum. The use charcoal in households can also be reduced at household's level by using energy saving stoves. Under the Moderate Scenario, the government can promote the use energy saving charcoal stoves in the rural and urban households. Energy saving wood stoves should be promoted mostly in the rural areas. The government can train the peasants to produce quality stoves as a business enterprise. It is assumed that 10% of the household will be using efficient stoves in urban households by the year 2025 and will increase to 20% by the year 2030.

In the Enhanced Scenario, the government will undertake intensive sensitization in the use of efficient stoves; the estimated penetration will reach 15% of the households by 2025 and 30% by the year 2030. The other mitigation options includes; use of improved kilns with efficiency 25-35% (Cassemance and Adam retort). These types of kilns are expensive compared to the traditional kilns. All though the government promotes the use of efficient kilns, implementation is expensive. The use of LPG and kerosene in households is one of the options to reduce GHG in this sector.

Charcoal is also used in the commercial sector. The commercial sector includes, schools, restaurants, hotels and other institutions such as hospitals, schools etc. The use of institutional stoves with efficiency of 30-35 % will reduce energy emissions in this sector. The other mitigation options will include the use of LPG, though it is also emits GHG but is has a higher efficiency.

Due to low level of industrialization in Somalia, most of the electric energy is used in the household sector. In most cases energy inefficient bulbs are used. Under the Moderate Scenario, the government should promote the use of efficient bulbs which will reduce energy consumption in this sector. There are practices such switching off light when not needed which can easily be prompted through public sensitization. The government can provide tax incentives to the business community to buy new generators which are more efficient.

The use of solar and wind energy is one of the best mitigation options available in this sector. Low power for households can be promoted by the government through incentives such as tax abetments. Solar comes very handy in this sector because the large pastoral and rural population can use low capacity power system for their households. Such actions fall under Moderate Scenario

Large-scale solar plants are viable in cities and in other urban centers. Solar –wind integrated systems is also very good option for urban setting and cities. These are capital intensive venture which can only be achieved with international assistance. Large Scale development of these sources of energy falls under Enhanced Scenario.

4.4.2.1. Hydropower

Hydropower potential is mainly found the southern region of Somalia and the Tidal power along the coastline. It was initially used for irrigation and electricity generation. The old plant needs rehabilitation. There is potential sites for larger scale hydropower plant upstream Jubba River. The FRS can maximise its hydropower resources by putting in place measures to protect water resources. Development of hydropower is capital intensive. It can be implemented under Enhanced Scenario by carrying out the following.

a) Developing an integrated study on development of hydropower especially in the southern region of the country.
b) Developing the water resource inventory and identify potential threats to water resources
c) Developing measures to protect water resources from uncontrolled exploitation
d) Increase the efficiency of water supply and introduce a system of water demand management.
e) Establishing institutions that will be responsible for measurement and control system for water resources management and a unified system for hydrological data management
f) Developing the potential tidal power along the coastline of Somalia

4.4.2.2. Transport Sector

Transport plays a great role in the national development in transportation of goods and services. The emission in the transport sectors is estimated at 483.52 Gg in 2015. It will increase since there is growing stability in the government and improving economic development. Among the contributors of emissions in the transport sector in the state of the infrastructure and the vehicles. The infrastructure suffered as results of poor maintenance due to the instability of the government.

The present state of the transport infrastructure is not adequate for smooth flow for goods and services. Improved infrastructure both in the cities, towns and main roads will reduce on the emissions. The uses of the old vehicles which are not well maintained also add to the emissions of GHG. In Somalia all the bulk goods are transported by road. There is no railway infrastructure.

In the Moderate Scenario, the government can carry out basic maintenance of the infrastructure in towns, cities and improve on the rural roads. The government availability of necessary spare parts for the vehicles and improved driving practice can reduce emissions in this sector. Improved transport management, registration of vehicles, road furniture in the cities and towns. In the Enhanced Scenario, the migration options will include improvement on the infrastructure in the cities and towns and regional transport systems. Other mitigation options in the transport sector will be based on development and thereafter increased use of biofuels and investment in fuel efficient vehicles by both government and private sectors stakeholders. These measures will need to be driven by policies and must be enforces.

Somalia has a long cost line with main fishing activities. The fishing boats should keep well maintained to reduce the emissions. This also applies to ship which are used in transporting goods are services within the Somalia boarders. Further, the Federal Republic of Somalia has many regional airports. Most of the regional airports suffered due to lack of maintenance and reduced traffic flow. Of recent the increases in flow of traffic at the regional levels. There are now some regions which handle international flights. These regional airports should be rehabilitated and others are improved to handle internal and international flights

4.4.2.3. Biodiesel and Other Potential Mitigation Options

As the economy improves, the population in the cities and town is likely to increase. The need of mobility will increase and the fuel consumption will increase proportionately. Apart from the infrastructure development in the cities, mass transit system mostly in the urban areas may be initiated by the year 2025, it will start by putting in place appropriate infrastructure.

Biodiesel is the name of a clean burning alternative fuel, produced from domestic and other renewable resources of energy which are from crops. Biodiesel can be produced from crops and plant oil which are not edible, such as custer seed, jatropha and corton, so that it will not compete with food crops. Biodiesel can be operated in any diesel engine with little or no modification to the engine or the fuel system. It can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. The emission from diesel engines is a major exhaust pollutants, both unburned hydrocarbons and nitrogen oxides. The use of biodiesel results in a substantial reduction of unburned hydrocarbons. In the areas where there are vast marginal lands can be used for growing energy crops.

4.4.2.4. Household Level Mitigation Options

Most the fuel used in the households generate biogenic GHG, therefore there is not net effect in the atmosphere from the CO_2 emissions. But it should be note that Non CO_2 is also produced in process. The use of kerosene in the households for lighting and cooking do emit GHG. High rate of charcoal consumption in the urban households had led to deforestation and land degradation in Puntland. As a mitigation measure, Puntland State of Somalia is to initiate programmes that would promote the use efficient cooking stoves and encourage consumers to switch to alternative fuels, such as kerosene and liquid petroleum gas (LPG). The use of electricity is still out of reach for most of the households in the foreseeable future.

Most the fuel used in the households generate biogenic GHG emission; therefore there is not net effect in the atmosphere from the CO_2 emissions. But it should be note that Non CO_2 are also emitted in process. The use of kerosene and LPG in the households for lighting and cooking do emit GHG. The mitigation options at household level will include the following:

a) The use of solar energy and wind energy are good mitigation options for lighting, instead of using kerosene lamps, which emits GHG.
b) The promotion and use efficient cooking stoves for biomass fuels such as firewood and charcoal is also another avenue for reduction possible GHG by reducing the amount of biomass used in the households and reduction in deforestation and land degradation in the rural areas.
c) Fuel switching from wood and charcoal to biogas and LPG respectively, are among the possible mitigation options for the household sector, although LPG is fossil fuel, it is cleaner than charcoal as far as indoor air quality is concerned. On the other hand, the effects of the GHG emissions from the use of LPG in household sector, is less than the effect of emissions due to the deforestation, use of inefficient kilns used in charcoal production and land degradation.
d) Wind and solar energy are possible sources of electricity for water pumping and electricity generation. This will be a viable mitigation options in water pumping instead of use of petrol and diesel engines which emits GHG.
e) Use of biogas at household level can reduce fuel wood and charcoal in the household sector. It should be noted that for biogas to function successfully, water availability in the vicinity is very important. Operation of biogas plant at household level is labour intensive.
f) PLG is one of the most favourable fuels to substitute charcoal. The LPG usage in households will current low usage in the major cities and towns to about 5% of households using it for cooking, but there should be infrastructure for delivery of fuel.

4.4.2.5. Industrial, Commercial and Institutional Mitigation Options

The major sources of energy are electricity, biomass and petroleum fuels. The mitigation options in this sector will include but not limited to the following:

a) The energy use in industries is high due to the low efficiency, in adequate skilled work force and general sensation on energy related matters. The next step is to conduct energy audits in high energy intensity industry and commercial sectors. This informs these sectors which mitigation actions can be carried by the private sector. Energy management is more important in industries. Awareness creation in good energy saving practice in all sectors should be promoted.

b) The use of efficient devises such as institutional stoves in commercial and institutions sector, should be promoted as a mitigation options mostly in biomass (charcoal and fuel wood. Industries use old equipment lack of skilled human resources to run machines effectively including equipment maintenance. There are several good practices which should be adapted by the industry, commercial and institutions. Energy efficiency is the cheapest entre points for mitigation options in terms of energy use.

c) The infrastructure such as commercial buildings should be designed such a way that the use of day light is maximized so that less electricity will be required during the day. Since most the electricity is generated using thermal energy, it implies that less fuel will needed to light industries, commercial and institutions. In the later stages, Federal Republic of Somalia can develop building codes for all types of the building. Further to that good well designed buildings will minimise the need for energy consuming air conditioners and ventilation equipment.

d) As results of inefficient equipment, the load factor is generally low. Industries can use capacity banks to improve on the load factor; this will reduce the cost running industries since the tariff is one of the highest in the world.

e) For Federal Republic of Somalia industries to be competitive against the imported products from other countries. As the country stabilises, the income will increase and hence the purchasing power of the Somalis. This will call for replacement of the old equipment in industries which are energy consuming.

f) Industries and commercial sector should carry out periodic energy audits in high energy consuming sector, so is very important for these sectors should be benchmarked against other countries.

There low level of industrialization in Somalia, the emission will consequently be very low. If the industries such cement and lime is developed, there will low level emissions in this sector. It is envisaged these industries will be developed during the ongoing rehabilitation efforts by the government and private sector. Lime is produced in three major steps; stone preparation, calcination and hydration. Calcination in the process by which lime stone, which is mostly calcium carbonate is heated at high temperatures. When calcium carbonate is heated in a kiln to produce lime, carbon dioxide is a by-product of this reaction and usually emitted to the atmosphere.

Cement production involves treating limestone with heat to produce calcium oxide, or lime, and adding silicates to yield "clinker," raw cement. At times clinker is imported. Carbon dioxide (CO_2) is a by-product of a chemical conversion process used in the production of clinker, a component of cement, in which limestone ($CaCO_3$) is converted to lime (CaO). Clinker is ground to size and blended to yield various cement-type products. The major end-uses of energy in this sub-sector are process heat for producing clinker from limestone and other minerals, plus motive power using electricity for grinding, moving, and blending intermediate and final products.

4.4.3. Agriculture Sector Abatement Options

This is very important for national economy inters of providing food, it also contributes to the export of commodities to the foreign markets. Most the people are employed in agriculture sector. Agriculture covers subsectors like crops, livestock and fisheries. Agriculture is wide; it includes activities and practices in the agriculture sections, cropland management; grazing land management/pasture improvement; management of agricultural organic soils; restoration of degraded lands; livestock management; manure/biosolid management; and bioenergy production. All these activities are potential emitter or sequester of greenhouse gasses. The major forms of GHGs emitted are; Methane (CH_4) mostly from manure and rice production.

The possible sources of emissions are burning; field burning of agricultural residues, manure management and agricultural soils. Land has to be opened for agriculture as the result, emissions from land tilling. Most of the emissions in Somalia in agriculture is coming are from the livestock. The main sources of the emissions are from: enteric fermentation; animal wastes. Livestock is a thriving business in Somalia with large export potential. The total emission from Somalia is 18540.29Gg of CO_2 eq.

Mitigation in the agricultural sector requires a holistic approach because of the interlink ages within the three subsectors and more especially livestock and crop. The manure is which available at household level can be used under integrating animal manure waste management systems in agriculture, including biogas capture. The biogas can be used for lighting and cooking in households. That would save on firewood and use of charcoal. The effluent from the digester, thus the slurry can be used as fertilisers in gardens. There are other benefits such as improve the livelihoods of families while contributing to climate change mitigation. The government of Somalia can promote agroforestry which can intern increase soil carbon sequestration. Promote cultivation of legumes; adopting fertilizer management will have mitigation impacts in the agriculture sector.

In general mitigation options in agriculture need to be locally appropriate and placed within a holistic approach to land management.

a) Crop residue has many applications, it often used to improve soil fertility it can also be used as energy source by gasification technologies which can be used in generation of electricity in rural areas.
b) Improved cultivation methods which will minimize tilling of land and other practice
c) Rational application of fertilizer especially those which are not organic based.
d) Drip irrigation that will reduce the amount of water needed for irrigation as well as other water conservation techniques

e) Solar (photovoltaic) and wind water pumps for irrigation and watering of livestock to replace the use of diesel and petrol generators
f) Solar energy for processing agricultural products will improve on farm productivity.
g) Maintenance of the fishing boats and using efficient engines and clean fuels in engines.

Agriculture plays important role in national economy. This sector has the high emissions as illustrated in this first national communication. The sources of emissions are sources of the emissions are from: enteric fermentation; animal wastes; agriculture soils. The most important emissions are CO_2, N_2O and CH_4. There are mitigation options which can be implemented depending on the national development plans. Integrating animal manure waste management systems in agriculture, irrigation practice, improved seeds and promotion of agroforestry and use of renewable energy such solar and wind in agriculture.

4.4.4. Mitigation Options in the LULCF Sector

The forestry sector is very important in GHG emission reduction through emission removals (carbon sink) as well through land management. The mitigation in the forest sector mitigation in forestry has other co-benefits as it enhances sustainable management of other natural resources and ecosystems. It can also enhance agricultural productivity. The land under forest provides a wide range of ecosystem services including mitigation of climate change. The potential for greenhouse gas emission reductions in the forest sector comes from both enhanced GHG removals as well as from reduction of emissions through the management of forest. The emission in the forest sector is expected to increase due to deforestation at national level. These are mitigation options which can reduce the emissions. The sours of emission are covered in the inventory. If appropriate mitigation action is applied the emission will reduce and the carbon sequestration will increase.

In general, mitigation strategies in the forestry sector can largely be grouped into four main categories:

a) Reducing emissions from deforestation
b) Reduce emissions from forest degradation
c) Enhancing forest carbon sinks
d) Product substitution

It is well know that generally forests can reduce GHG emissions by either through to main mechanisms and these are either active absorption or sequestration of carbon dioxide by growing trees and other similar vegetation or from avoided emissions by protecting existing forest vegetation from activities that will result into release of carbon dioxide and other GHGs into the atmosphere. Most of these activities are as results of human activities.

The government of Somalia can intensity activities that will result in to increasing the stock of trees in the forests thus accelerated plating of tress in the regions with favourable climate for growing tress of particular species. The other activities will include increasing growth rates of existing forest stands through better silvicultural practices. Under all these activities there will be need to protect the forest from human induced activities. Activities such as forest fires or decomposition of biomass and woody vegetation will result into carbon loss. It calls for improved forest management practice.

The demand for land for agriculture is on increase, the government should halt or reduce conversion of forests to other land uses or deforestation, reducing damage of events such as logging, fires or pests and disease to existing forests. It will call for strict forest management and control of forest resources. It will also require required law to be implemented in the forest sector.

Product substitution comprises fossil fuels such as LPG instead of wood and charcoal, and the use of materials such as cement, steel, aluminum, plastic instead of wood. Opportunities for mitigating GHGs in forestry fall into three broad categories based on the underlying mechanism:

a) Enhancing removal of CO_2 from the atmosphere
b) Reduced emissions
c) Avoiding emissions

Carbon dioxide removal from the atmosphere is referred to as carbon sequestration. Trees have the largest terrestrial carbon sequestration potential. This arises from the size as well as the fact that trees are long lived. As trees grow, they absorb carbon dioxide, the bulk of which is fixed in tree biomass as wood. This carbon dioxide is only released when parts of the tree are removed or when the tree dies, and decomposition sets in.

Forest operations can greatly influence both the rate of carbon sequestration but also the amount and carbon each forest will store even after sequestration. Reduced emissions can be achieved through low impact logging operations, where use of heavy machinery is reduced of minimized in logging operations. This will mainly reduce emissions in two ways. The first involves less damage to vegetation in the forest other than the tree of interest. Secondly, the release of carbon dioxide from operation of machinery is low. Forest management practices that reduce emissions include diminished deforestation, increased forest rotation length, expanded forest reserves, and improved disturbance management with respect to fires, pest outbreaks, and harvest practices.

Green plants absorb CO_2 through photosynthesis and use the contained carbon to build organic matter. Thus, plants store (sequester) carbon as they grow. At the end of plant life, most of the carbon is quickly released to the atmosphere through oxidization, microbial decomposition, and/or combustion. However, some enters other terrestrial pools .Agricultural and forests soils sequester carbon. About 80% of global carbon is sequestered in soils or forests. Because of the land use changes over the last few decades, a lot of the carbon stored in soils was released to the atmosphere. There is potential to reverse this with mitigation actions in the agricultural and forestry sectors. In order to enhance carbon sequestration, the two key processes that need to be emphasized are increasing the rate of carbon accumulation by the plants and soils and at the same time decreasing carbon destruction through combustion and decomposition.

Emissions can be reduced by forest management practices that reduce emissions including diminished deforestation, increased forest rotation length, expanded forest reserves, and improved disturbance management with respect to fires, pest outbreaks, and harvest practices.

4.4.4.1. Supply-side Mitigation Options

Thousands of hectares of forest is lost annually, this results in emissions arising from deforestation, which could be reduced conservation of existing carbon pools in forest vegetation and soil. This can be done by protecting forests and controlling other anthropogenic disturbances such as possible fire and pest outbreaks. Promotion of afforestation and reforestation interventions will also lead to improved biomass on non-forested agricultural lands, it will improve on the soil fertility around the forested areas Tree planting must be promoted and supported. However best practice should be promoted, the planning can be in the form of either monocultures or mixed species plantings. If these activities are carried out successfully, it will have a wide range of social and environmental benefit and

4.4.4.2. Enhancing Forest Carbon Stocks

Woodlands and forests contain substantial carbon in the soil, trees and other vegetation. Globally forest provides one of the largest carbon sinks. , and play important roles in the carbon and hydrological cycles. Forest management activities that conserve carbon stocks in forests include the following:

a) Sustainable practices of forest management and use;
b) Integrated fire management;
c) Management of forest health and vitality;
d) Management of forest biodiversity;
e) Management and extension of protected areas.

4.4.4.3. Co-Benefits of Mitigation in the LULCF sector

Co-benefits of climate change mitigation refer to benefits of mitigation in the forest sector to other sectors. The co-benefits and trade-offs among GHG mitigation measures include; may result in maintaining or increasing crop productivity improve regional food security. This can be achieved through increasing soil carbon by maintain forest sector sequestration that prevent soil degradation by avoiding erosion and improving soil structure.

4.4.4.4. Challenges of Mitigation in the LULCF Sector

There is an up surging pressure for land from an increasing population causing forest cover conversion to other land use. Reducing the cover area under forests reduces the net mitigation potential of the forest sector. This can be addressed through building capacity for monitoring reporting and verification (MRV) with regard to mitigation in forestry. The increasing demand of charcoal in the Middle East is also increasing pressure on the forest cover, coupled with low m high level of poverty around the forest.

Forestry sector is very important in GHG emission reduction through emission removals (carbon sink) as well through land management. Further, mitigation in forestry has other co-benefits as it enhances sustainable management of other natural resources and ecosystems which are endangered by deforestation.

4.4.5. Waste Abatement Options

Generally in Somalia, all regions most the waste collection is not well managed. The waste composition is influenced many factors, such as geographical location, the population's standard of living, energy source, and weather. Waste is one the major sources of greenhouse gas emission. Most of wastes generate GHG (Methane), as the rate of urbanisation is increasing so is the waste generated. Waste management represents an important challenge for the reduction of GHG emissions. Waste is also a potential resource, much of which can be recycled and reused. In municipalities, wastes are collected and dumped in shallow landfills; while a times wastes are burned in open as a solid waste management practice. Waste can be a cause of serious risks to ecosystems and human health are thus inevitable, it call for careful planning of waste management by the relevant authorities so as to minimise the GHG generated in the process.

There is no organized recycling system in Somalia. Waste are deposited in the landfill, most of which are unmanaged shallow landfill. Most of the people who are involved in recycling are informal sector, thus it is not regulated. There are mature technologies such as landfill gas recovery which reduces methane emissions. The other methods are to minimizing waste generation which can be done post-consumer recycling. It is also possible to avoid GHG generation by composting wastes. Waste GHG reduction is one the viable CMD projects in some parts of the world. Thermal processing such as incineration is very limited in treatment of medical waste. There are also other thermochemical processes such as pyrolysis and gasification which is not commonly used as waste management in Somalia. It is expensive and requires large volume of wastes.

4.4.5.1. Composting

Composting is defined as a controlled aerobic, biological conversion of organic wastes into a complex stable material. The products of composting are commonly used for agriculture and landscaping. The composted organic product has several potential applications. A primary application of compost is for agriculture, compost serves as a soil conditioner and it supplies nutrients to soils. Compost can also be used in landfill operations as a daily cover material.

4.4.5.2. Waste as Energy Source.

Wastes dumped at the landfill contain energy which can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another types of fuels. In the case of direct conversion, landfills can be designed with landfill gas extraction systems installed to extract the gas. Gas is pumped out of the landfill using perforated pipes and flared off. In this case instead of emitting CH_4, which a gas with high global potential (GWP), CO_2, which has a lower GWP will be released to the atmosphere. The gas can also be used as a fuel source for cooking and heating. The gas can also be used to generate electricity.

Solid waste, if large amount generated and prepared for combustion, can also be used to fuel boilers to generate steam and electricity. There are other thermochemical applications which be used to generate energy. The examples are pyrolysis, where waste is heated at high temperatures in limited oxygen. The product is combustible solid fuel (charcoal), other are liquids and gaseous fuels. The waste can also be heated at a higher temperature in presence of air or any other oxidizing agent such as steam to produce combustible gas (producer gas). The gas can be used as fuel for thermal application.

Faecal sludge can be prepared for gasification by first drying and reduce the moisture content, to produce energy by gasification for thermal application and electricity generation. Energy can be generated from methane generated in sewage treatment system which can be used operate sewerage treatment plants. Incineration and industrial co-combustion are other ways of providing renewable energy and offsetting fossil fuel use.

Good management of wastewater offers many benefits for greenhouse gas mitigation, as well as environmental protection, public health and water conservation. However, a lack of local capital is a key constraint for implementing better waste water management at this time. There are many technologies available for wastewater management, collection, treatment, re-use and disposal. Wastewater can be treatment by natural purification processes, but not commonly practiced for large amount of waste water. It is application in industrial water treatment systems.

There are other wastes management systems such as pit latrines which are the most common in urban and rural areas; the use of septic tanks is limited to urban areas. There are advanced treatment plants such as sludge treatment, trickling filters, anaerobic or facultative lagoons, anaerobic digestion and constructed wetlands but has not find applications in the least developed countries such as Somalia. As the country is planning to develop, it will be a good practice to plan for modern system of waste treatment. It can also be used for energy generation (biogas).

Most of the wastes generated in Somalia are poorly managed. Most the waste is from biomass. As the population increases more waste will be generated. Wastes emit methane to the atmosphere. There are several mitigation options in the waste sector. Composting can be initiated at regional capital cities and other urban areas many town councils. There is potential of using sewerage to produce biogas energy. It can be used to run engines and generators for electricity generators. It is envisaged that waste collection will improve in the near foreseeable future that will lead to better management and reduction in greenhouse gas emissions.

4.5. Policies and Measures to Mitigate Climate Change

The Federal Republic of Somalia needs to put in place favorable policies to support short term and long term mitigation actions. These policies will attract investment in the Federal Republic of Somalia State of Somalia. The policies should be able to guide Somalia to implement mitigation actions. Some policies may be developed in the future; there are urgent activities which have to be developed in the short-time. The policies should be drafted to safeguard the national interests and needs that can be integrated with climate change mitigation objectives. The policy for infrastructure development, will guide the future development of the cities, the location of essential infrastructure, low energy building designs and standardization of energy saving equipment.

CHAPTER FIVE

CLIMATE CHANGE IMPACTS, VULNERABILITY AND ADAPTATION OPTIONS FOR SOMALIA

CHAPTER FIVE

CLIMATE CHANGE IMPACTS, VULNERABILITY AND ADAPTATION OPTIONS

5.1. Introduction

Climate change is an acknowledged fact, and it is likely that the Horn of Africa will become drier with more extreme and frequent droughts and floods, even though the factors causing climate change are beyond the borders of Somalia, as the country has a small carbon foot-print. Somalia is one of the most vulnerable countries to climate variability and changes due to its high dependence on natural resource-based livelihoods, underdeveloped water resources, low health service provision capacity, population growth, low economic development, limited adaptive capacity, poor road infrastructure in drought-prone areas, weak institutional structures, low levels of climate change awareness among other factors (IUCN, 2006).

Somalia is one of the country's most vulnerable to climate variability and changes due to, among others, its high dependence on rainfall agro-pastoral practices and natural resources. The country is indeed rated as among the most vulnerable to climate change as a result of its low adaptive capacity. It has frequently experienced extreme events like droughts and floods, and other climate-related hazards. The country experiences high levels of rainfall variability and the increasing temperature which results to the frequent droughts that cause famine and as a consequence affecting the people's livelihood. Since the early 1980s, the country has suffered seven major droughts, five of which led to famines in addition to dozens of local droughts. Major floods also occurred in different parts of the country[82].

The country experiences an arid to semi-arid climate where precipitation the major defining characteristic of the climate and has a great spatial and temporal variability. The climate of Somalia is determined by the north and south movement of the inter-Tropical Convergence Zone (ITCZ). This result into two rainfall seasons namely the "Gu" experienced when the zone passes northwards and the "Deyr" as it moves south. Rainfall is the principal climatic factor affecting life in Somalia as seem from the impacts of variation rainfall amounts from season to season, and within the season making agricultural and pastoral activities most vulnerable.[83]

The country's vulnerability is exacerbated by lack of capacity to deal with climate related disasters such as droughts and floods largely attributed to over 25 years of civil unrest. Further a greater proportion of the country falls under a climatologically fragile ecosystem; mainly the arid and semi-arid lands covering the northern part of the country, where the annual rainfall is as low as 50-100 mm (FROS, 2013; IUCN, 2006). In Somalia; increased rainfall variability is a significant indicator of climate change, and this is manifested through extreme events, among them, droughts and floods whose frequency and intensity show an upward trend in recent years.

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[82] Muchiri P.W. (2007), Climate of Somalia. Technical Report No W-01, FAO-SWALIM, Nairobi, Kenya.

[83] Muchiri P.W. (2007), Climate of Somalia. Technical Report No W-01, FAO-SWALIM, Nairobi, Kenya.

Unless early action is taken to adapt to climate change, the country may not be in a position to achieve any of the SDGs. At present there is little appreciation of the threats that climate change pose, even though there are drought early warning systems in place, and the Somali people have time tested risk management and resilience enhancement strategies. It is important adaptation measures are put in place otherwise this could have drastic effects on the country's development.

Adaptation presents one of the most effective and crucial responses to the impacts of climate change because stabilizing the atmospheric concentrations of greenhouse gases (GHGs) that are responsible for climate change will take a very long time. In addition, some of the GHGs already in the atmosphere have long lifetimes and their effect will therefore continue to be experienced long after their removal. If properly implemented, adaptation activities have the capacity to reduce present and future losses from climate variability and change. It is important to understand that adaptation is neither a one-off intervention nor a stand-alone activity, but an iterative process needs to be integrated into development policy-making and planning, including in the context of Sectoral and national plans, such as Poverty Reduction Strategies (OECD, 2006).

It is well recognized that climate change poses a serious threat to agricultural production, the natural resource base, and the livelihood of communities, more particularly in the dry lands. The Federal Republic of Somalia has demonstrated its determination to address climate change at the international level by signing and ratifying all the Rio Conventions that is, the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, the Convention on Bio-diversity (CBD) and the Convention to Combat Desertification (CCD (FROS, 2013).

The purpose of this chapter is to identify the impacts of climate change and the vulnerabilities of selected sectors of Somalia, identify the potential adaptation options, and present measures the country has put in place to facilitate adequate adaptation to climate change pursuant to Article 12.1 and 4.1 of the UNFCCC to which the country is party to.

5.2. Methodology

The methodology used to analyse the impacts of and vulnerability to climate change and variability involved five steps, namely:

i) Generation of current and historic climate: this involved the analysis of current and historic trends in rainfall, temperature, and major climate related hazards at national and regional levels.
ii) Assessment of current vulnerability to climate variability.
iii) Projection of the future climate using climate model outputs to outline a range of scenarios for future rainfall, temperature and other climate variables.
iv) Assessment of future impacts of climate change.
v) Review of ongoing adaptation measures and identification of new options.

5.3. Factors Determining Vulnerability

The main environmental factors are soil erosion, deforestation, recurrent droughts, desertification, land degradation, and loss of biodiversity including wildlife and depletion of ecosystem services. The vulnerability of Somalia to climate variability and change is mainly a result of very high dependence on rain-fed agriculture and pastoral which is very sensitive to climate variability and change. The other causes include; under-development of water resources, low health service coverage, a high population growth rate, low economic development, low adaptive capacity, inadequate road infrastructure in drought prone areas, conflicts, weak institutional structures, and lack of awareness. .

Vulnerability to climate change is determined by the exposure to hazards that result from the changing climate, sensitivity to the impacts, and adaptive capacity. Vulnerability is thus high if changes in climate increase the exposure of populations to events such as drought and floods. Hence, vulnerability increases with increased frequency and severity of the climate event, and is highest where the ability of people to cope is limited.

The capacity to cope is most limited, and thus sensitivity highest, where livelihoods are based on a narrow range of assets that are easily damaged by climate hazards, with few other options or means of managing risks. Vulnerability is therefore especially high for the poor in the marginal areas where climate change exacerbates exposure to climatic hazards.

Since vulnerability is a combination of exposure and sensitivity, then reducing vulnerability demands actions that will:

i) Reduce exposure to hazards;
ii) Reduce sensitivity to their effects, and
iii) Build capacity to adapt.

The latter component (of building adaptive capacity) enables communities and nations to mobilize the decisions and resources needed to reduce vulnerability and adapt to climate change (Nelson, Lamboll and Arendse, 2007).

5.4. Climate Change in Somalia

The climate of Somalia ranges from arid to semi-arid with only two areas receiving rainfall ranging between 400 - 600mm. These small areas include parts of the Northwest region of Somalia and the river valleys areas of Shebelle and Juba. Droughts are common with mild to moderate ones occurring every 3 - 4 years and serious drought occurring every 8-10 years. There are four distinct seasons experienced in Somalia which include, April-June (called Gu), October-November (Deyr), July-September (known locally as Hagaa) and December-March (known locally as Jilaal). The country experiences a bimodal annual rainfall pattern which is brought about by the movement of the Inter Tropical Convergence Zone (ITZ). The April to June season with the northerly movement of the ITZ brings the major Gu rains while in the October to November season; the southerly movement of the ITZ results in the minor Deyr rains. These two rainy seasons are separated by two dry spells Jilaal and Hagaa.

The spatial variation of the mean annual rainfall for Somalia is shown in Figure 5.1. The figure 5.1 shows that rainfall is characterized with a variation, ranging from about 600mm over some areas in the Northwest to less than 100 mm around the horn of Africa in the northeast tip of Somalia. The seasonal rainfall characteristics are closely associated with large-scale global circulation systems, especially the movement and characteristics of the Inter-Tropical Convergence Zone (ITCZ). Figure 2 below shows the average annual rainfall distribution in the country.

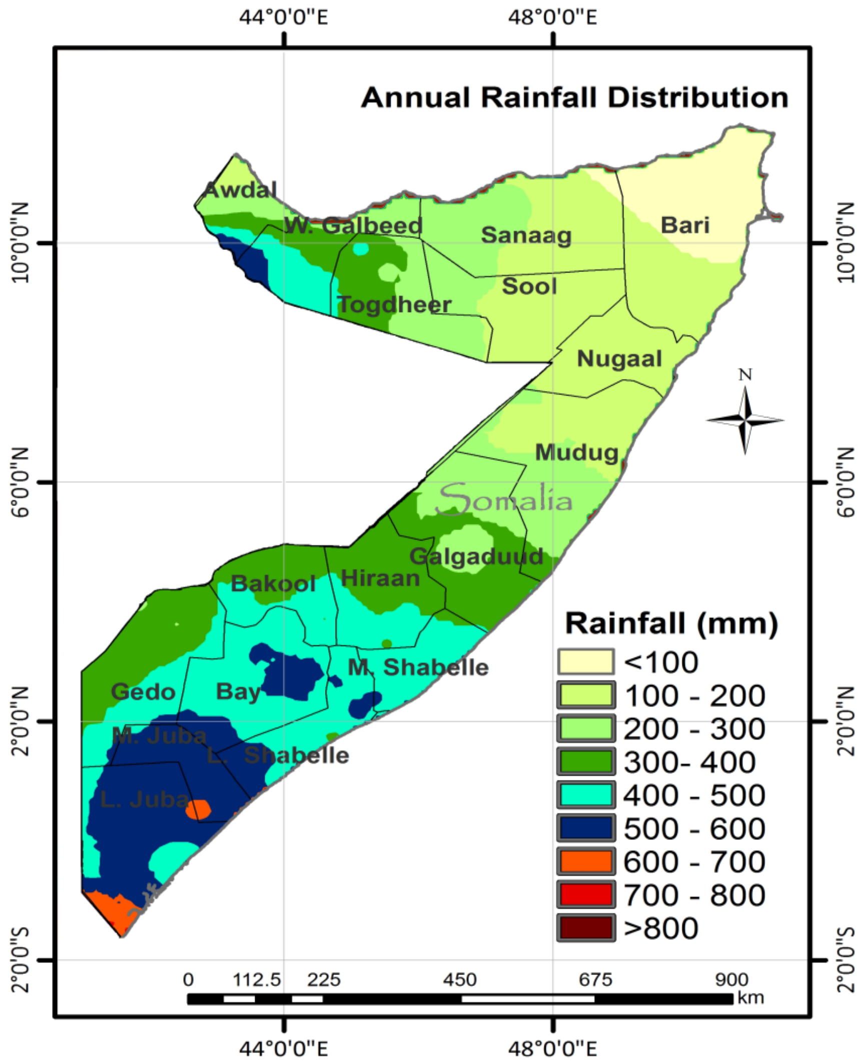


Figure 6-1: Annual Rainfall Distribution in Somalia (Source: FROS, 2013)

Somalia experiences low and erratic precipitation with an average annual rainfall of 250mm. The northern part of the country is characterized by extremely hot and arid conditions with an average rain of less than 250mm, while the average annual rainfall in the south is approximately 400mm and 700mm in the south-west. In the central semi-arid parts, the rainfall received is as low as 50-100mm/year (FAO, 1995). The seasonal rainfall characteristics are closely associated with large-scale global circulation systems, especially the movement and characteristics of the Inter-Tropical Convergence Zone (ITCZ).

The analysis of the inter-annual variation of rainfall for the period 1920s-2015 shows fluctuations of the total annual rainfall, with some years experiencing above normal rainfall, others below normal, and still others around the average value[84] (Figure 5-3).

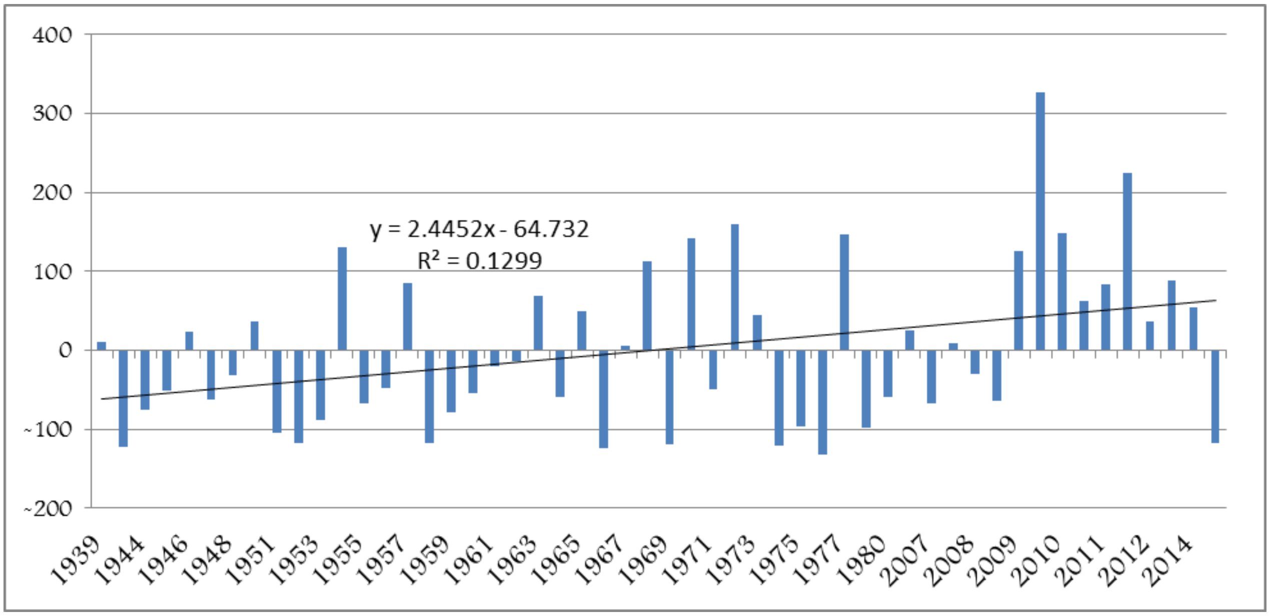


Figure 6-2 Year-to-year variation of Puntland's rainfall (1920s-2015) relative to the mean Source: FAO SWALIM, Station data85

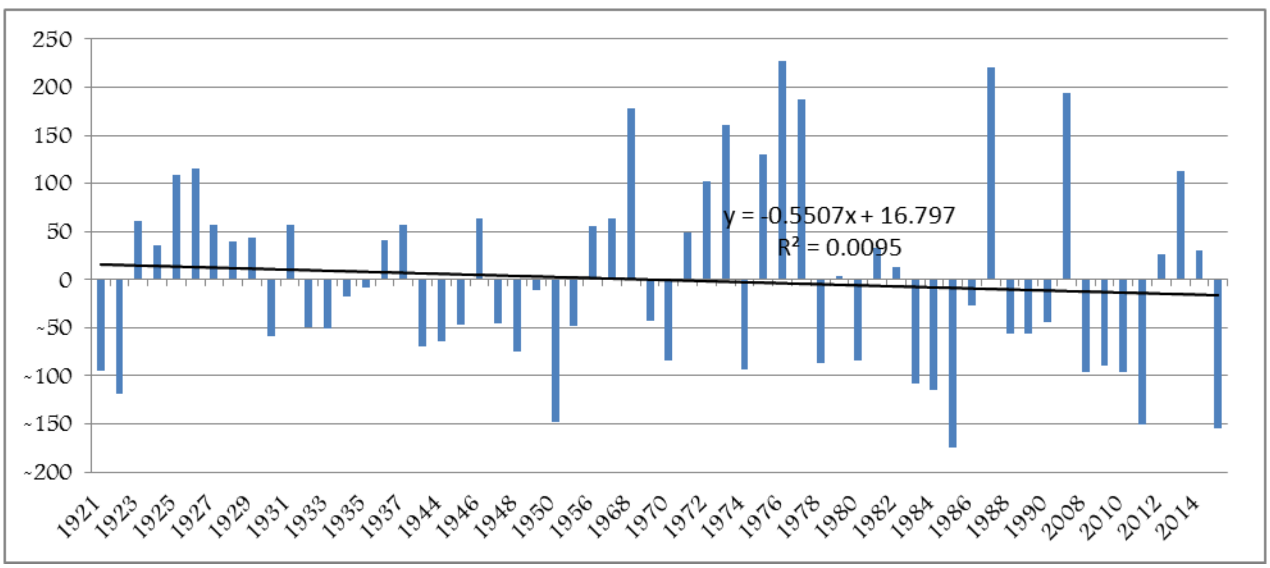


Figure 6-3 Year-to-year variation of Somaliland's rainfall (1920s-2015) relative to the mean Source: FAO SWALIM, Station data

[84] http://sddr.faoswalim.org/climate_manual.php?catid=2&subid=16&mapsubid=18

[85] http://sddr.faoswalim.org/climate_manual.php?catid=2&subid=16&mapsubid=18

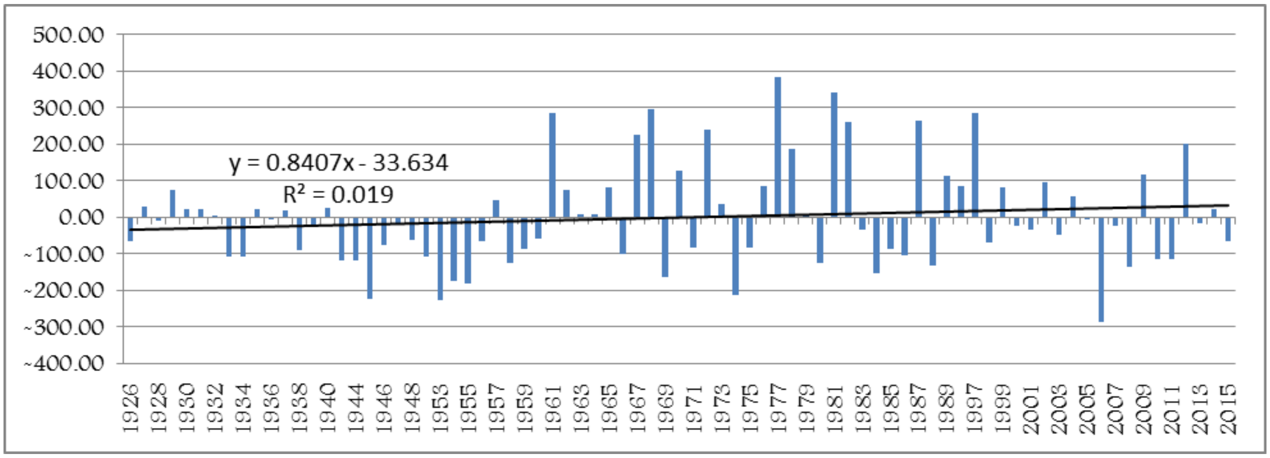


Figure 6-4 Year-to-year variation of South and Central Region's rainfall (1920s-2015) relative to the mean (Belet Weyne)

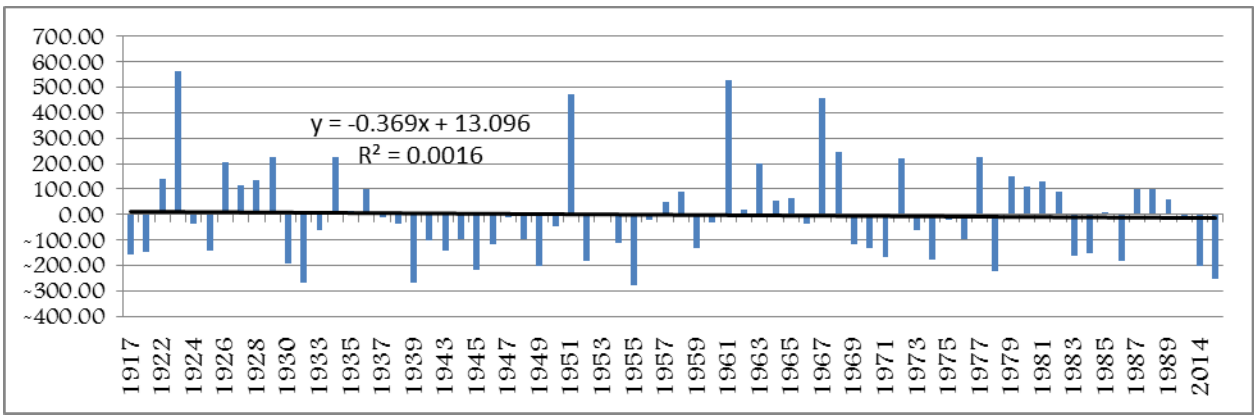


Figure 6-5 Year-to-year variation of South and Central Region's rainfall (1920s-2015) relative to the mean (Mogadishu)

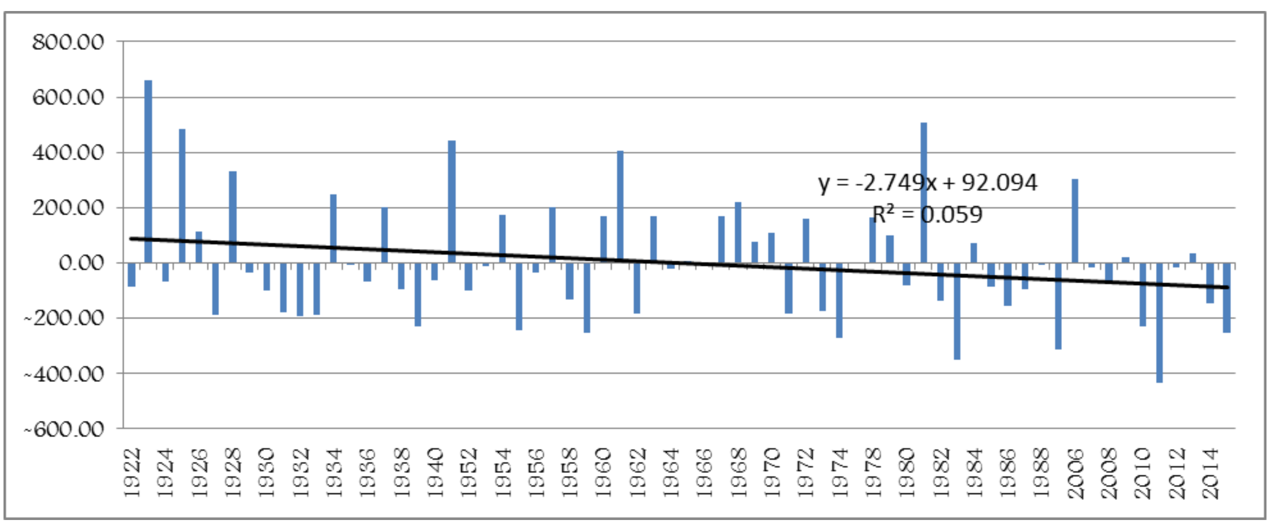


Figure 6-6 Year-to-year variation of South and Central Region's rainfall (1920s-2015) relative to the mean (Baidoa)

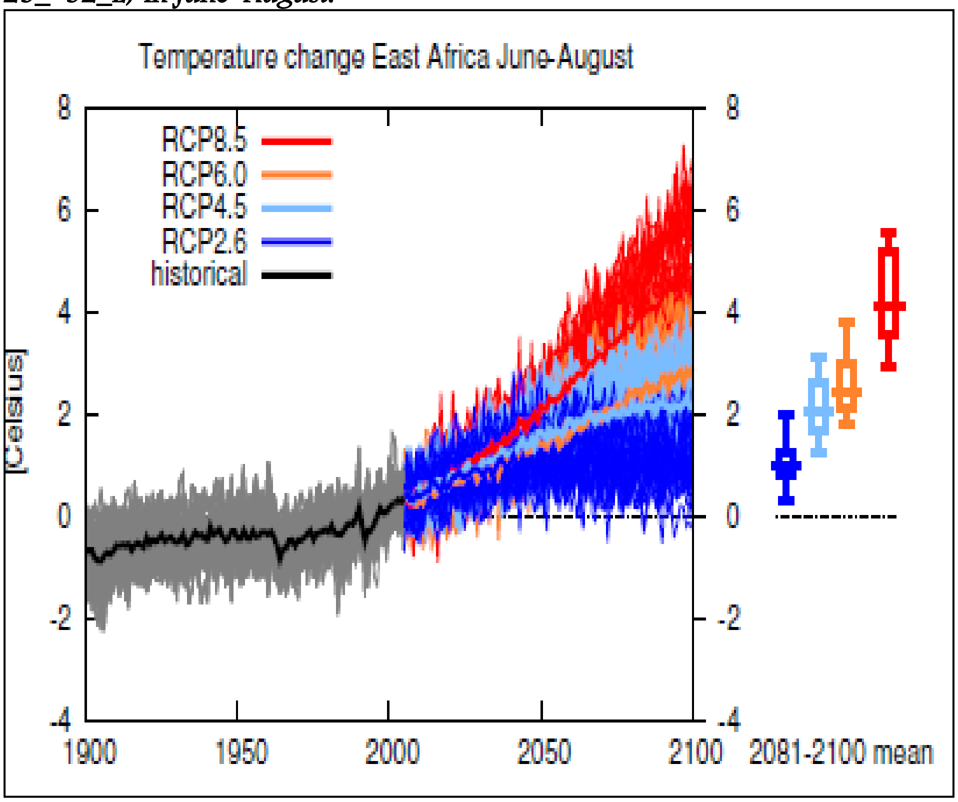
Studies have indicated that the total annual trend varies from region to region, with some regions like Somaliland and south and central showing as significant decline in rainfall.

5.5. Spatial and Temporal Changes in Rainfall and Temperature

5.5.1. Climate change Scenarios

The Fifth Assessment Report of the IPCC mid-range emission scenarios indicate that the mean annual temperature is projected to increase in the range of 0.9 -1.1 °C by 2030 compared with the 1961-1990 base period. Further, an increase in the range of 1.7 - 2.1 °C by 2050, and in the range of 2.7-3.4°C by 2080 over Eastern Africa (including Somalia) is expected when compared with the 1961-1990 base period (Figures 5-6 and 5-7)[86].

Figure 6-7 Time Series of Temperature Averaged over Land Grid Points in East Africa (11.3_S–15_N, 25_–52_E) in June–August.



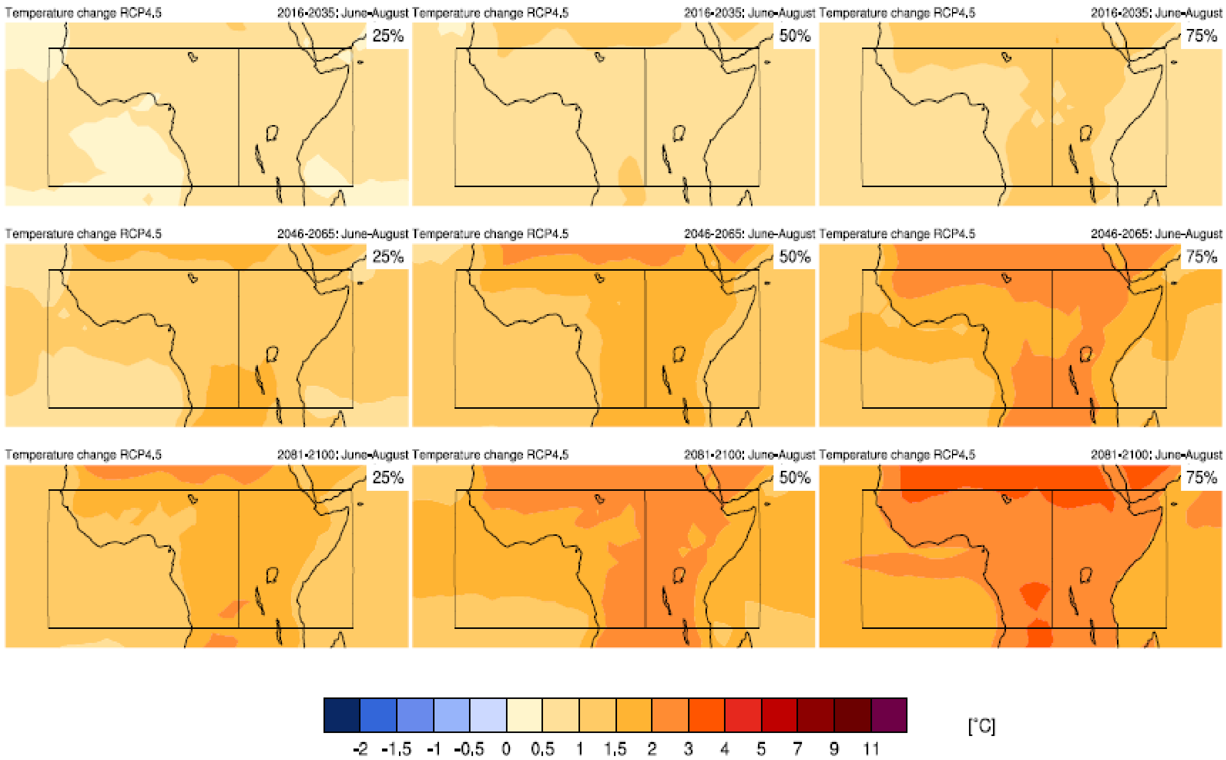
Note: Thin lines denote one ensemble member per model, thick lines the CMIP5 multi-model mean. On the right hand side the 5th, 25th, 50th (median), 75th and 95th percentiles of the distribution of 20-yr mean changes are given for the period 2081–2100 (relative to 1986–2005) for the four RCP scenarios.

.Source: IPCC, 2014

The projected change in the number of hot days up to the year 2100 indicates substantial increases in the frequency of days considered "hot" in the current climate, and are consistent with other temperature projections for the country (Figure 5-8). The trend explains a very high proportion of the total variance ($R^2 = 0.910 \approx 91\%$). Figure 5-9 shows a similar projection for each of the four seasons of the year, namely, January-March (JFM); April–June (AMJ); July-September (JAS); and October–December (OND).

[86] IPCC, 2014: Fifth Assessment Report of the IPCC (IPCCC_AR5).

Figure: 6-8: Temperature Changes in 2016–2035, 2046–2065 and 2081–2100 with respect to 1986–2005 in the RCP4.5 Scenario



Note: For each point, the 25th, 50th and 75th percentiles of the distribution of the CMIP5 ensemble are shown; this includes both natural variability and inter-model spread. Hatching denotes areas where the 20-yr mean differences of the percentiles are less than the standard deviation of model-estimated present-day natural variability of 20-yr mean differences. Source: IPCC, 2014.

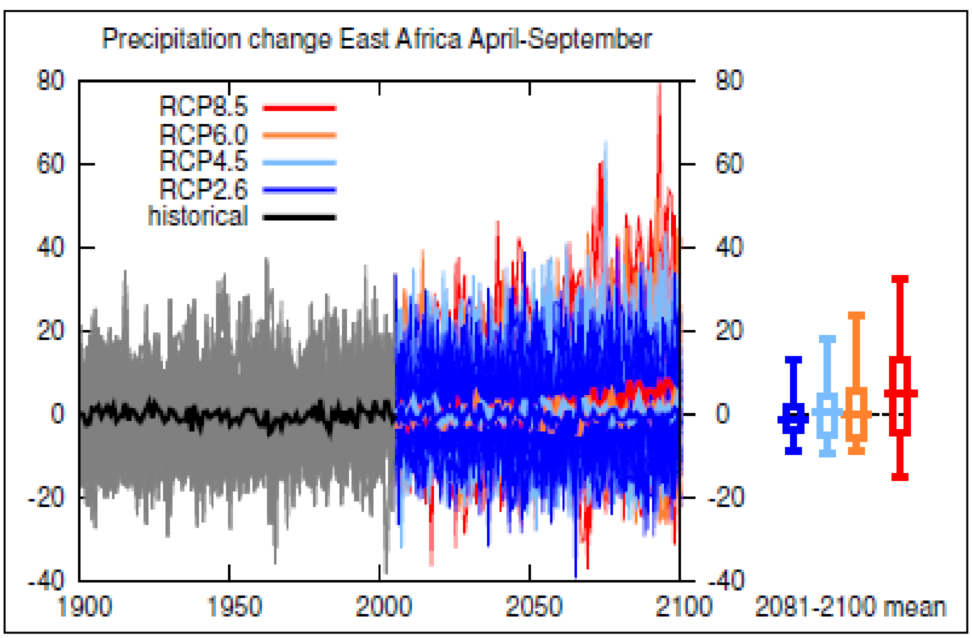


Figure 6-9; Time Series of Relative Precipitation Averaged over Land Grid Points in East Africa (11.3_S–15_N, 25_–52_E) in April–September

. Note: Thin lines denote one ensemble member per model, thick lines the CMIP5 multi-model mean. On the right-hand side the 5th, 25th, 50th (median), 75th and 95th percentiles of the distribution of 20-yr mean changes are given for the period 2081–2100 (relative to 1986–2005) for the four RCP scenarios

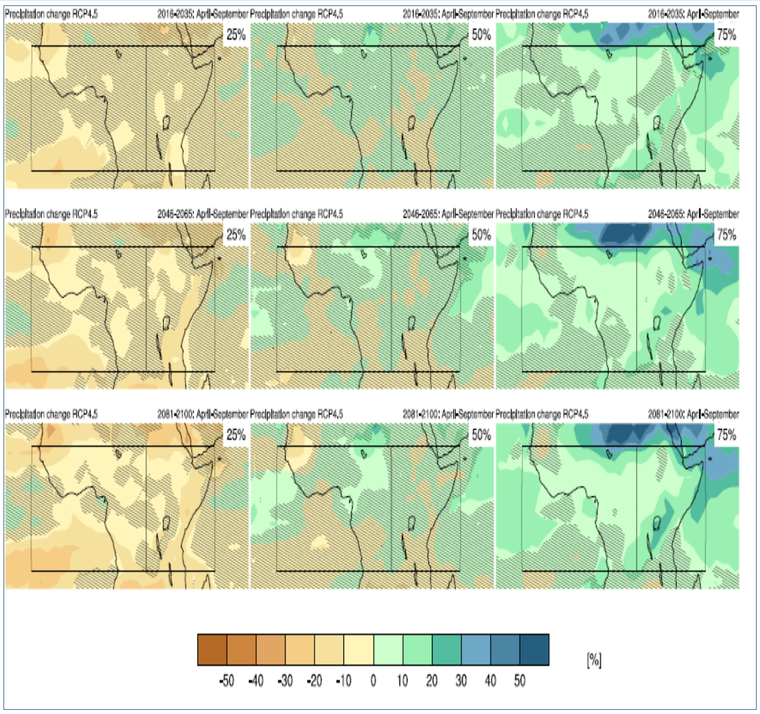


Figure: 6-10: Maps of Relative Precipitation Changes in 2016–2035, 2046–2065 and 2081–2100 with respect to 1986– 2005 in the RCP4.5 scenario

.Note: For each point, the 25th, 50th and 75th percentile of the distribution of the CMIP5 ensemble are shown, this includes both natural variability and inter-model spread. Hatching denotes areas where the 20-year mean differences of the percentiles are less than the standard deviation of model-estimated present-day natural variability of 20-year mean differences.

A consistent increase in the proportion of the total precipitation occurring in "heavy" rainfall events is observable[87]. This is indicative of an increase in "stormy" weather up to the year 2099 and is consistent with previous studies that have indicated that climate change will lead to an increase in the frequency and intensity of extreme climate and weather events like droughts, floods, and storms. However, shows almost no trend for the January–March and the July–September with the October–December season showing only a slight trend.

Applying coupled global climate model the Rossby Center regional atmospheric model (RCA4) driven by the Earth system version of the Max Planck Institute for Meteorology (MPI-ESM-LR) is used from the CORDEX; data is simulated to produce the results reported[88][89]. The model was integrated into the CORDEX-Africa domain (see Nikulin et al. 2012, Endris et al. 2013), with a horizontal grid spacing of 0.44 degrees. The

BOX 5.2: Definition of Terms

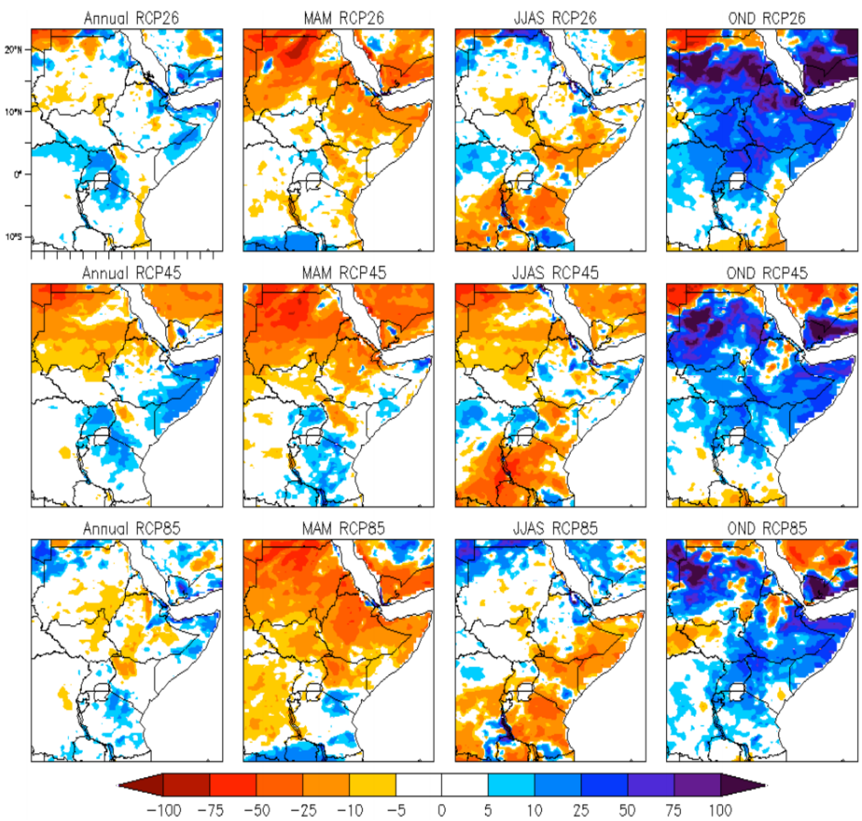
Projection of Climate Change

The projected climates change signals for each time window are calculated as the difference between the future time windows (averages calculated over 30 years) and the reference period. For example, the rainfall change by 2070s is computed based on the difference in average rainfall between the period 2055-2085 and the reference period (1971-2000). This is because the conditions prevailing in any individual year will be strongly affected by the natural climatic variability to reliably predict

[87] IPCC, 2014: Fifth Assessment Report of the IPCC (IPCCC_AR5).

observed natural and anthropogenic atmospheric composition for the period 1950 – 2005 was used to generate the historical simulations; while the projections for the period 2006–2100 are forced by Representative Concentration Pathways (RCPs). The results from the model were used based on the obtainability of the three different scenarios (RCP2.6, RCP4.5 and RCP8.5). In addition, the model has been found to produce more representative scenarios as the El Niño Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) in the historical period over the eastern Africa region than RCA model run driven by the other GCMs[90].

The period 1971-2000 was considered the reference for the present climate. This period was used to project changes in rainfall and temperatures (maximum and minimum) based on the RCP 2.6, RCP 4.5 and RCP 8.5 scenarios. The projections were analysed for four future time slices 2020s (2006-2035), 2030s (2016-2045), 2050s (2036-2065) and 2070s (2055-2085) to provide information on the expected magnitude of the climate response over each time window.



5.6. Rainfall Projection

The projected changes rainfall in Somalia is shown in figure 9 to figure 12 indicating the annual and seasonal rainfall components covering the Greater Horn of Africa (GHA).

Figure 6-11 Projected rainfall changes over GHA by 2020s

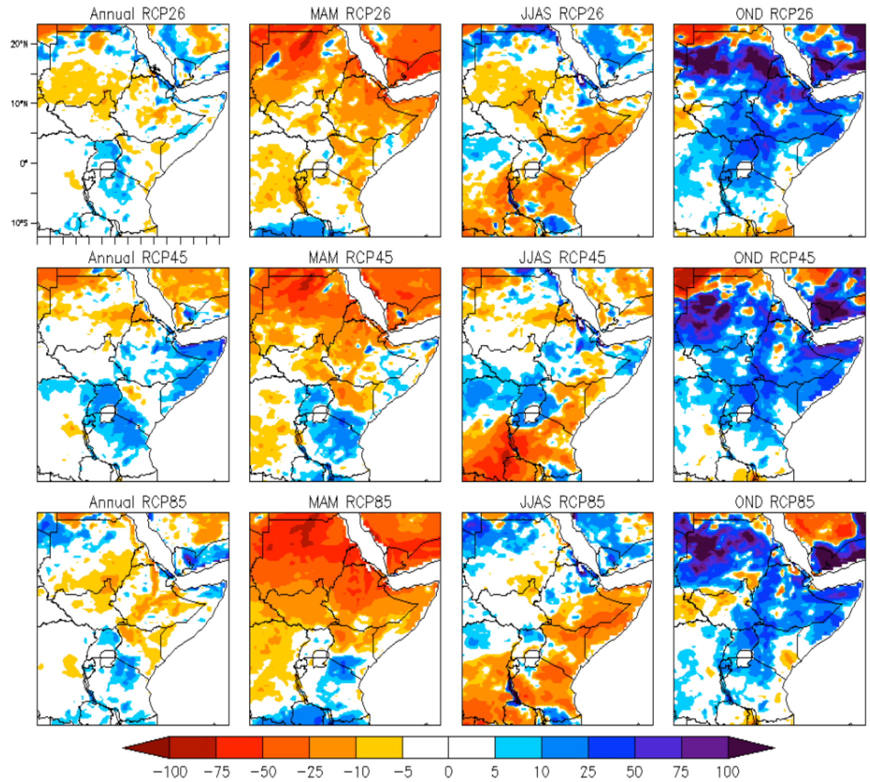
Annual (1st column), MAM (2nd column), JJAS (3rd column), OND (4th column); each row corresponds to emission scenarios: RCP2.6 (1st row), CP4.5 (2nd row) and RCP8.5 (3rd row) CP4.5 (2nd row) and RCP8.5 (3rd row

[88] Nikulin, G., Jones, C., Giorgi, F., Asrar, G., Büchner, M., Cerezo-Mota, R., & van Meijgaard, E. (2012); Precipitation climatology in an ensemble of CORDEX-Africa regional climate simulations. Journal of Climate, 25(18), 6057-6078

[89] Endris, H. S., Omondi, P., Jain, S., Lennard, C., Hewitson, B., Chang'a, L., & Panitz, H. J. (2013). Assessment of the performance of CORDEX regional climate models in simulating East African rainfall. Journal of Climate, 26(21), 8453-8475.

[90] Endris, H. S., Lennard, C., Hewitson, B., Dosio, A., Nikulin, G., & Panitz, H. J. (2015). Teleconnection responses Eastern Africa. Climate Dynamics, 1-26.

The results are shown for the time windows of 2020s, 2030s, 2050s and 2070s under the three scenarios as compared to the reference period (1971–2000). The projected changes in the annual rainfall component under each of the three different scenarios and time windows show little change in the annual rainfall component compared to the projected changes in the seasonal rainfall components.



The short rains (OND period) are projected to increase over most parts of the region under all the three scenarios (>50%) according to the model projection results. By contrast, the long rains (MAM) and JJAS are projected to decease over most part of the region (10-70%).

Figure 6-12: Projected rainfall changes over GHA by 2030s

Annual (1st column), MAM (2nd column), JJAS (3rd column), OND (4th column); Each row corresponds to emission scenarios: RCP2.6 (1st row), RCP4.5 (2nd row) and RCP8.5 (3rd row).

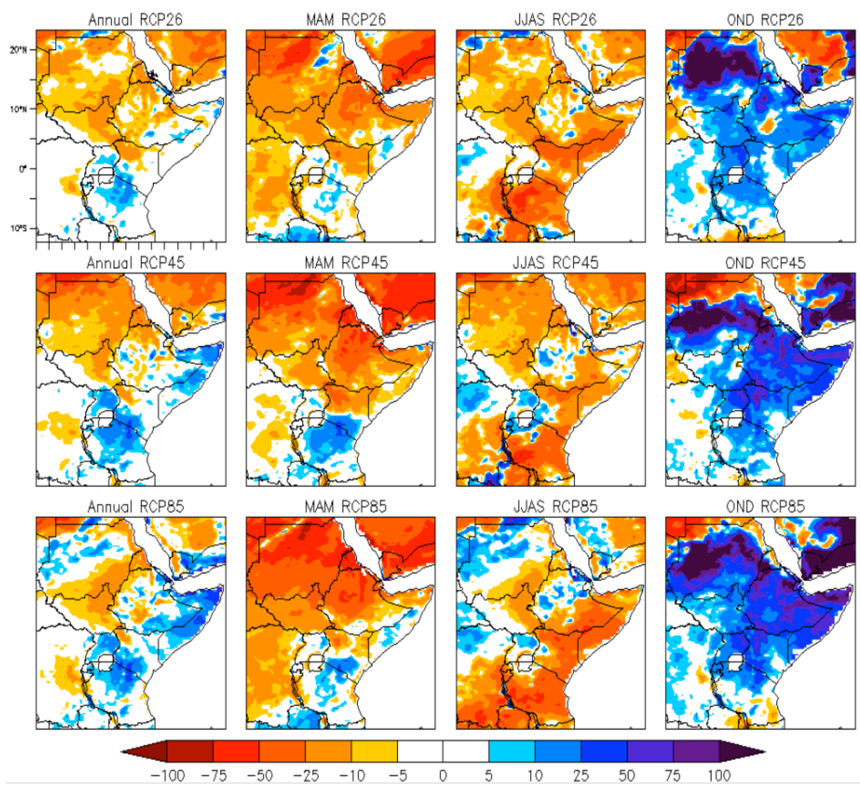


Figure 6-13Projected rainfall changes over GHA by 2050s

Annual (1st column), MAM (2nd column), JJAS (3rd column), OND (4th column); each row corresponds to emission scenarios: RCP2.6 (1st row), RCP4.5 (2nd row) and RCP8.5 (3rd row).

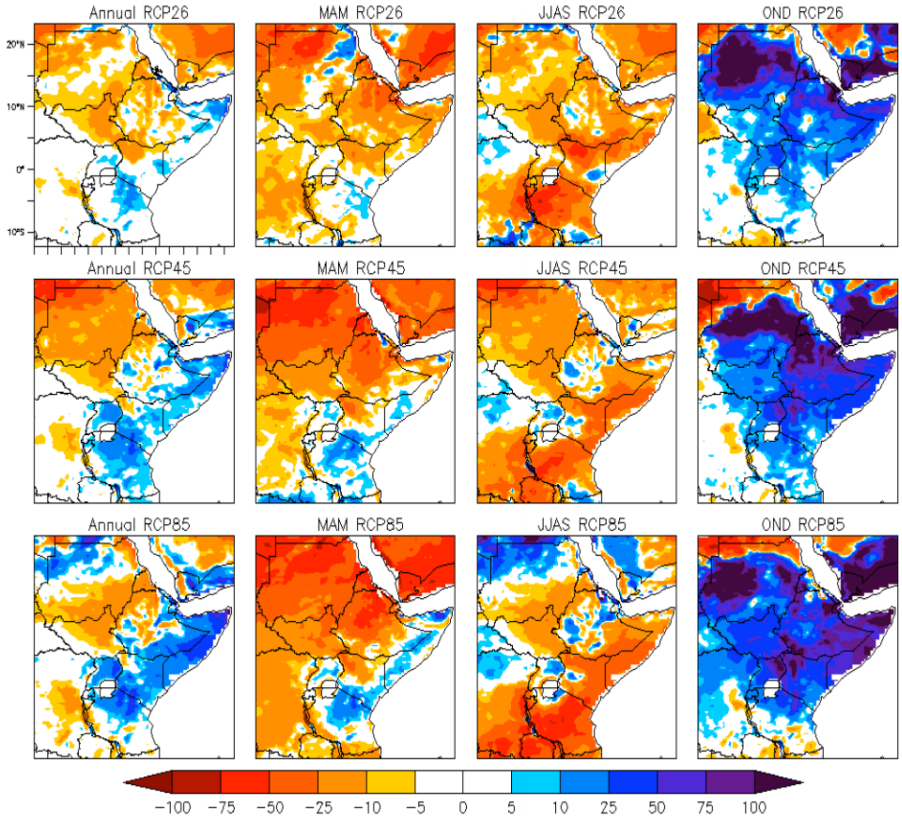


Figure 6-14 Projected rainfall changes over GHA by 2070s

Annual (1st column), MAM (2nd column), JJAS (3rd column), OND (4th column); each row corresponds to emission scenarios: RCP2.6 (1st row), RCP4.5 (2nd row) and RCP8.5 (3rd row).

There is a general indication that the projected rainfall changes in different scenarios and time windows show relatively little change compared to projected rainfall changes in different seasons while OND rainfall projected to increase across GHA, while MAM and JJAS rainfall tends to decrease over most part of the region. In addition, the annual rainfall changes are projected to increase over eastern and south-eastern part of the GHA region, and decrease in the rest of the region[91].

5.6.1. Temperature Projection

The maximum temperature component for the three scenarios (RCP2.6, RCP4.5 & RCP8.5) in the 2020s, 2030s, 2050s and 2070s periods projected changes projection results are shown in figure 13 as compared to the reference period (1971–2000). Unlike for rainfall, the projected temperature changes for the three different scenarios and time windows show relatively large changes compared to the projected changes in the seasonal components. By 2020, annual maximum temperatures are anticipated to be 0.5 to 1.0 °C higher under the RCP2.6 scenario but 0.5 to 1.5°C higher under the RCP4.5 and RCP8.5 scenarios over most parts of the region, with slightly less warming apparent in some coastal areas.

[91] Source: ICPAC Report, 2016; Projected changes in rainfall and temperature over Greater Horn of Africa (GHA) in different scenarios

The expected warming extent is greatest during MAM and JJAS seasons and least during the short rains (OND). By 2030, maximum temperatures during MAM, JJAS and throughout the year (Annual component) will likely increase by 1.0 to 2.5°C covering most parts of the region but with spatial variation similar to those for 2020. By 2050, annual maximum temperatures are expected to be 1.0 to 2.0°C higher under the RCP2.6, 1.5 to 2.5°C higher under the RCP4.5 and 2.5 to 3.5°C higher under the RCP8.5 scenarios over most parts of the GHA, with slightly less warming expected in some coastal areas[92].

The greatest potential warming will likely occur in the JJAS and MAM. In the far future (2070), projected annual maximum temperatures will likely be 0.5 t0 1.5 °C higher under the RCP2.6 scenario, which is notably smaller than the changes anticipated by 2050[93]. In contrast, under the RCP8.5 scenario, the expected annual warming will likely result in temperatures 3.5 t0 5 °C higher than the reference period, with far greater warming expected during MAM and JJAS.

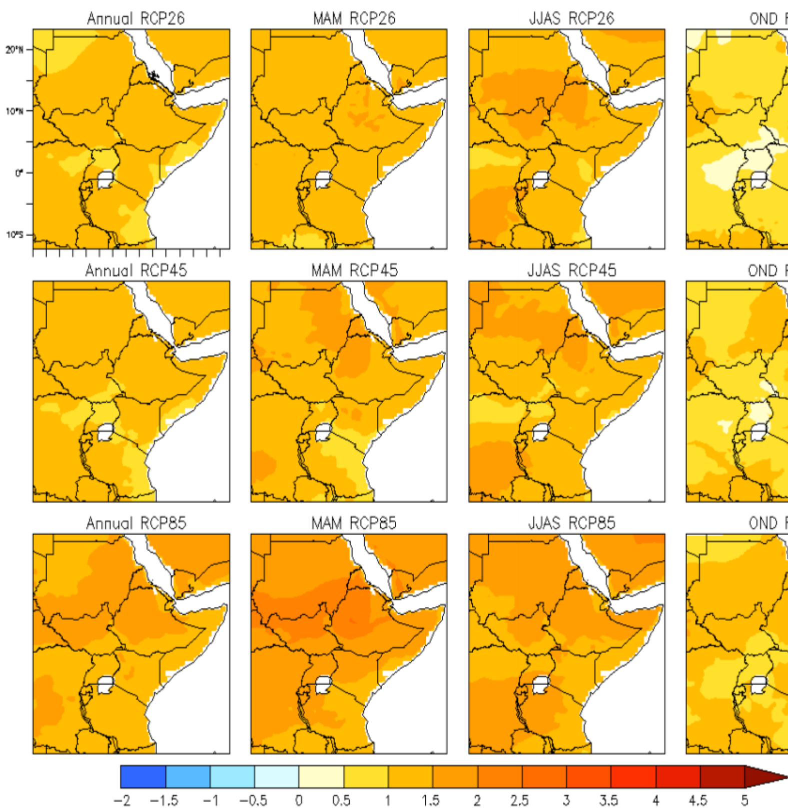


Figure 6-15 Projected maximum temperature changes over GHA by 2030s

Annual (1st column), MAM (2nd column), JJAS (3rd column), OND (4th column); each row corresponds to emission scenarios: RCP2.6 (1st row), RCP4.5 (2nd row) and RCP8.5 (3rd row).

The projected changes in the minimum temperatures through time for the three scenarios are shown in Figures 14. The results suggest that there will likely be a greater increase in the minimum than the maximum temperatures in future. By 2020, annual minimum temperatures will likely be 0.5 to 1.5 °C higher under the RCP2.6 and the RCP4.5 scenarios, but 1.0 to 2.0°C higher under the RCP8.5 scenario

[92] Source: ICPAC Report, 2016; Projected changes in rainfall and temperature over Greater Horn of Africa (GHA) in different scenarios

[93] Source: ICPAC Report, 2016; Projected changes in rainfall and temperature over Greater Horn of Africa (GHA) in different scenarios

over most parts of the GHA region. By 2030 and 2050, almost all the GHA region will likely be 1.0 to 3.0ºC warmer than the base period, with the greatest warming expected during the MAM and JJAS under the RCP8.5 scenario. By 2070, the projected increase in the annual minimum temperatures will likely be 4 to 5ºC higher under the RCP8.5 scenario relative to the base period[94].

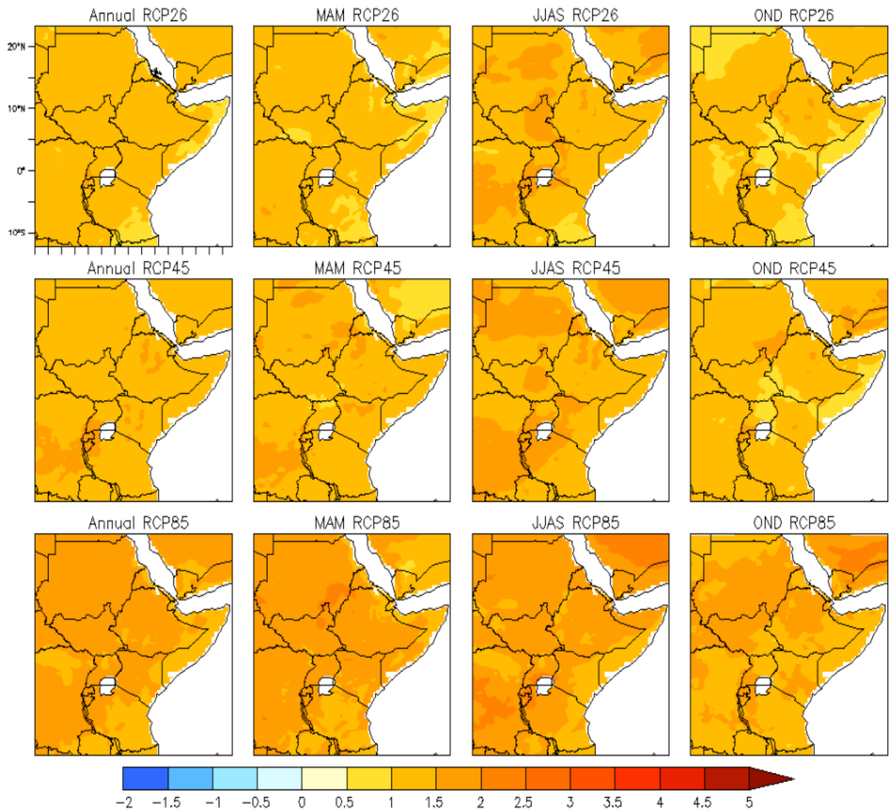


Figure 6-16 Projected minimum temperature changes over GHA by 2030s

Annual (1st column), MAM (2nd column), JJAS (3rd column), OND (4th column); each row corresponds to emission scenarios: RCP2.6 (1st row), RCP4.5 (2nd row) and RCP8.5 (3rd row).

5.6.2. Spatial and Temporal rainfall distribution

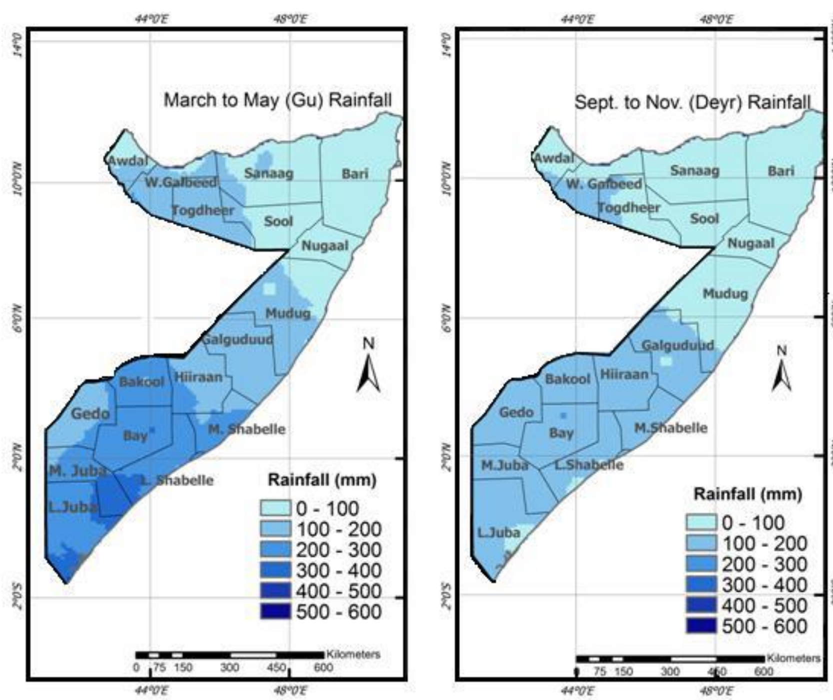
5.6.2.1. Temporal rainfall distribution

Rainfall shows a lot of spatial and temporal variability, with the seasonal rainfall patterns being determined by the north - south movement of the Inter-Tropical Convergence Zone (ITCZ). Somalia has a bimodal rainfall distribution composed of two rainy seasons, that is *Gu* and *Deyr* and the timing of seasons varies from one part of the country to the other. The first rainfall season (*Gu*) generally occurs between March and July, with peak rains in April-June. The second rainfall season (*Deyr*) is from August to November, with peak rains in October-November. There are two distinct dry seasons, namely, *Jilaal* and *Haggai*, which occur in December - March and July - August, respectively (Muchiri, 2007).

[94] Source: ICPAC Report, 2016; Projected changes in rainfall and temperature over Greater Horn of Africa (GHA) in different scenarios

Jiilaal is normally dry and hot, and is dominated by the northeast monsoon winds. During this season, the northern parts of the country experience some cool and dry air with the central and southern parts experiencing very hot conditions. This is followed by *Gu,* which considered as the major rainfall season for the country in April – June. Wet and hot conditions prevail over most parts of the country, with the southern regions receiving more rainfall than the north. The season at times extends into June or July due to the influence of humid onshore winds (FROS, 2013).

The dry *Haggai* season dominates during the July – September period dominated by the southwest monsoon winds. During this period, relatively cool conditions with showers persist along the coast, while areas inland experiences dry conditions. The October - November period is the *Deyr* rainfall season that generally brings less rainfall than the April – June season. The season is dominated by wet conditions over the central part of the country, influenced by a humid inflow from the Indian Ocean. The northern part of the country, however, is under the influence of dry air from the Arabian Peninsula leading to less precipitation (Muchiri, 2007).



The climate of Somalia is highly influenced by the El Niño/Southern Oscillation (ENSO). The southern region, for example, experiences enhanced rainfall amounts and flooding during El-Niño and droughts in La Niña years. These fluctuations have adverse impacts on food security and human settlement (FAO, 1971-1990; FROS, 2013; FEROS, 2015).

Figure 6-17: Rainfall during *GU* and *Deyr* Rainfall Seasons (Source: FROS, 2013)

A study by Oldenborgh *et al.* (2017) indicates that rainfall was depressed by about 20% below the long-term average in southern and central Somalia in 2016. The study further indicates that the strong La Niña that dominated the 2016 rainfall season increased the probability of a dry season and explains a third of the precipitation deficit.

5.6.2.2. Spatial rainfall distribution

The areas that receive high rainfall are mainly the middle and lower Juba and along the coastal area of the middle Shabelle, with total annual rainfall amounts of 700–800 mm. The total rainfall reduces further inland in the south, with the upper Shabelle River valley (Hiran and surroundings) receiving about 400 mm/year while the area between Shabelle and the Juba River valleys receives relatively higher rainfall (500–700 mm/year). Annual rainfall decreases further to the north with the exception of areas around Sheikh, Hargeisa and Borama that receive 500-600 mm/year. The areas around Ceerigavo receive up to 400 mm annually. The northern coastline is characterized by low rainfall of less than 100 mm/year. Low rainfall (100mm/year) is also experienced at the inland areas of the north-eastern coast (Lasa nod, Qardo and Iskushuban), while the rest of the northern regions and central Somalia receive an annual mean of 200-300 mm (Muchiri, 2007). The figure 19 to 23 shows monthly rainfall distribution patterns for Somalia.

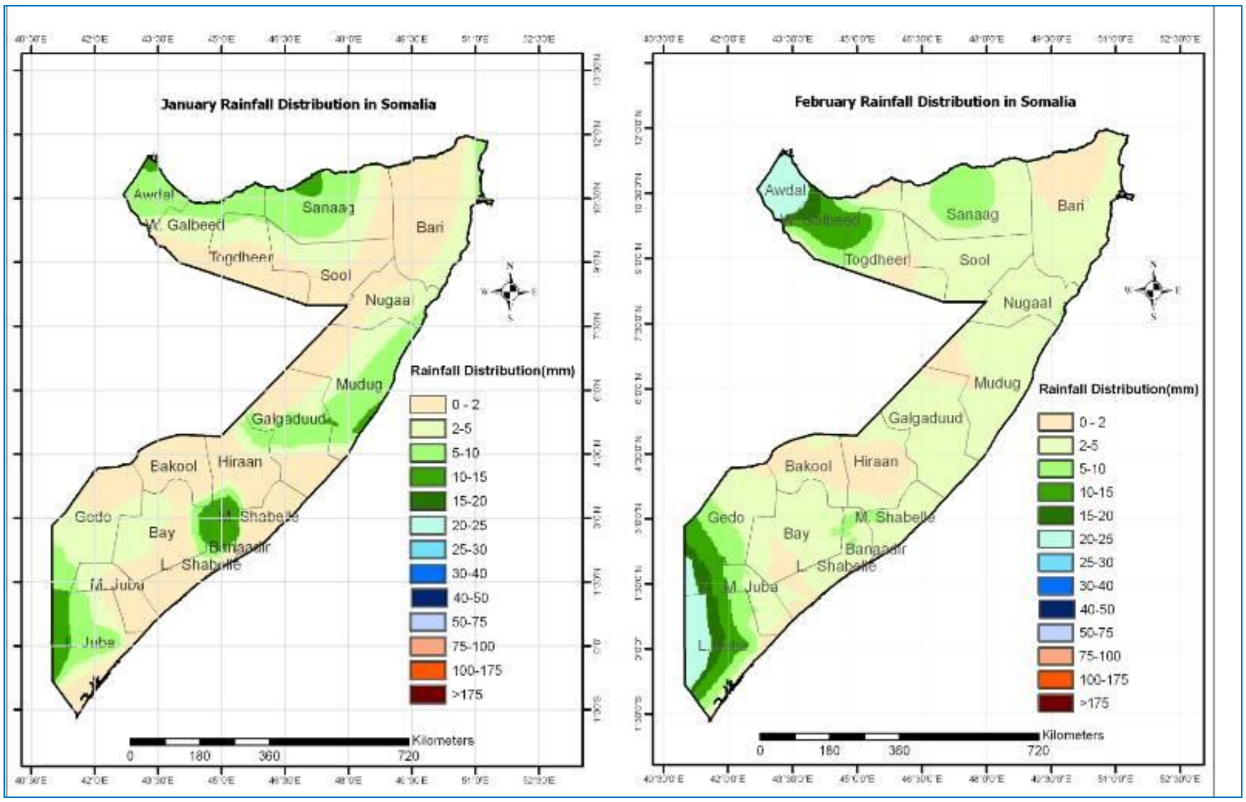


Figure 6-18 Monthly rainfall distribution patterns for Somalia: January and February

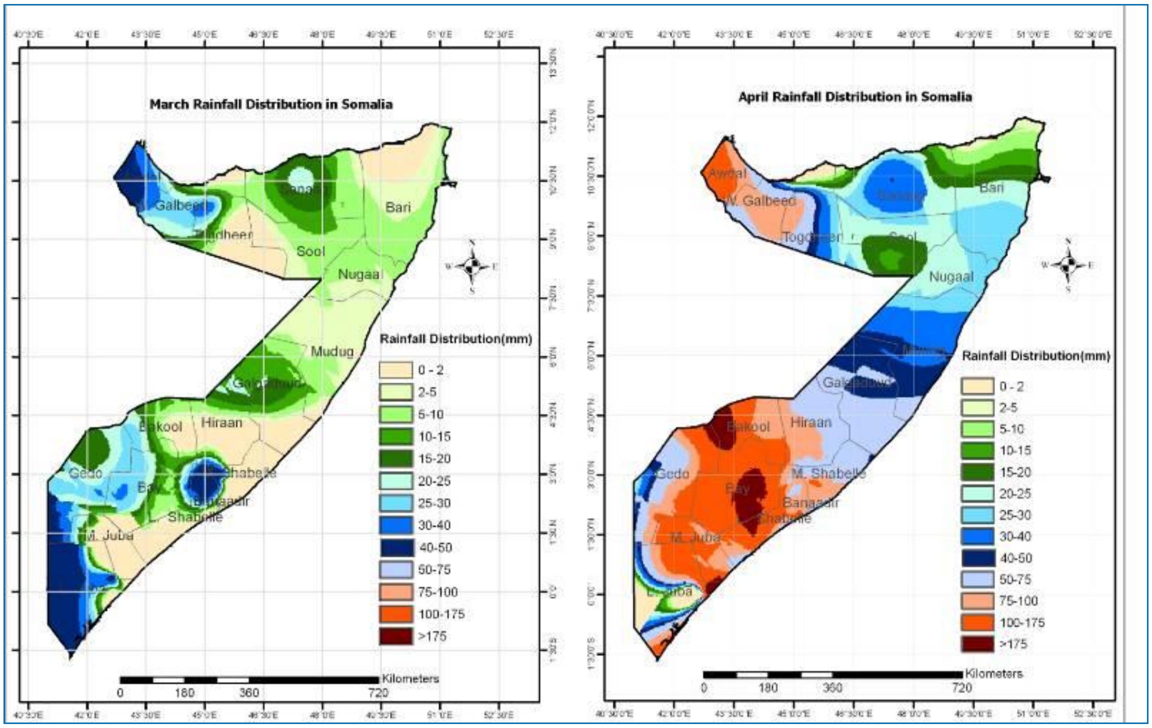


Figure 6-19 Monthly rainfall distribution patterns for Somalia: March and April

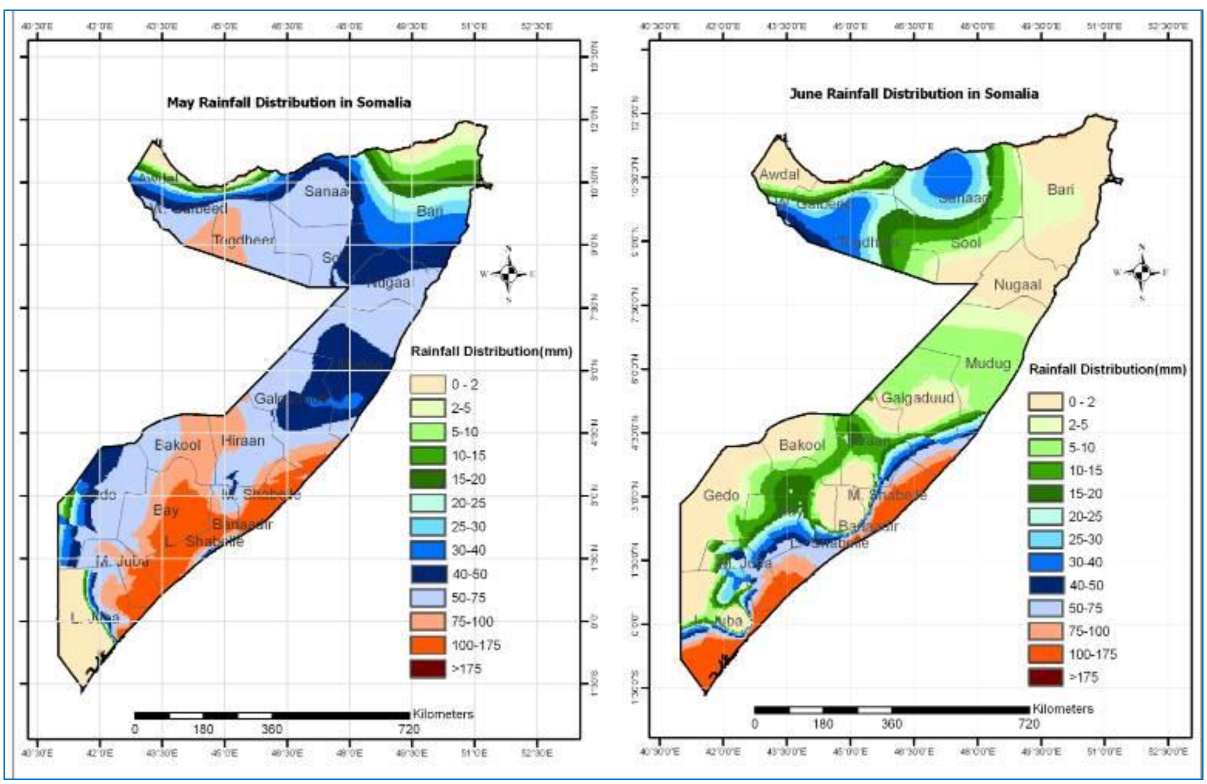


Figure 6-20 Monthly rainfall distribution patterns for Somalia: May and June

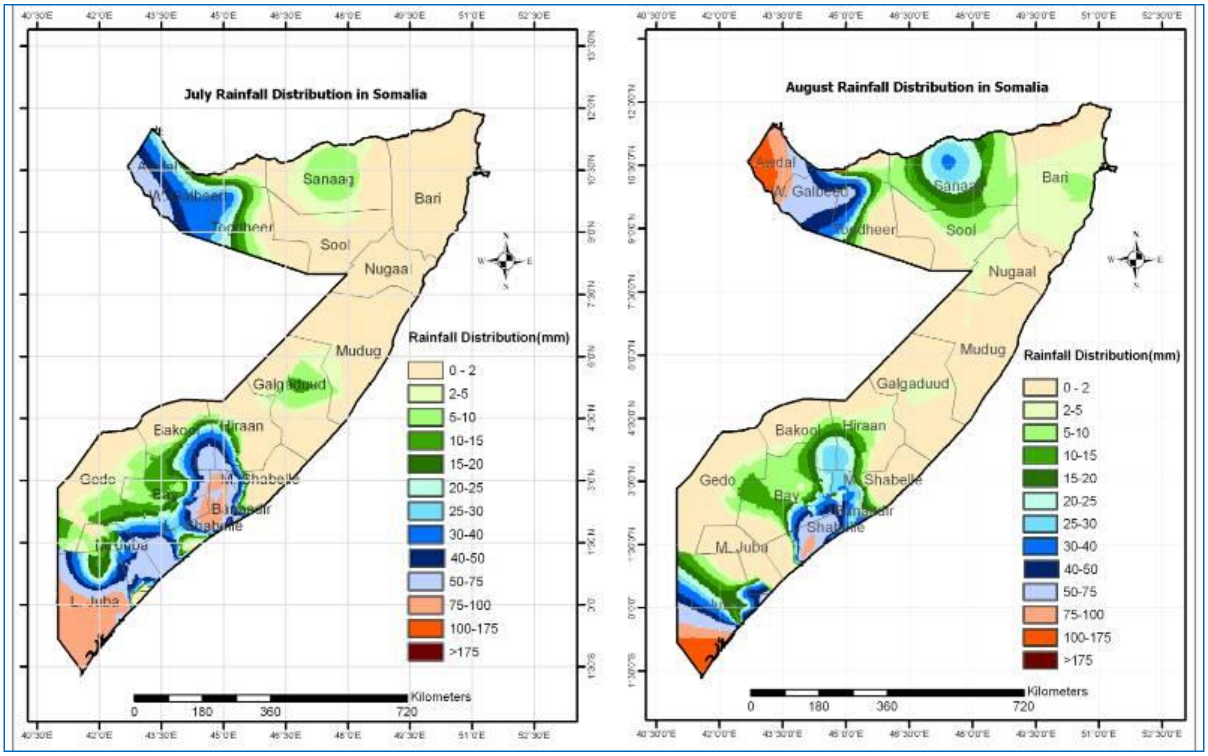


Figure 6-21 Monthly rainfall distribution patterns for Somalia: July and August

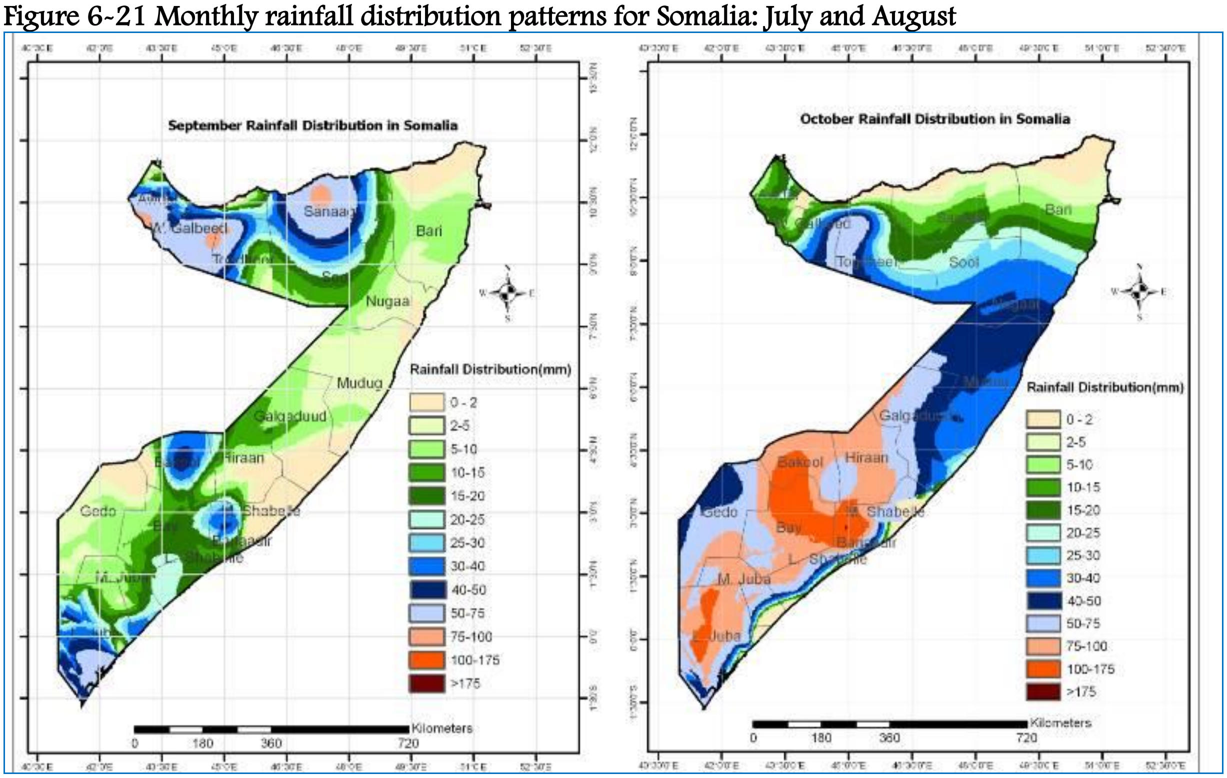


Figure 6-22 Monthly rainfall distribution patterns for Somalia: September and October

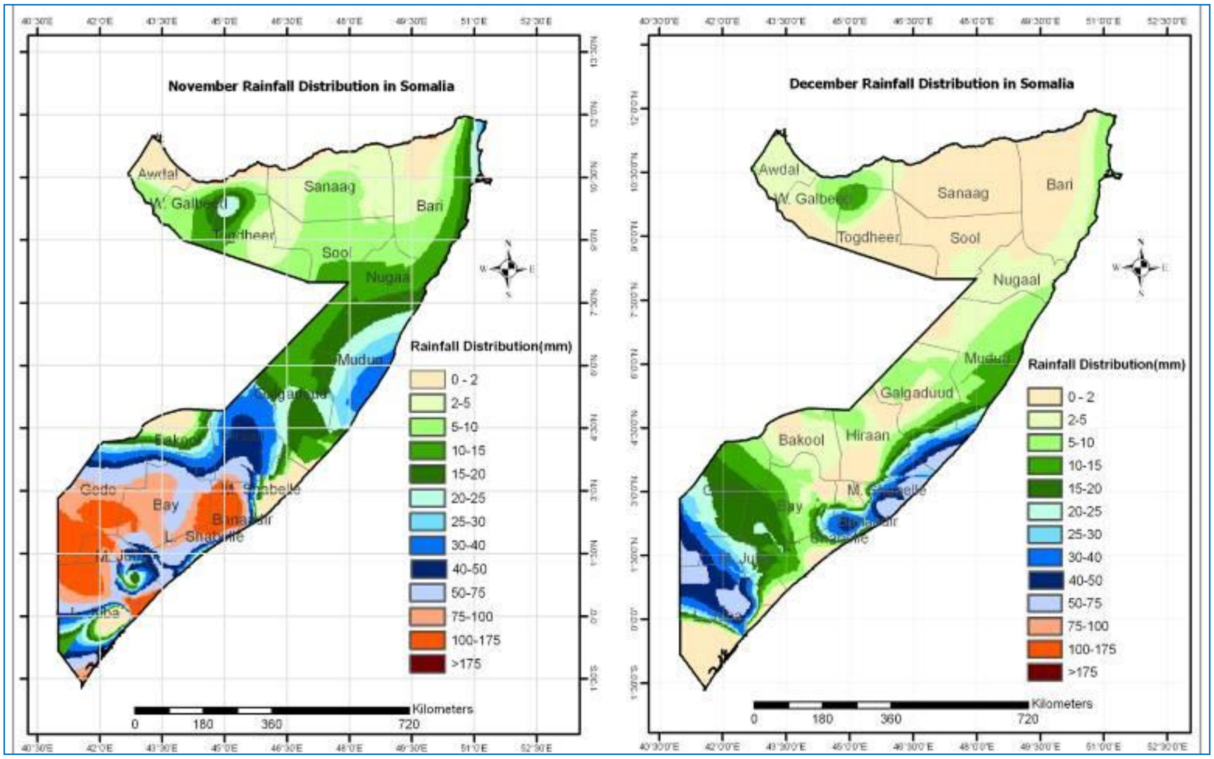


Figure 6-23 Monthly rainfall distribution patterns for Somalia: November and December

Basically, the driest months are January to February countrywide, with little or no rainfall. In March a few places receive rainfall, especially to the west of the Juba valley and areas around Awdal and Galbeed, with monthly averages between 10-20 mm. During the months of April and May the whole country receives significant amounts of rainfall during the GU rainy season. However, a small area of Sool around Lasa nod is dry during this season. The southern coast and north-western regions receive some rainfall during the months of June to September before the peak of the *Deyr* season in October and November that are characterized by rains throughout the country. During the month of December only a little rainfall is seen around the southernmost parts of the country. Rainfall is well-correlated with elevation in northern Somalia, but this is not the case in the southern parts of the country. There is limited variation in elevation across southern Somalia, although higher ground occurs in inter-riverine areas. Elevations increase towards the Ethiopian border, but do not correspond to increases in rainfall (Muchiri, 2007).

5.6.3. Rainfall Variability in Somalia

The assessment of rainfall variability which is one of the major factors of vulnerability in Somalia was carried out using Geo-Clim model. The results indicate extensive reduction in rainfall in the range of -30 to -50 mm/decade largely in the Southern parts of the country and some parts of North West of Somalia. The assessment was carried out for the four seasons experienced in Somalia namely; Gu, Deyr, Jiilaal and Hagga The results from the assessment are shown in figure 18 as changes in average rainfall over the four seasons. The results were achieved by comparing change in both annual and seasonal averages for period 1998-2014 minus the averages for the period 19981-1997. The major rain season; Gu and the minor rain season; Deyr, are considered most important seasons for agricultural Agro-pastoral and pastoral livelihoods.

5.6.3.1. Gu Season Rainfall variability

For the Gu rain season, rainfall was shown to declines by 33 to 30 mm per decade across the south western districts of Doolow, Belet Xaawo, Luuq, Garbahaarey, Qansax Dheere, Ceel Waaq, Diinsoor , Rab Dhuure, Baardheere, Waajid . It is noted that the Gu season is the major season in Somalia and in overall all areas in the country experience decline in rainfall. This is considered disruptive to the Agricultural, Agro-pastoral and pastoral livelihoods which have very high dependency on the season. The least affected districts with the decline of 9 to 14 mm/decade in Gu rains include; Laasqoray, Zeylac, Xarardheere, Cabudwaaq, Qandala, Garoowe, Laas Caanood, Burtinle, Iskushuban, Badhaadhe,Bossaso and Caluula. The results are shown in figure 18 c indicating change in average rainfall over the April to June Season achieved comparing averages for 1998-2014 minus 19981-1997 (Gu Season)

5.6.3.2. Deyr Season Rainfall variability

The Deyr rainfall season, has shown rainfall declines in the range of 2 to 7 mm per decade across the southern districts and pockets within northern parts of the Country. The areas most affected by the declines include; Kismaayo, Badhaadhe, Jamaame, Afmadow, Jilib, Saakow, Bu'aale, Baardheere, Baraawe, Sablaale and Diinsoor. However, It is noted that during the Deyr rainfall season; a minor season in Somalia, there is pronounce increase in rainfall in most of the central parts of the country. The districts receiving incremental rainfall include; Ceel Afweyn, Qandala, Ceerigaabo, Caluula, Berbera, Sheikh, Owdweyne, Hargeysa, Lughaye, Baki, Gebiley, Zeylac and Borama; with 6 t0 20 mm/decade above the 1981-1997 average. This is considered as a reprieve to the Agricultural, Agro-pastoral and pastoral livelihoods which have high dependency on rain-fed systems especially when poor Gu rains are experienced. The results are shown in figure 18a indicating change in average rainfall over the October-November Season achieved comparing averages for 1998-2014 minus 19981-1997 (Deyr Season)

5.6.3.3. Jilaal Season Rainfall variability

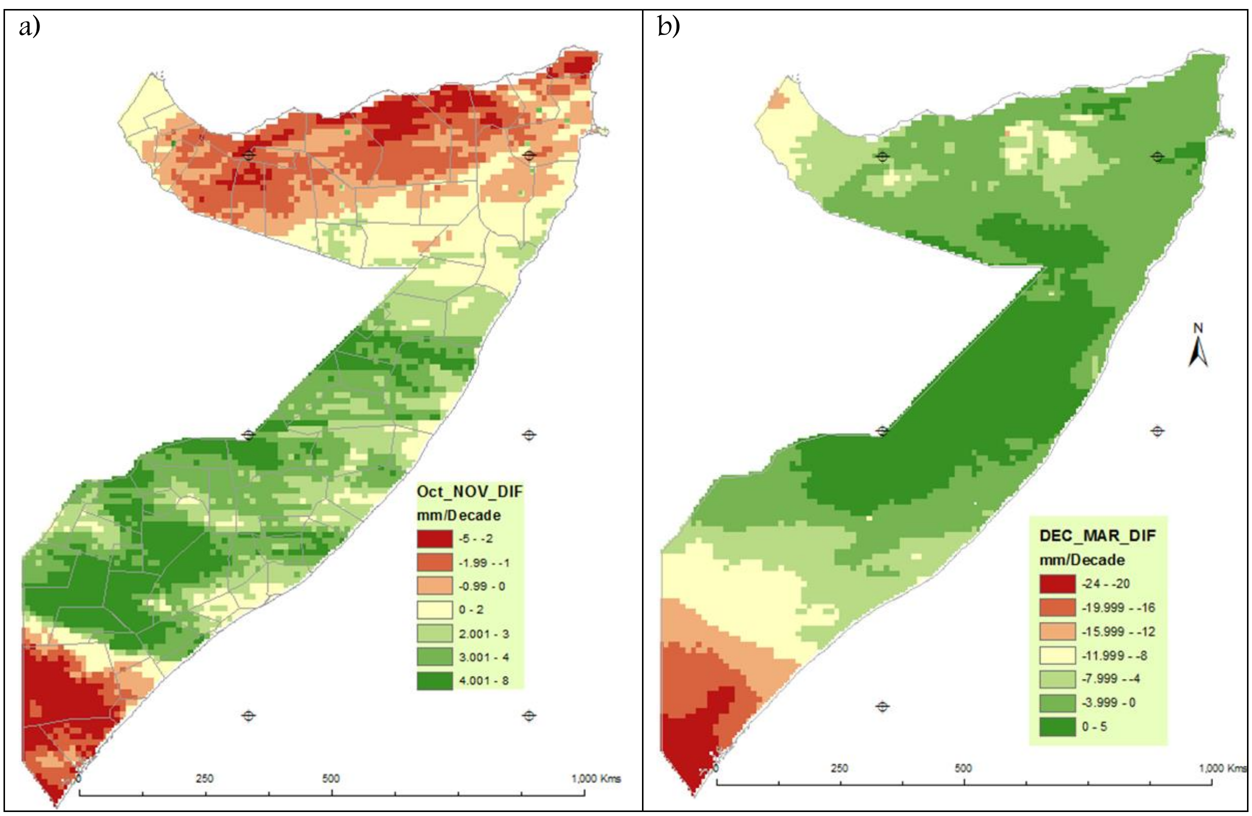
The Jilaal Season; is the major dry season in the country. The Jilaal season has shown high rainfall declines in the range of 19 to 24 mm per decade across the southern districts and pockets within north western parts of the Country. The areas most affected by the declines include; Badhaadhe, Kismaayo, Afmadow, Jamaame, Jilib, Saakow, Bu'aale, Zeylac, Baardheere, Borama, Diinsoor, Lughaye, Baraawe, Ceel Waaq and Sablaale. However, it is noted that during the Hagaa season; there is some increase in rainfall in in some districts in the central region of the country with afew pockets in the northern Somalia regions. The districts receiving incremental rainfall include; Ceel Buur, Tayeeglow, Xudur, Hobyo, Ceel Barde, Gaalkacyo, Galdogob, Belet Weyne, Dhuusamarreeb, Cadaado and Cabudwaaq;

with 3 to 5 mm/decade of rainfall above the 1981-1997 average. This is considered as a minor reprieve to the Agricultural, Agro-pastoral and pastoral livelihoods which have high dependency on rain-fed systems especially when poor Gu and Deyr rains are experienced. The results are shown in figure 18b indicating change in average rainfall over the December to March Season achieved comparing averages for 1998-2014 minus 19981-1997 (Jilaal Season).

5.6.3.4. Hagaa Season Rainfall variability

The Hagaa Season; is a minor dry season in the country experienced in July to September. The Hagaa season has shown low rainfall declines in the range of 3 to 7 mm per decade across the southern districts. The areas most affected by the declines include; Kismaayo, Badhaadhe, Jamaame, Afmadow, Jilib, Saakow, Bu'aale, Baardheere

Baraawe and Sablaale. However, there is significant increase in rainfall in some districts in the northern region of the country. The districts receiving incremental rainfall include; Iskushuban, Burco, Bossaso, Laasqoray, Ceel Afweyn, Qandala, Ceerigaabo, Caluula, Berbera, Sheikh, Owdweyne, Hargeysa, Lughaye, Baki, Gebiley, Zeylac and Borama; with 5 to 26 mm/decade of rainfall above the 1981-1997 average. This is considered as a significant reprieve to the Agricultural, Agro-pastoral and pastoral livelihoods which have high dependency on rain-fed systems especially when poor Gu rains are experienced. The results are shown in figure 18d indicating change in average rainfall over the July to September Season achieved comparing averages for 1998-2014 minus 19981-1997 (Jilaal Season)



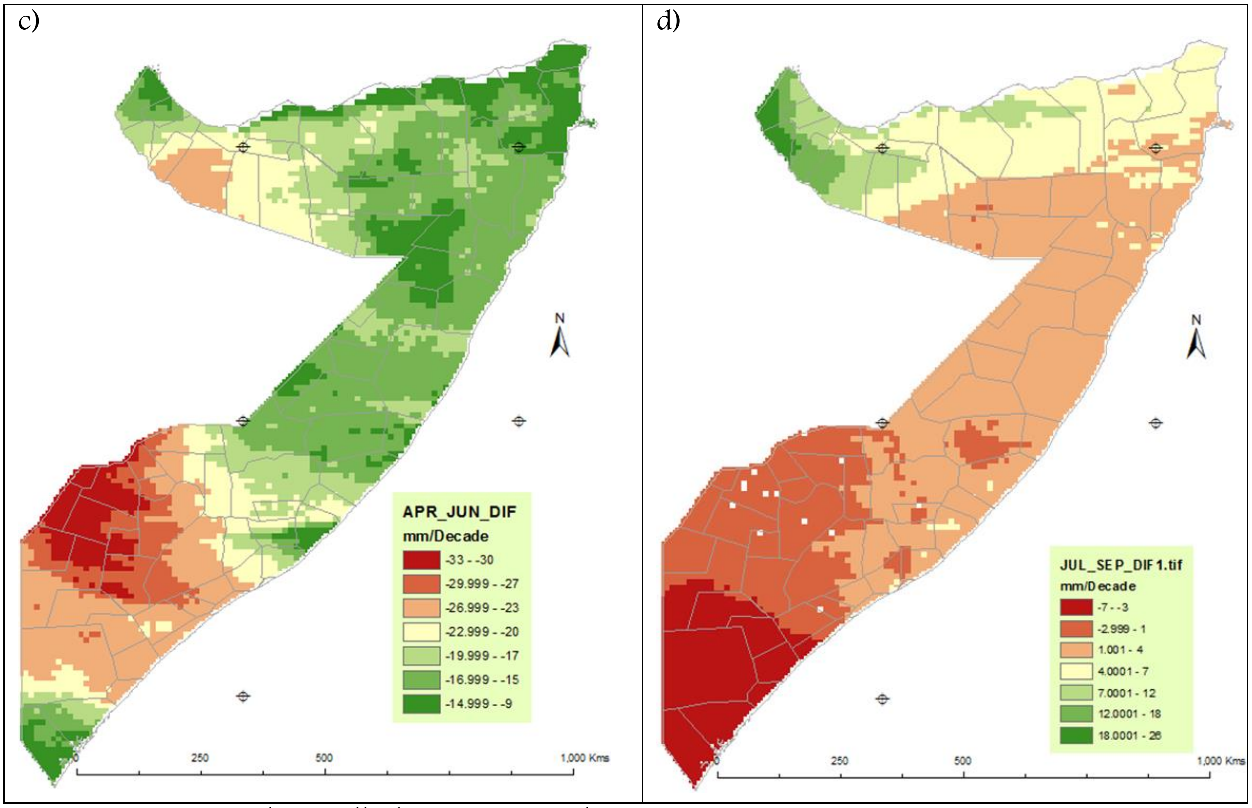


Figure 6-24 Seasonal rainfall Changes in Somalia

a) Shows change in Average Rainfall over the October to November Season, comparing averages for 1998-2014 minus 19981-1997) (Deyr Rain)

b) Shows change in Average Rainfall over the December to March Season, comparing averages for 1998-2014 minus 19981-1997 Jiilaal Season)

c) Shows change in Average Rainfall over the April to June Season, comparing averages for 1998-2014 minus 19981-1997 (Gu Season)

d) Shows change in Average Rainfall over the July to September Season, comparing averages for 1998-2014 minus 19981-1997 (Hagaa Season)

5.6.4. Annual Rainfall variability

Figure 19 indicate the results generated from the GeoClim modeling of the rainfall data. The results show change in the average total annual rainfall (January - December) compared against the average annual rainfall for 1998-2014 minus 19981-1997.

The results indicate overall rainfall declines in all areas except a few pockets in the central western and north western regions of the country. The annual trend has shown very high declines in rainfall declines in the range of 33 to 43 mm per decade all across the southern districts and some pockets in the northern regions of Somalia. The areas most affected by the declines include; Afmadow, Jamaame, Jilib, Kismaayo, Badhaadhe, Doolow

Qansax Dheere, Baardheere, Saakow, Belet Xaawo, Bu'aale, Ceel Waaq and Garbahaarey.

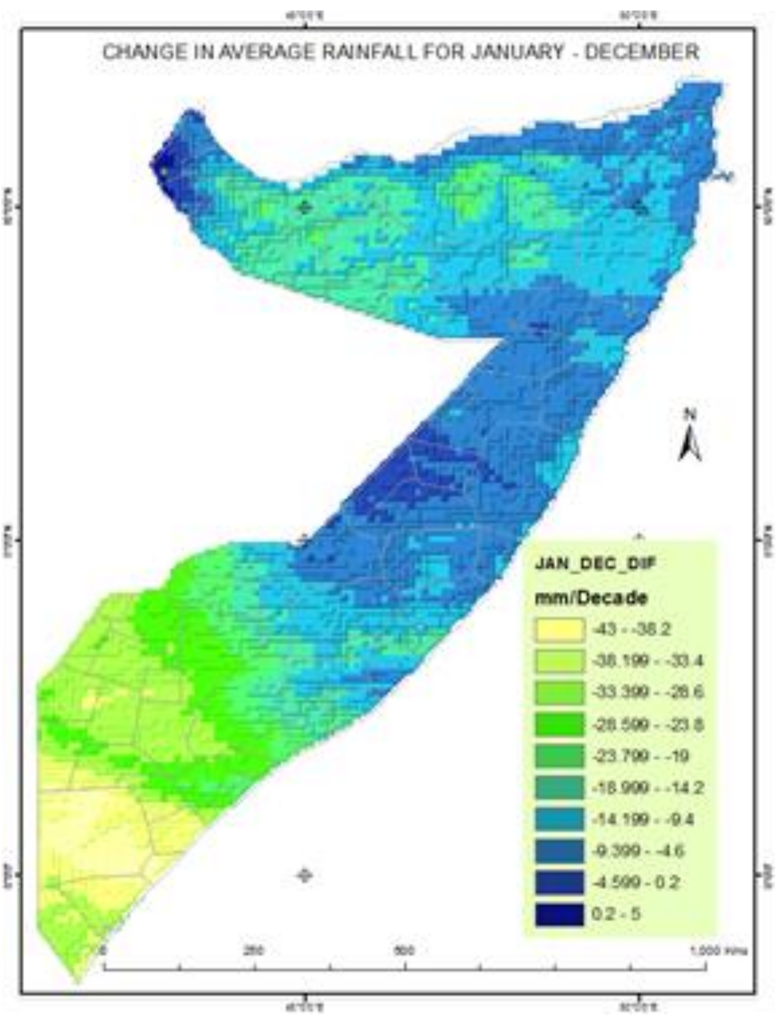


Figure 6-25; Change in January To December Average Rainfall Achieved Comparing Averages for 1998-2014 Minus 19981-1997 (Annual Rainfall Difference)

It is worth noting that there is no net increase in rainfall in any of the districts except a few pockets within the least affected areas. The districts that anre least affected by the rainfall variability include; Jariiban, Galdogob, Garoowe, Caluula, Belet Weyne, Hobyo, Burtinle, Gaalkacyo, Dhuusamarreeb, Cadaado, Zeylac, Cabudwaaq and Borama; with 7 to 3 mm/decade of rainfall below the 1981-1997 average. The results are shown in figure 19 indicating change in average rainfall over the January to December achieved comparing averages for 1998-2014 minus 19981-1997 (annual)

5.6.5. Climatically Secure Areas

Somalia is facing great challenges posed the erratic rainfall patterns that are causing frequent droughts in areas receiving below average and floods in areas receiving above average rainfall in the given season. Based on the global and regional models confirm that the overall trend that indicates that the country is becoming drier based on the 1981-1997 reference period with some areas experiencing a decline in rainfall up to 33mm/decade during the critical rainy seasons; Gu. The annual trend indicate that the worst hit area include Afmadow, Jamaame Jilib, Kismaayo, Badhaadhe and Doolow, and others as indicated in figure 20 showing districts with a decline of more than 30mm/decade. Figure 20 also shows that deyr season is has a more stable pattern in all the districts with a tendency of having slightly more than seasonal average rainfall. Further, the results show the Gu season has a decline of more than 15mm/decade in all the districts. This is also true for all the annual rainfall changes based on a reference period 1981-2014.

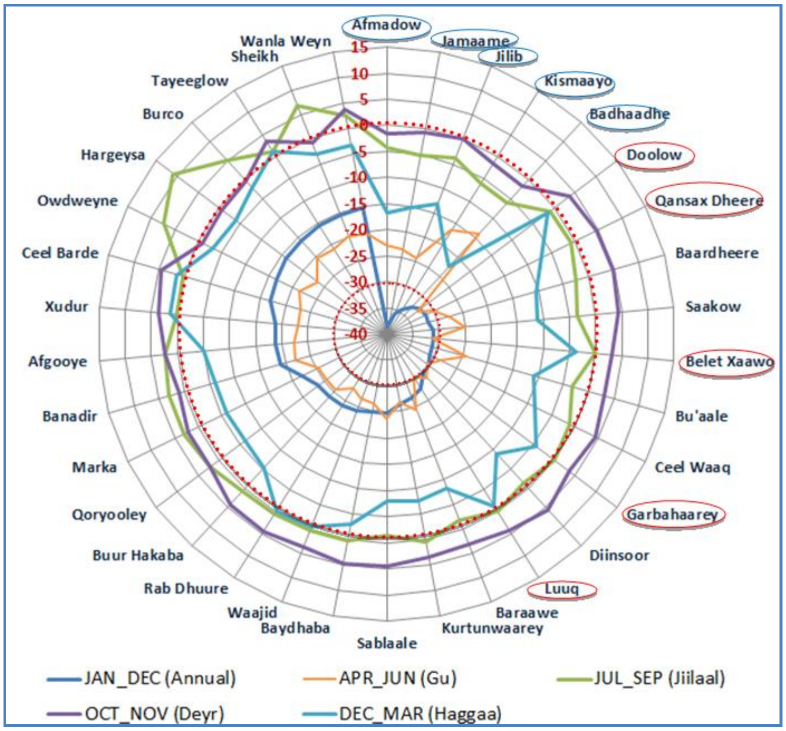


Figure 6-26 Most Affected Districts by Rainfall Variability

Figure 21 shows the districts least affected by rainfall variability; where most of the areas are indicated to have rains above normal in the Jilaal and Deyr seasons.

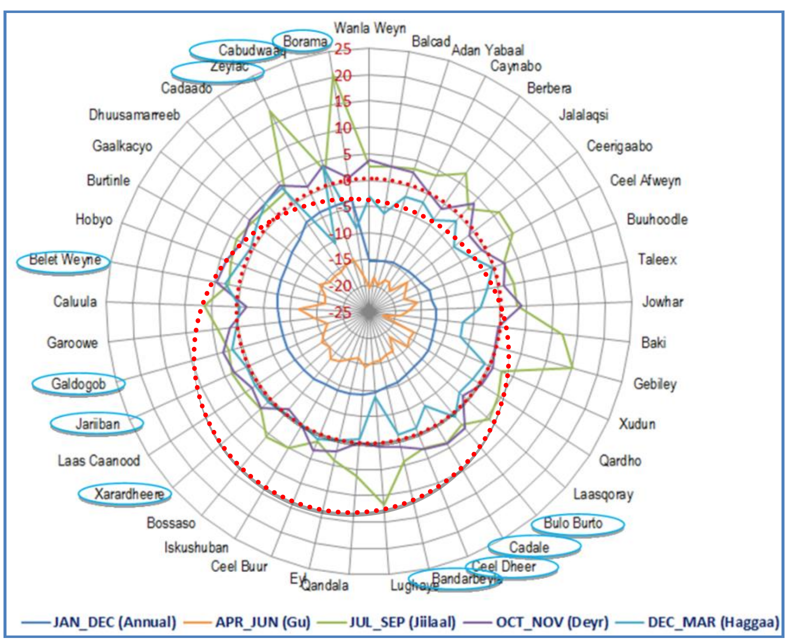


Figure 6-27 Least Affected Districts by Rainfall Variability

5.6.6. Spatial and temporal variations of mean air temperature in Somalia

5.6.6.1. Spatial Temperature Variation

Daily mean air temperatures are generally high throughout the year, with the highest inland temperatures being observed in the south parts of the country. Luuq in Gedo region near the border with Ethiopia and Kenya experiences the highest mean temperature in Somalia at over 30°C. Temperatures along the southern coast are lower than those inland, due to the influence of cool ocean currents. The relative thermal uniformity prevailing in the south is distorted by the effects of altitude in the north, where temperature decreases with altitude giving a larger mean daily lapse rate of about 6 °C per 1000 m. It must however be noted that the lapse rate varies with season throughout the year, being larger in the dry season than in the wet season. Southern Somalia is hottest in the months December - March. Temperatures are greatest at the Kenya, Somalia and Ethiopia borders (over 30°C), gradually decreasing towards the ocean (28°C) (Muchiri, 2007).

5.6.6.2. Temporal Temperature Variation

July and August are the coolest months in southern Somalia. The Somali low-level jet is coincidentally strongest over southern Somalia during this period, thus contributing to cooling effects in the region. The hottest weather in the north is experienced in the months June – September, especially around Awdal and Bossaso areas. The north becomes cooler in the months January - February (Muchiri, 2007).

Mean maximum and minimum temperatures in Somalia show a similar trend to that of the mean temperatures. The highest mean maximum value during the period 1963–1990) is 42° C in June and July at Berbera, and the lowest mean minimum temperature is 6° C at Ceerigavo in January. Greater contrasts between daily maximum and minimum temperatures occur inland compared to the coast, however these contrasts are generally small in comparison to those which might be expected for desert environments. Muchiri (2007) explain this by the relatively high humidity across the whole country.

5.6.7. Current climate variability

Total rainfall amounts vary dramatically from year to year, from drought periods that persist for several years to erratic periods of intense downpours and flooding. The prominent observation from analysis of weather station rainfall data, across all regions and seasons in Somalia, is a high inter-annual and inter-seasonal. Rainfall is shown to vary between the range of 57mm and 660mm at one weather station in central Somalia during a 20 year observation period (UNDP/ICPAC, 2013). The temporal patterns of high rainfall variability over Somalia can be directly associated with extreme events such as floods and droughts impacting the country (UNDP/ICPAC, 2013). Schreck and Semazzi (2004) concluded that Somalia's high rainfall variability is correlated with perturbations in the global Sea Surface Temperatures (SSTs), especially over the equatorial Pacific and Indian Ocean basins. The occurrences of most of these events are during periods when the Indian and Pacific Ocean experiences anomalous sea temperatures and circulation anomalies during El Niño/La Niña, together with IOD events (Lasco and Boer, 2006). These include the recent droughts of 2000, 2004, 2008 and 2010-2011; and floods of 1997/1998 (ICPAC, 2013).

Since 1960s, Somalia has experienced at least one major climate extreme event in each decade (Balint *et al.*, 2011). Major floods that have been experienced since 1960 include; 1961, 1977, 1981, 1997-98, 2005, 2006 and 2009, while major drought events were experienced in 1969, 1976, 1984, 1987, 1999, 2001, 2004, and 2010. In the past decade (2001 to 2010) the country has been alternating from drought to floods within the years (FAO SWALIM, 2012). The observed pattern (IPCC 2007, 2012) shows increasing variability in rainfall for Somalia suggesting an increase in the frequency and severity of future droughts and flash flood events.

According to the fourth assessment report of the IPCC, there have been extreme changes in temperature across the Greater Horn of Africa (GHA) region over the last 50 years (IPCC, 2007). Analysis of 1901-2005 global data shows a 1.0°C increase in temperature over a century. An inter-annual analysis of Somalia's national data shows that the mean air temperatures are usually high throughout the year with the hottest months in the south being March and April (UNDP/ICPAC, 2013).

5.7. Climate Change Vulnerability Assessment

The Intergovernmental Panel on Climate Change (IPCC) conceptual framework for mapping vulnerability was applied to identify the climate change hotspots. In this approach vulnerability was separated into three components: exposure, sensitivity, and adaptive capacity to climate stressors (Parry et al., 2007). This framework and variants have also been commonly applied in vulnerability mapping exercises in Africa and globally (e.g., Midgley et al., 2011; Yusuf and Francisco, 2009; Thow and De Blois, 2008). In the interest of identifying the climate change hotspots and the most vulnerable communities; this assessment focused on generic vulnerability based on the populations rather than separate vulnerability natural systems (e.g., ecosystems); sectors (e.g., water or agriculture); or population sub-groups (e.g., pastoralists).

The spatial indicators used in the vulnerability assessment are found in the table 5-1 below. In the assessment; a limited number of high-quality spatial data sets (most of which were sourced from FAO SWALIM, FSNAU and ICPAC) that best represent the component of interest were selected while avoiding low-quality data (data of high uncertainty or coarse spatial resolution). The data sets were converted from the original formats in excel to spatial data layers and rasterized[95].

Table 6-1 Indicators Utilized by Component of Vulnerability

Component	Data Source	Data Layer
Exposure	RFE Rainfall from the CHIRPS database for Africa; Precipitation in decadal, and monthly averages	Change in Average Rainfall over the March to June Season, comparing averages for 1998-2014 minus 19981-1997
		Percent of precipitation variance explained by

[95] Prior to conversion, grids were converted to tabular comma-separated values (CSV)-format files using a common grid referencing system. All data transformations and aggregations were performed in the R statistical package, and re-exported to ArcGIS for mapping.

		decadal component (1950–2009)
	Synoptic station data FAO SWALIM (1920s -2014)	Annual and Monthly Average rainfall
	CHIRPS database for Africa 1981-2014	Trend in temperature
	ISRIC - World Soil Information	Coefficient of variation of the Normalized Difference Vegetation Index (NDVI) (1981–2006)
	FAO SWALIM	Flood Extent and Risk maps
Sensitivity	FSNAU	Somali Livelihood
	UNDP/UNFPA	Population Density –Developed from 2014 population data
	FSNAU	No of People in crisis and emergency by region
	ISRIC - World Soil Information	Soil Organic Carbon
Adaptive Capacity	Irrigated areas (FSNAU)	Irrigated areas (area equipped for irrigation) Derived from Livelihood data
	FAO SWALIM	Access to safe water
	CIESIN/JRC	Anthropogenic Biomes

The aggregate indices were normalized (rescaled) from the raw data values (OECD, 2008) to indicator scores on a 0-100 scale, where 0 equates to lower vulnerability and 100 equates to high vulnerability.

5.7.1. Exposure Component

The exposure component was generated based on the four seasons experienced in Somalia, namely; Gu rains, Jilaal, Deyr rains and Hagaa. The assessment of exposure to climate changes and the component was analyzed based on seasonal rainfall variability. As shown in figures 6-28 to 6-31, the exposure results indicate extremes with significant hotspots spread through the country. The main hotspot areas resulting from the exposure to climatic stressors are found in Southern, Central and Northern Somalia.

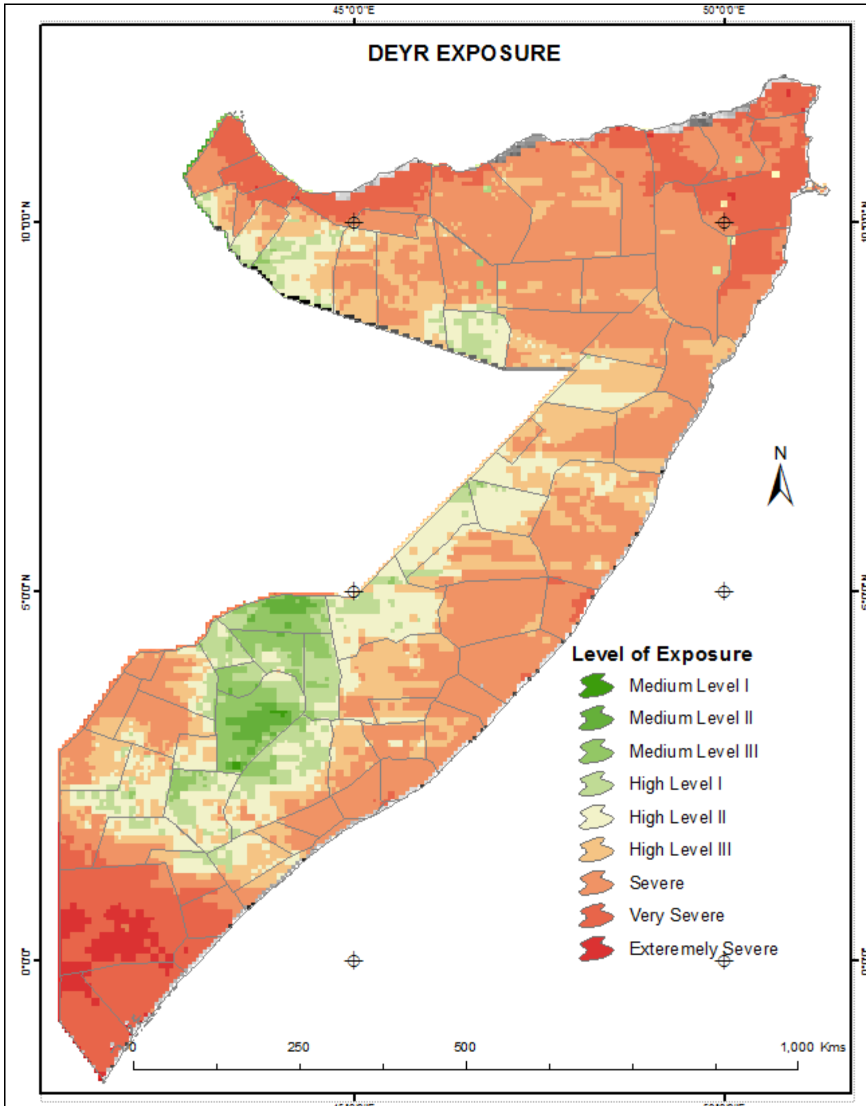


Figure 6-28; Deyr Season Exposure

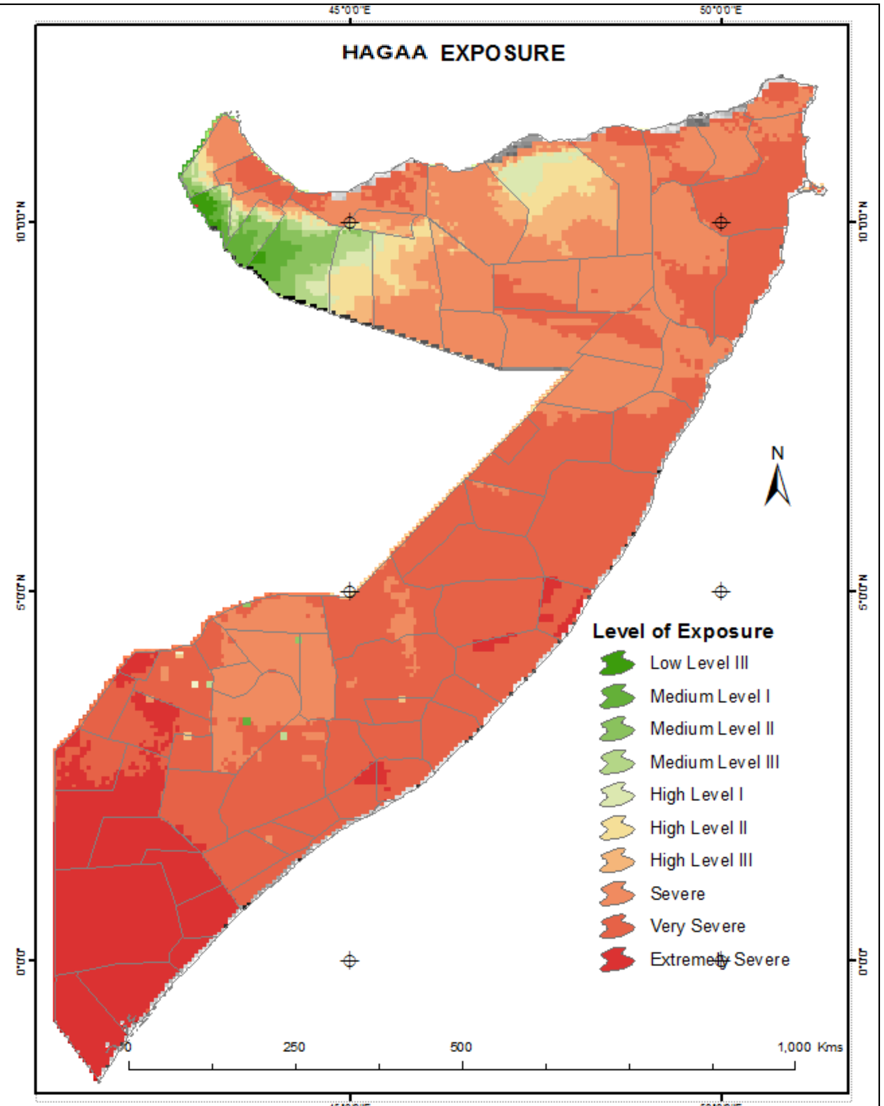


Figure 6-29; Hagaa Season Exposure

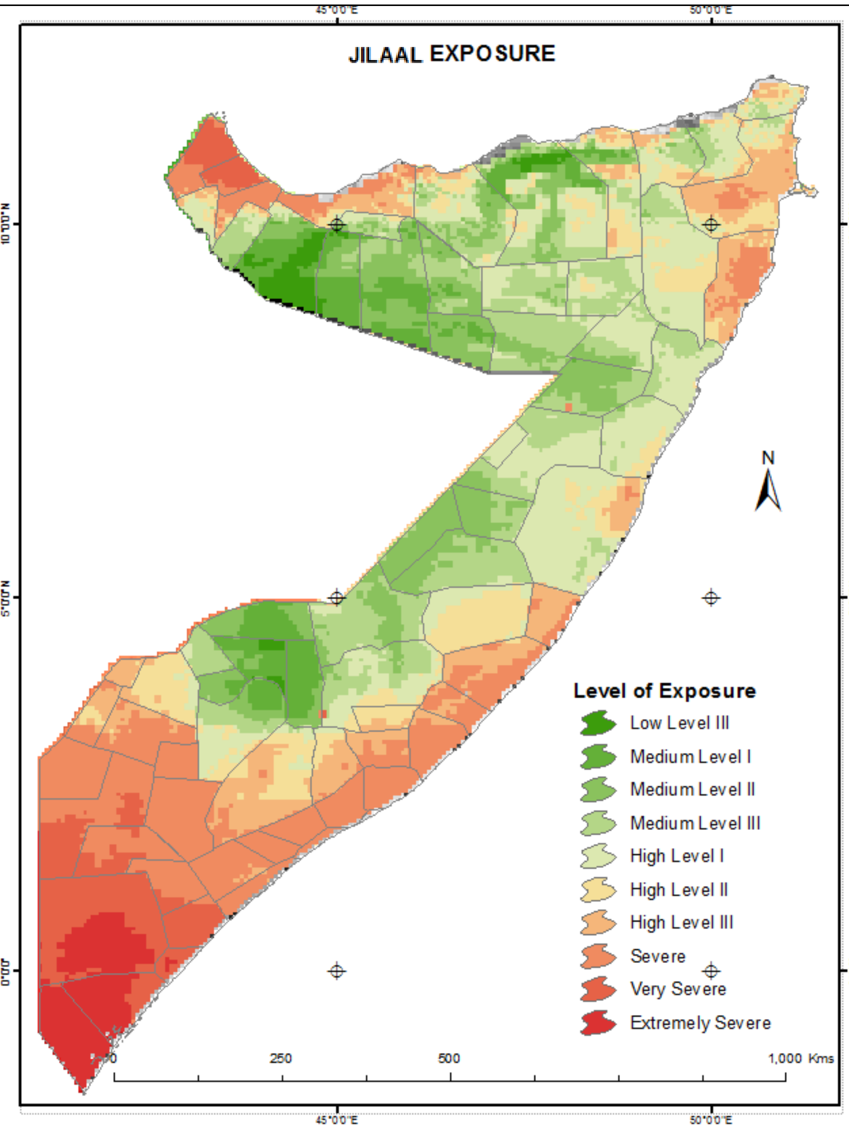


Figure 6-30; Jilaal Season Exposure

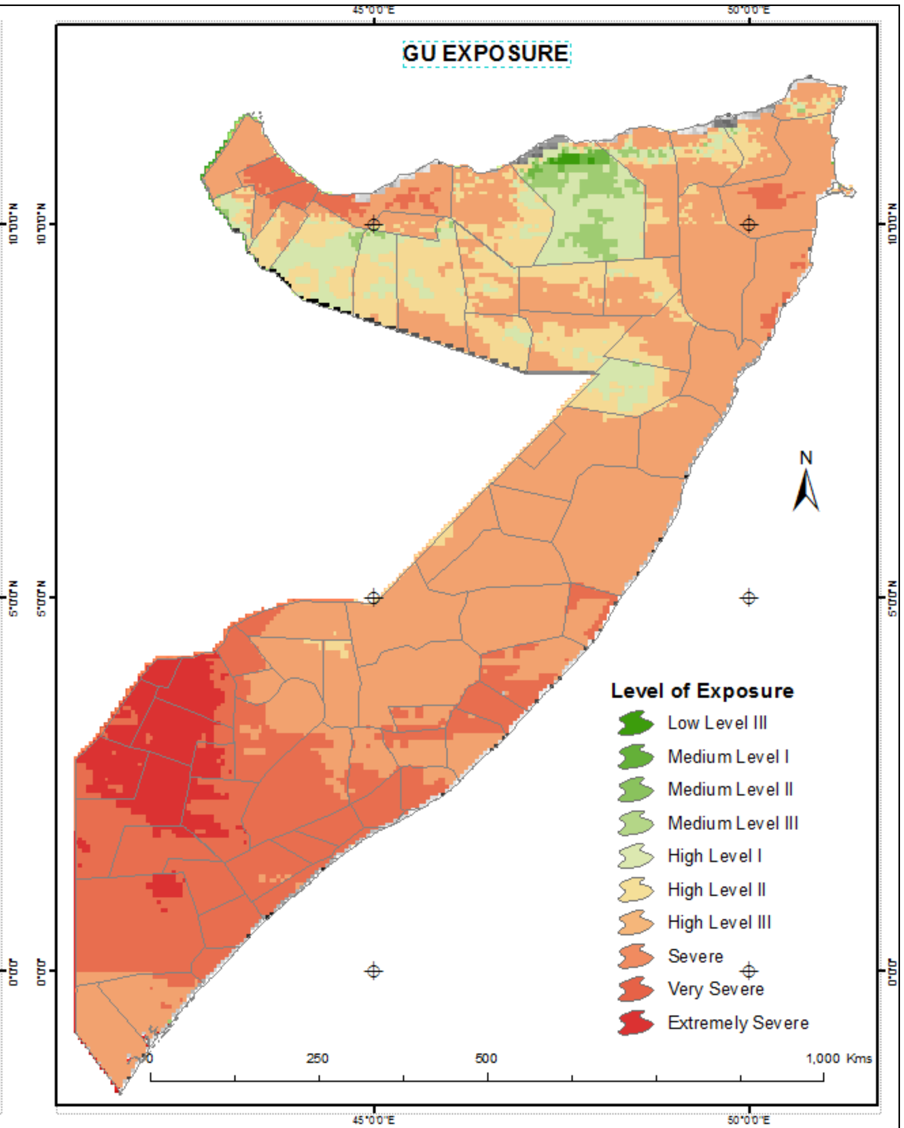


Figure 6-31; Gu Season Exposure

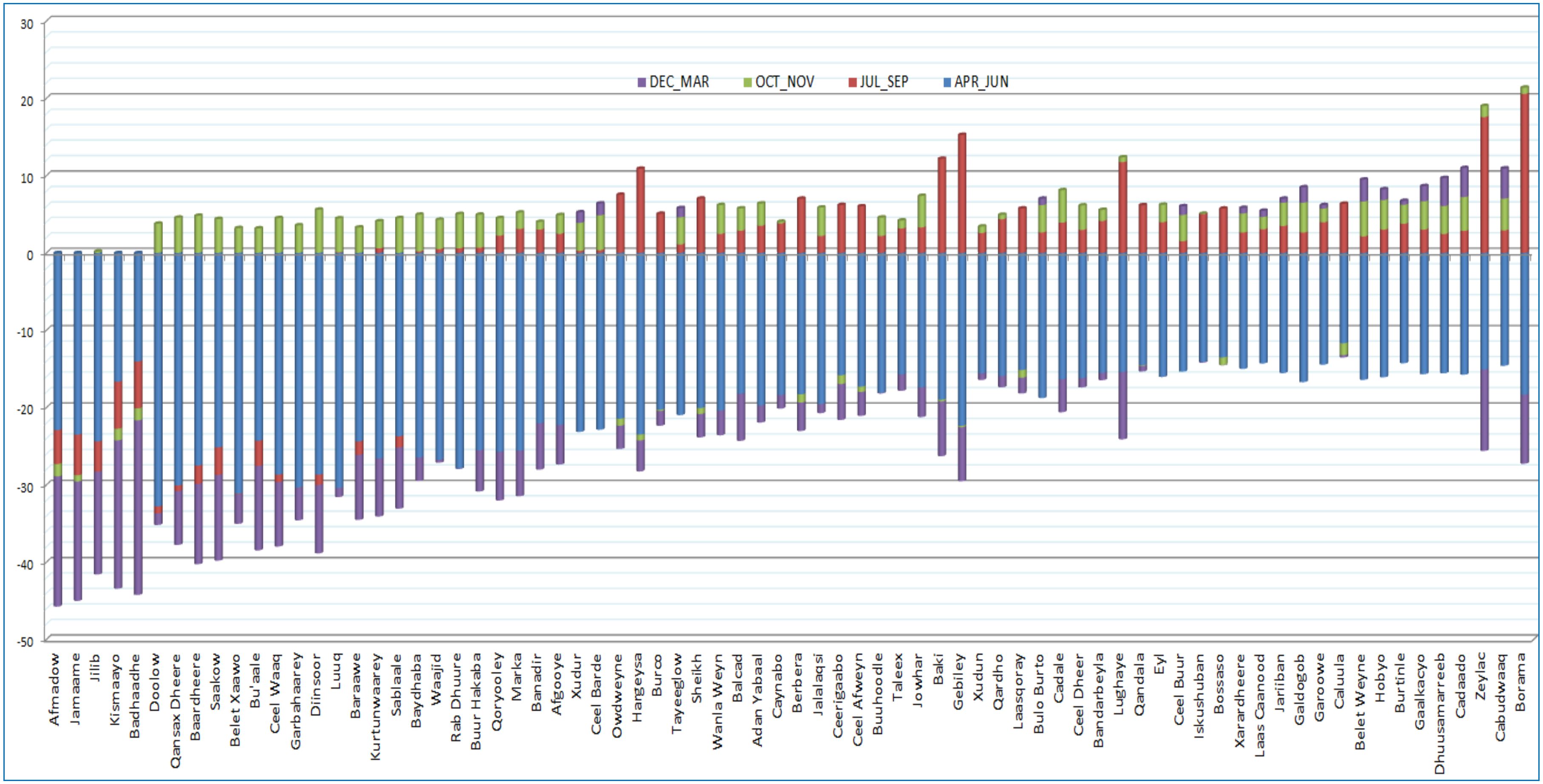


Figure 6-32 Seasonal Variability (mm/decade) of Rainfall in Various Districts

Based on the analysis results severe and extremely severe exposures are experienced in the Jilaal season in most parts of the country apart from south west of Somaliland region. During the Deyr season, most areas experience exposure levels above high level III but with lesser areas experiencing very severe and extremely severe exposures. During the Hagaa season, about 50% of the country is shown to have less than high level I of exposure while about 30% of the country especially in the southern region experiences higher levels of exposure. Just like the Jilaal, the Gu, season also experiences higher levels of exposure in most parts of the country with extremes in the south western and central Somalia.

5.7.2. Lack of Adaptive Capacity Component

Hazards, perturbations and sensitivity of the affected environment form the main variables for the function used in determining the impacts of climate change. The extent of the effects of climate change is further mediated by the human characteristics of the exposed communities and populations. The adaptive capacity of society is correlated with various social factors, including gender, class and age. These in turn give rise to differences in human capital (such as levels of education and status of health), financial capital (wealth) and access to facility and institutions. All these factors affect the ability of the population or society to anticipate, cope with, and respond to climate changes. Figure 26 shows lack of capacity to adapt to climate changes. Most adaptive districts include; Balcad, Afgooye, Qansax Dheere, Banadir, Marka, Jowhar, Badhaadhe, Qoryooley, Adan Yabaal, Baydhaba, Kurtunwaarey, Ceel Dheer, Rab Dhuure, Xarardheere, Diinsoor, Baraawe, Sablaale, Waajid, Buur Hakaba, Wanla Weyn, Xudur, and Luuq which have medium level I to III of lack of adaptive capacity. Among the least adaptive district include; Garoowe, Ceel Afweyn, Dhuusamarreeb, Eyl, Laas Caanood, Baki, Qardho, Zeylac, Iskushuban, Bossaso, Lughaye, Bandarbeyla, and Burtinle falling in the high level III class, in the severe level of lack of adaptive capacity are Gaalkacyo, Galdogob, and Cadaado, while Qandala, and Caluula are considered to have very severe lack of adaptive Capacity. Figure 26, shows lack of adaptive capacity in various parts of the country

Definitions

Hazard

A physically defined source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these (CARICOM, 2003).

Perturbations

These are small variations from the norm in the physical system, typically of lesser magnitude than a hazard, but possibly of longer duration. Perturbations may retrospectively be identified as incremental change.

Sensitivity

This is the extent to which a unit of analysis reacts to stimuli. In climate terms, biomes, ecosystems, countries and sectors are all examples of units, which may have different levels of sensitivity when exposed to the same climate hazard (depending on the scale of the analysis).

Adaptation

Adjustment in natural or human systems in response to actual or expected climate changes or their impacts, so as to reduce harm or exploit beneficial opportunities

Adaptive Capacity

The potential or capability of a system to adjust its characteristics or behavior to anticipate, cope with and respond to climate variability and change

Climate change vulnerability

Refers to the state of susceptibility to harm from exposure to climate hazards, and the ability of the sub-national territory (or other unit of analysis) to cope with, and recover from, such exposure as well as manage incremental and long-term change in climate

Source: UNDP 2010; Mapping Climate Change Vulnerability and Impact Scenarios. A Guidebook for

5.7.3. Sensitivity Component

This component of the vulnerability assessment considered the fact that different physical environments respond differently when exposed to the same manifestation of climate change, a hazard or perturbation. It is for instance considered that marginal or semi-arid areas will respond more to an increase of temperature of 1OC than a desert ecosystem subjected to a similar change. The sensitivity of the physical environment to climate change has knock-on effects for the human use of that environment. Climate changes are either negative or positive; and thus the effects can lead to the emergence of both detrimental and beneficial situation on the built environment. The economic sectors; such as population, agriculture, water, energy, tourism, fisheries, health, and biodiversity – will all differ depending on their sensitivity to the effects of climate change to which they are exposed.

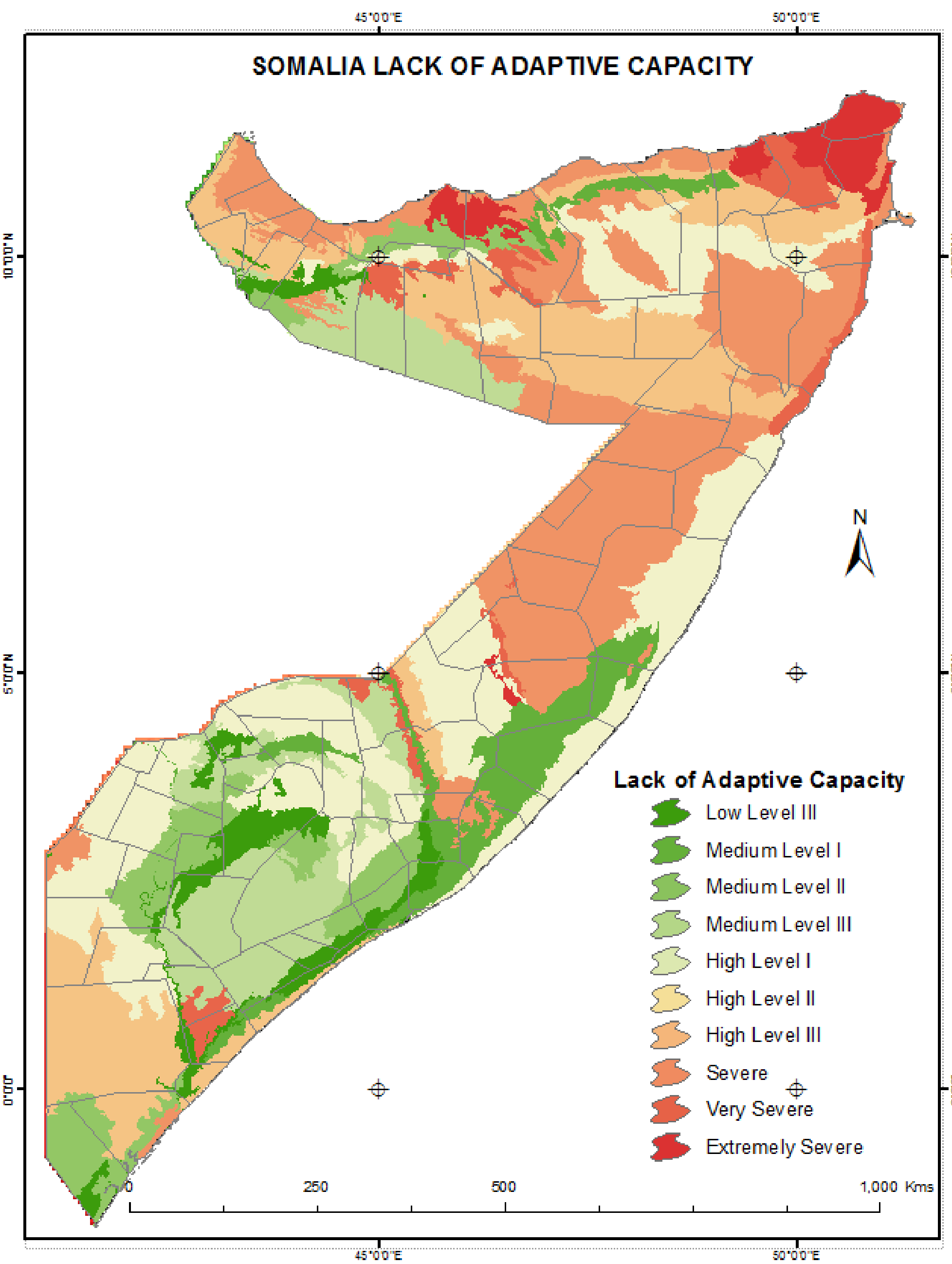


Figure 6-33; Lack of Adaptive Capacity to Climate Change

The assessment of sensitivity was carried out using the following indicators shown in Table 1. The results indicate that the most sensitive districts include: Jalalaqsi, Buuhoodle, Caynabo, Ceerigaabo, Burtinle, Dhuusamarreeb, Cabudwaaq, Cadaado, Belet Weyne, Bulo Burto, Wanla Weyn, Buur Hakaba, Borama, Gebiley, Burco, Baydhaba, Ceel Barde, Tayeeglow, Rab Dhuure, Owdweyne, Waajid, Banadir, Xudur and Hargeysa which are categorized in the High Level III, Severe and Very Severe sensitivity,. Figure 27 below show the sensitivity of the different parts of the country.

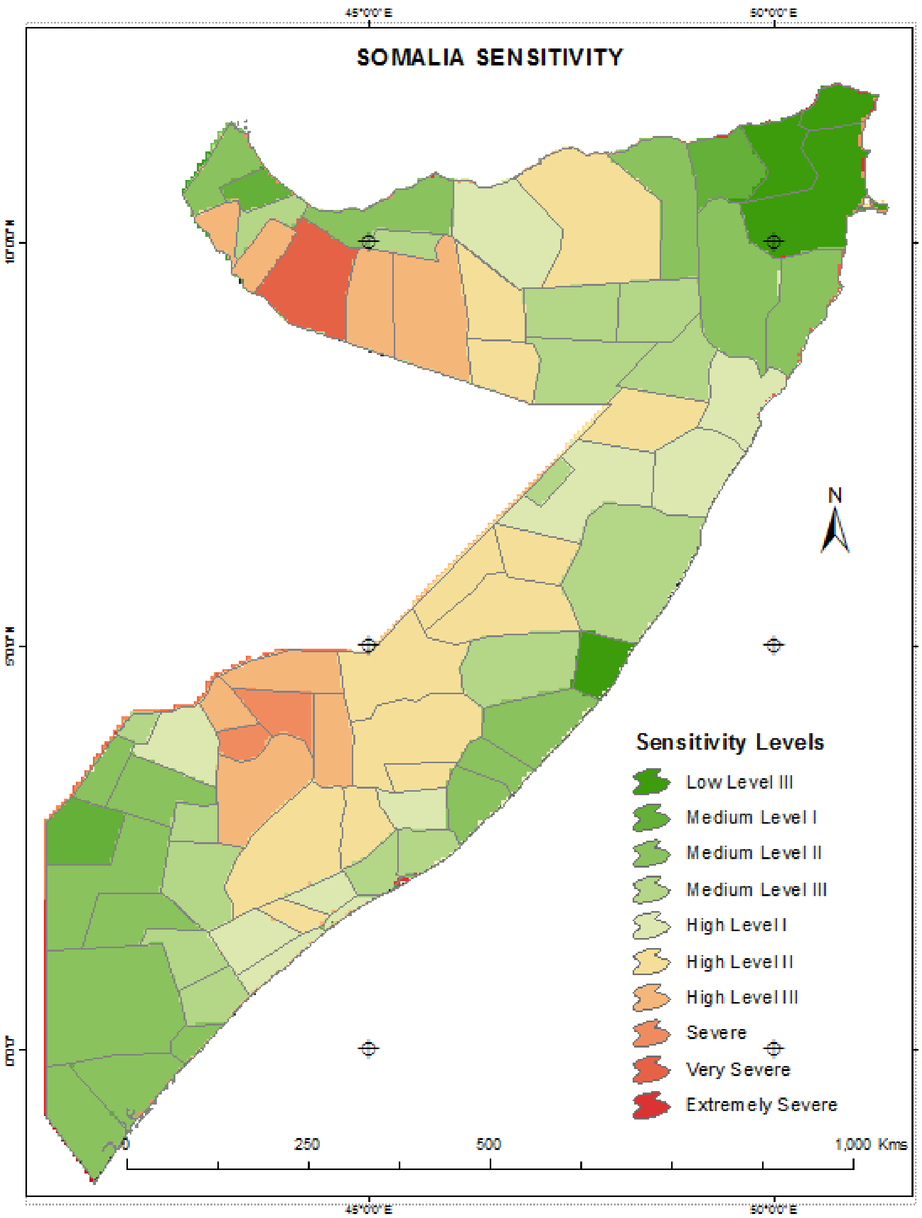


Figure 6-34; Sensitivity to Climate Change

5.8. Vulnerability analysis

This climate change analysis, along with common perceptions derived other research findings demonstrates that temperatures are projected to increase significantly, while rainfall is expected to increase in some few areas during the given season as indicated in prior discussions while significant rainfall declines are also being experienced. The increasing temperatures may affect the phonological cycles of crop production, increase pest populations and disease occurrences in crop and livestock production systems. These changes are also expected to result in more frequent dry spells and severe storms that compromise productivity. Farmers have consistently noted that the nature of the rainy season(s) is changing, insects and crop disease have increased and severe weather events are more common.

Vulnerability analysis was done by combining the three components in ArcGIS spatial analyst environment using the equation below.

$$Vulerability = (Lack\_Adaptive\_Capacity + Exposure + Sensitivity) * \frac{1}{3}$$

The analysis produced results for Gu, Jilaal, Deyr and Hagaa seasons as shown in figure 26, 27 and 28.

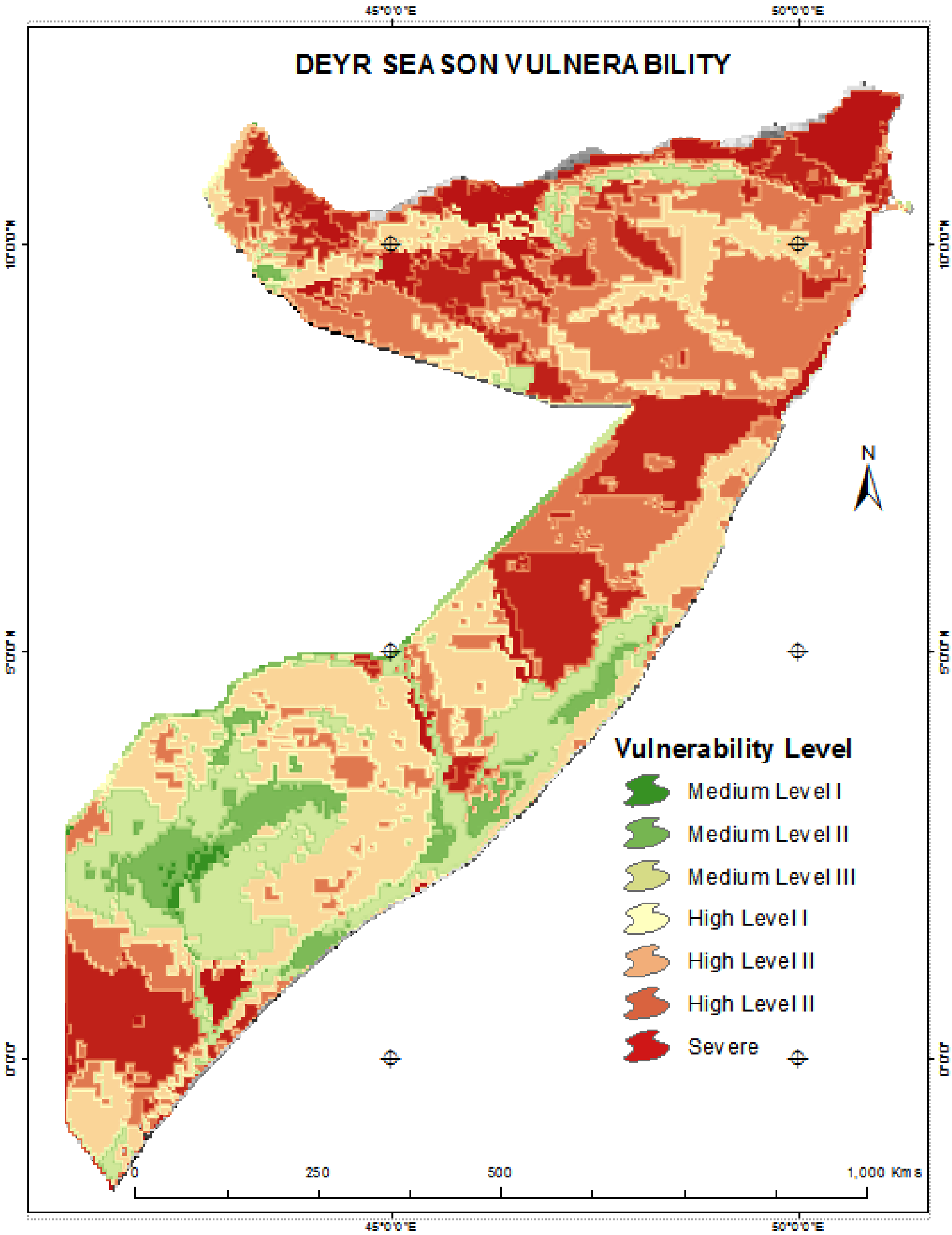


Figure 6-35 Deyr season Vulnerability

The assessment indicates that the vulnerability to climate in the Deyr seasons varies widely across the country and its impacts are experienced at the local level since the Deyr rains are dependable for most livelihoods in Somalia. This calls for local responses and solutions as part of the national plan for climate change adaptation. The Least vulnerable in the Deyr Season, Qansax Dheere, Diinsoor, Balcad, Baraawe, Marka and Baardheere which fall in the Medium level II vulnerability. The most vulnerable districts that fall the range of high level III include Kismaayo, Galdogob, Jalalaqsi, Borama, Ceerigaabo, Zeylac, Jilib, Bandarbeyla, Hargeysa, Burco, Eyl, Lughaye,Caynabo, Gaalkacyo, while Banadir, Berbera, Owdweyne, Iskushuban, Dhuusamarreeb, Baki, Ceel Afweyn, Cadaado, Afmadow, Bossaso, Burtinle, Qandala, and Caluula are ranked at the severe level of vulnerability in the Deyr season. This analysis also considered the Gu season which is the main rain season in Somalia.

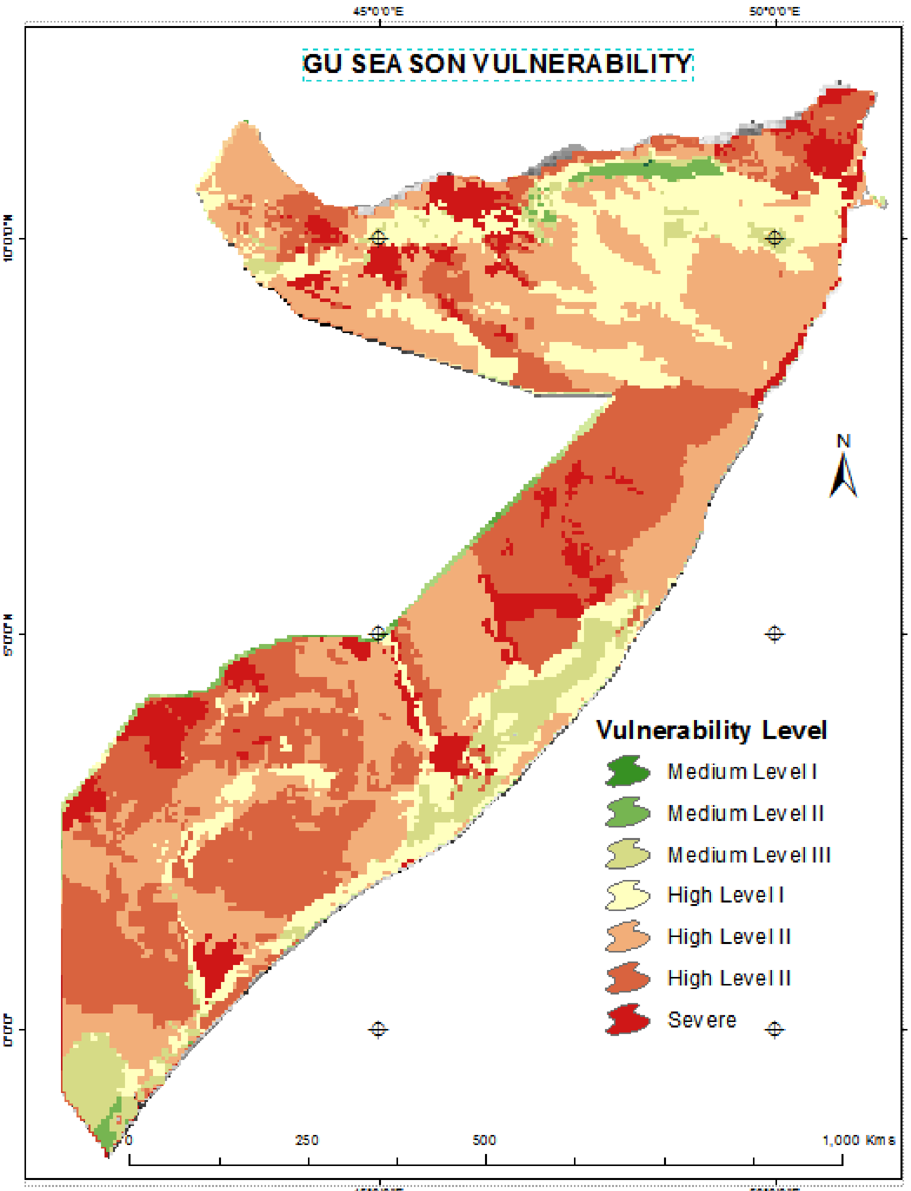


Figure 6-36 Gu Season Vulnerability

As indicated earlier the vulnerability to climate in the Gu seasons varies widely across the country with most vulnerability; mainly resulting from the pronounced decline in rainfall. The direct and indirect impacts are experienced at the local level among the populations which are dependent on the Agricultural, Agro-pastoral and pastoral livelihoods that are largely rain fed.

There should be serious consideration given to adaptation measures suitable for the Gu season, especially focusing on the most affected districts. The Least vulnerable districts in the Gu Season include, Badhaadhe, that fall in the Medium level II and Xarardheere, Laasqoray, Ceel Dheer, Balcad and Adan Yabaal which fall in the Medium level III vulnerability class. The most vulnerable districts include; Waajid, Galdogob, Dhuusamarreeb, Cadaado, Jalalaqsi, Gaalkacyo, Belet Xaawo ,Caluula, Luuq, and Doolow all of are ranked in high level III vulnerability in the Gu season.

The Jilaal season has mild climate change vulnerability as shown in figure 28. This season is the longest dry season in Somalia. The Least vulnerable districts in the Jilaal Season include, Xarardheere, Ceel Dheer, Adan Yabaal, Balcad, Qansax Dheere and Marka, which fall in the Medium level II vulnerability class.

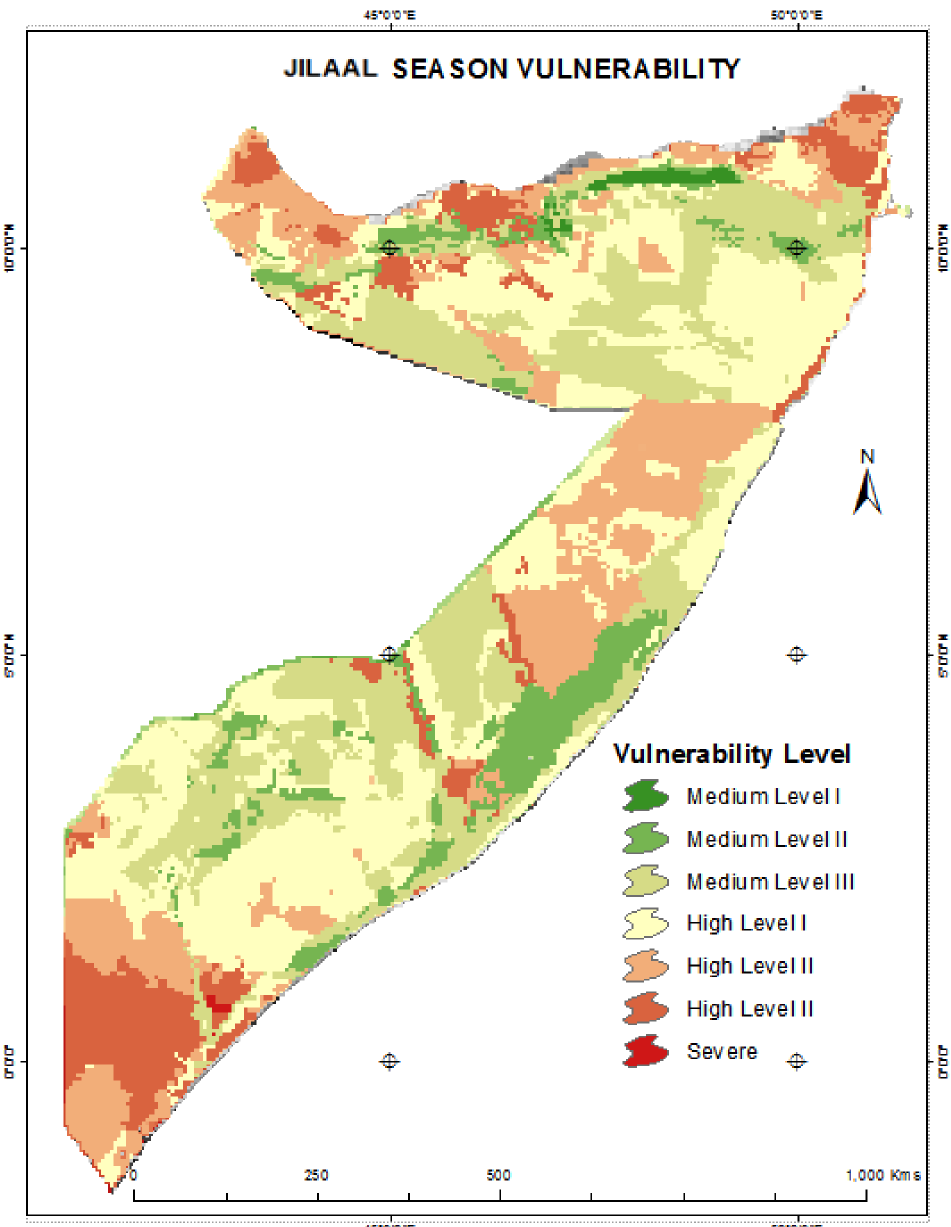


Figure 6-37: Jilaal Season Vulnerability

The most vulnerable districts include; Banadir, Jalalaqsi, Jamaame, Zeylac, Caluula, Kismaayo, Afmadow and Jilib all of are ranked in high level III vulnerability in the Jilaal season.

Finally the climate change analysis indicates that the vulnerability in the Hagaa season; a short dry spell experienced between July and September varies widely across the country with hot spots in the Central and Southern Somalia. The least vulnerable in the Jilaal Season include; Borama, Marka, Balcad, Zeylac, Laasqoray, Ceel Dheer, Adan Yabaal, Sheikh, Xarardheere, Hargeysa, Qansax Dheere and Ceerigaabo which fall in the Medium level III and hih level I vulnerability. The most vulnerable districts that fall the range of high level III include Ceel Buur, Buuhoodle, Bu'aale, Ceel Barde, Xudur, Belet Weyne, Hobyo, Qandala, Kismaayo, Jalalaqsi, and Eyl, while Cabudwaaq, Jariiban, Afmadow, Dhuusamarreeb, Burtinle, Caluula, Gaalkacyo, Galdogob, and Cadaado are ranked at the severe level of vulnerability in the Deyr season.

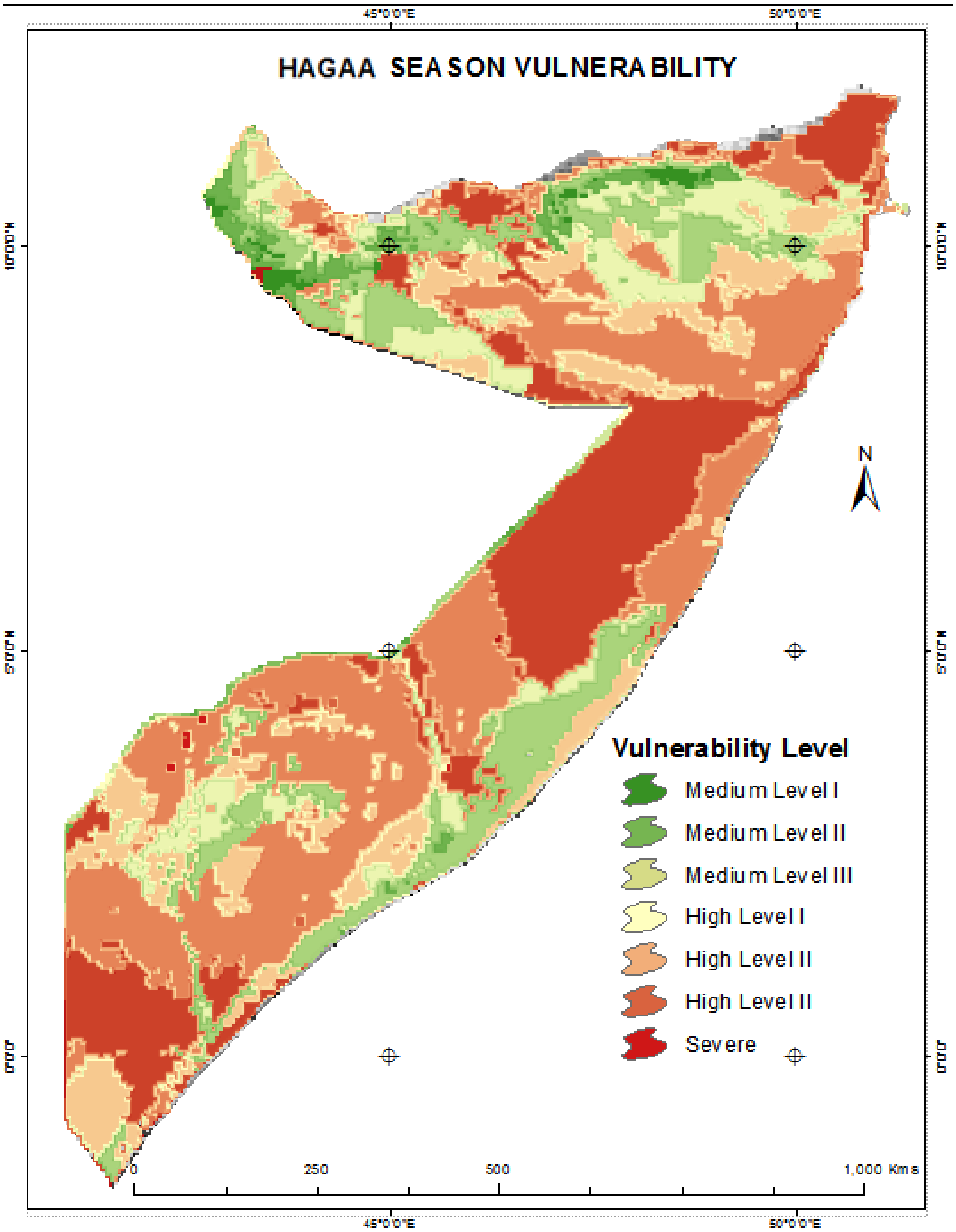
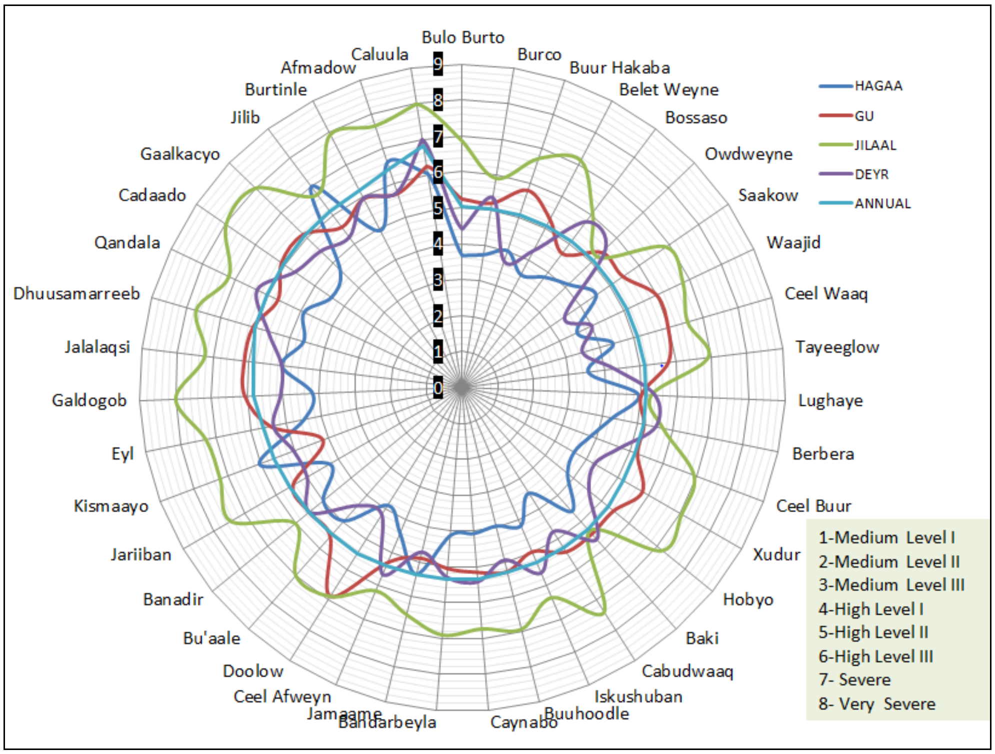


Figure 6-38: Jilaal Season Vulnerability

Considering the average climate change vulnerability over the country it was found out that Jilaal season has the highest levels of risk across the country as shown in figures 30. This is followed by the fact that the major rainfall season; Gu, is the presents the second most vulnerable status. In this most important rainy season in Somalia, greatest declines of precipitation has been recorded in all areas of the country. As shown in figure 30, the performance of the season indicates higher vulnerability levels than the mean annual levels. In this analysis the districts showing annual vulnerability levels higher than 5 (high level II) are considered to be at critical risk to climate change. The districts falling under critical level of vulnerability include; Bulo Burto, Burco, Buur Hakaba, Belet Weyne, Bossaso, Owdweyne, Saakow, Waajid, Ceel Waaq, Tayeeglow, Lughaye, Berbera, Ceel Buur, Xudur, Hobyo, Baki, Cabudwaaq, Iskushuban, Buuhoodle, Caynabo, Bandarbeyla, Jamaame, Ceel

Afweyn, Doolow, Bu'aale, Banadir, Jariiban, Kismaayo, Eyl, Galdogob, Jalalaqsi, Dhuusamarreeb, Qandala, Cadaado, Gaalkacyo, Jilib, Burtinle, Afmadow and Caluula; in an ascending order of risk to climate change .The districts falling in the vulnerability range of 3 to 5 (medium level III, High level I and II); are considered to have moderate to above average level of risks resulting from climate changes. The districts that can be categorized in the moderate to above average risk include; Xarardheere, Ceel Dheer, Marka, Adan Yabaal, Qansax Dheere, Baraawe, Laasqoray, CA dale, Jowhar, Afgooye, Sheikh, Baydhaba, Badhaadhe, Diinsoor, Ceerigaabo, Rab Dhuure, Gebiley, Telex, Borama, Baardheere, Garbahaarey, Sudan, Qardho, Sablaale, Qoryooley, Kurtunwaarey, Hargeysa, Luuq, Laas Caanood, Wanla Weyn, Ceel Barde, Garoowe, Belet Xaawo, and Zeylac; in an ascending order.



It is important to note that there are no districts in Somalia with low to moderately low vulnerability to climate change using the scale provided in table 6-2. However, there are some pockets of low vulnerabilities (Medium I) in the some of the districts. Table 6-2 below shows the scale used in the assessment of vulnerability

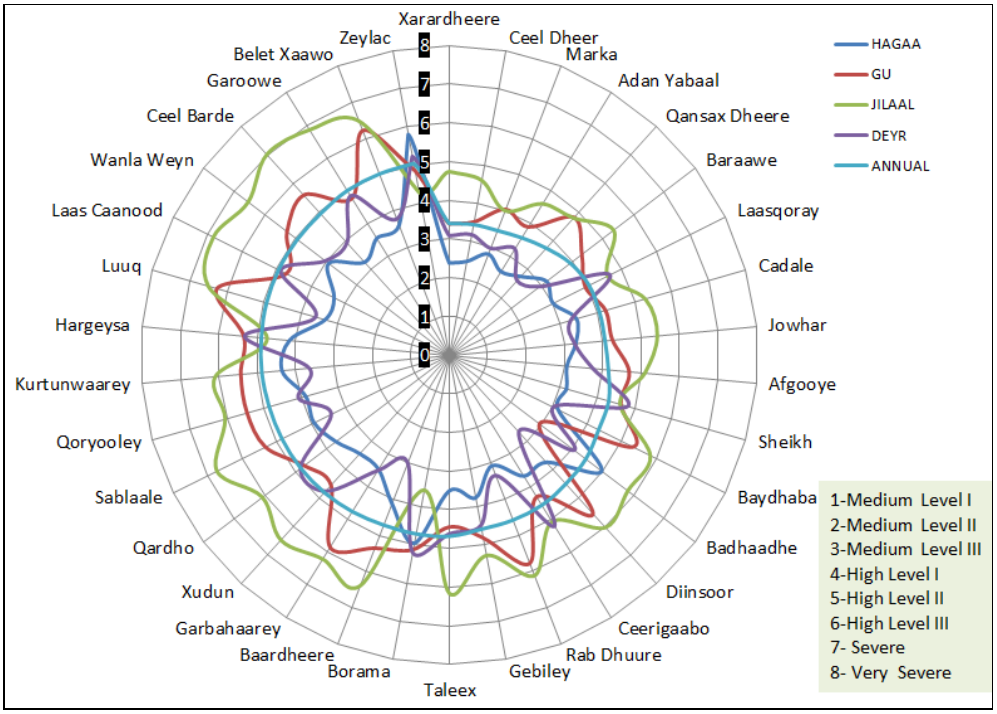


Figure 6-39 Level of Seasonal and Annual Vulnerability by District

Table 6-2; Scaling of the Vulnerability Analysis Results

Category	Scale Ranges
Low I	0 to 10
Low II	10 to 17
Low III	17 to 22
Medium I	22 to 27
Medium II	27 to 32
Medium III	32 to 36
High I	36 to 40
High II	40 to 44
High III	44 to 48
Severe	48 to 62
Very Severe	62 to 75
Extremely Severe	75 and Above

5.9. Sectoral Assessment for Impacts, Vulnerability and Adaptation to climate change

About 70 per cent of Somalia population is dependent on climate-sensitive agriculture and pastoralism. With natural resource degradation also rampant throughout Somalia, most notably for the production of charcoal, Somalia is becoming increasingly vulnerable to conflicts over scarce resources. This makes the country highly vulnerable to the impacts of climate change since the livelihoods are dependent on the factors of climate whose exposure is exacerbated by the fact that the country is poor and disrupted by war (Kinyangi et al., 2009; Kolmannskog, 2009). The severity of the factors of climatic exposure is expected to increase in both frequency and intensity. For instance the recurrent drought events in the past have resulted in huge losses of life and property as well as migration of people. There is therefore dire need to find approaches that can reduce the sensitivity of farmers and pastoralists to increasing rainfall variability and increase adaptive capacity to the impacts of climate change. The major factors contributing to the vulnerability of Somalia to the impacts of climate change include;

i) Food insecurity arising from occurrences of droughts
ii) Outbreak of diseases such as malaria, dengue fever, water borne diseases (such as cholera, dysentery) associated with floods and respiratory diseases associated with droughts.
iii) Land degradation due to deforestation, and overgrazing
iv) Damage to infrastructure by floods;
v) Loss of life and property,
vi) Soil erosion and
vii) Desertification.

5.9.1. Disaster Risk Management

The impacts of Climate change are exacerbated low resilience levels owing to resource scarcity, and inadequate of policies on natural resource management and disaster risk management at the national level. The local communities also lack the financial, technical and informational resources needed to build their resilience to climate change. Further; there is inadequate knowledge on how to prepare for extreme climate change and weather impacts which include floods and droughts.

5.9.2. Recurrent droughts

Drought is the most important, devastating and recurrent natural disaster affecting the country with more frequency and greater intensity in the recent decades. Severe droughts are often alternating with overwhelming floods causing pronounced starvation and death of people and livestock. It is estimated that in year 2004, an 200,000 pastoralists in the northern and central regions were threatened by drought considered to be the worst in 30 years (UN OCHA, 2004) when about 500,000 were reported to be in humanitarian emergency or livelihood crisis in drought-affected areas (UN, 2005). Owing to significantly reduced herd sizes, excessive debts and widespread destitution recovery was slow as pastoralists due to recurrent instability which limited access to markets, grazing and other resources; despite the good Deyr rains received in year 2004-2005

5.9.3. Recurrent floods

Recent flooding is known to hamper cereal production in the Jubba and Shabeelle regions. Flooding frequently occurs in during the Gu rainy season in the Hiran and Middle Shabeelle regions where the situation was described as “precarious”, with several thousand households being forced to flee their riverine villages (UN, 2005).

5.9.4. Tsunami

Coastal areas of Somalia, particularly in “Puntland”, suffered damage and the loss of several hundred lives as a result of the December 2004 Indian Ocean tsunami that was experience when many parts of the country recovering from four years of consecutive drought and periodic flooding (UNEP, 2005). Apart from loss of life, the livelihoods of about 44,000 were affected through loss of housing, loss of fishing materials, associated revenues and the need for relocation in some instances following salinization of coastal fresh water sources. The coastal infrastructure such as roads was also damaged

5.9.5. Desert Locust Plagues

The desert locust plagues have occurred in the year 1986-1989 and 1996-1998 running havoc on agricultural areas and easily spread across borders and causing emergencies. In the recent years has been out break but there is still a threat of outbreaks in the region, with attention focusing on the Chad/Sudan border and the Eritrean Red Sea coast (FAO, 2005b). table 3 below shows the most recent disasters experienced in Somalia.

Table 6-3. Recent natural disasters in Somalia

Disaster	Date	Number of people Killed	Number of people Affected
Drough	December 1964		700,000
	197	19,000	230,000
	198	600	500,000
	January 2000		650,000
	June 2001		1,100,00
	December 2001		500,000
	200		200,000
Flood	November 1961	200	
	October 1997	2,31	1,230,00
	July 2000		220,000
Epidemic	March 1985	1,26	
	October 1997	500	
	January 1986	1,30	
	February 1998	248	
	April 2000	390	
Wave/Surge	December 2004	298	44,000
Famine	March 1999		375,000

Source: EM-DAT: The OFDA/CRED International Disaster Database, www.em-dat.net. Université catholique de Louvain, Brus- sels, Belgium. May 2005.

5.10. Coping with Climate Hazards and Disasters

Somalia has a lean capacity to deal with frequent disaster events such as the tsunami, floods and recurrent droughts. Droughts are often followed by floods intensifying exposure of already weakened communities and livestock resulting in further devastation and damage of property. There are monitoring systems being run by the FSNAU-FEWSNET and FAO-SWALIM for Famine and drought/flood early warning systems based on climate modelling. However, the ability to react to such early warning systems is inadequate leading to the occurrences of such disasters causing havoc on property and vulnerable groups. Historical records show that eighteen (18) floods were experienced in Somalia during the period 1961-2004, resulting into the death of 2,600 people and directly affecting about 1.8 million others. Twelve droughts were experienced during the same period, leading to the loss of 19,600 lives and directly affecting about 4 million people.

In general as noted by the local communities and organizations recently disasters recurring on a short cycles in the Horn of Africa, have weakened the resilience of pastoralists accrued over many generations" (OFDA-CRED, 2005; IUCN, 2006). According to IUCN (2006); water scarcity and competition to access to critical areas of vegetation are a traditional source of social conflict in Somalia, especially when local supplies diminish during drought periods; pastoralists have to negotiate for water access.

5.10.1. Displaced people

Migration is at the heart of Somali nomadic culture which is characterized by a subsistence economy, a trading mindset and nomadism, a traditional and well-established form of livestock keeping well attuned to the region's climate. However, not all population movements are voluntary in Somalia, but wars, civil unrests are known to spark movements of populations. In spite of the conflicts in Somalia's, largely the parts in the north are relatively peaceful and secure. The renowned conflict is concentrated in the South between the Al-Shabaab group, government forces being supported with the African Union peacekeeping forces. However most of the incidents of insecurity and violence are unrelated to Al-Shabaab, but are linked to communal clashes, revenge killings and struggles over resources which are worsened by the worsening climatic situation. The majority internally displace persons are found in the southern and central regions with Mogadishu having the largest numb nearly 370,000[96] of the 1.1 million IDPs; about 9 per cent of the Somali population (UNPESS). The IDPs are mainly from the minority clans from the Bay, Bakool and Shebelle regions, fleeing not just drought but also discrimination majority of the Somali people. Most of the IDPS in Mogadishu are from the Digle and Mirifle clans or the Bantu minority as a result of the 2011 famine[97].

5.11. Somalia's Vulnerability to climate change; Natural Resource management

5.11.1. Land Degradation

Land degradation[98] the long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided[99]. The table below shows the common causes of land degradation in the country. The most prevalent land degradation experienced in the country include soil erosion both water and wind erosion, reduction of vegetation cover (biological degradation), aridification/desertification (water resource degradation), bleaching of biodiversity aggravated by the decline of palatable plant and animal species, and declining soil fertility in agriculture potential areas. The important areas of consideration include land degradation, deforestation, Soil erosion, and loss of biodiversity recurrent droughts, inadequate

96 UNHCR Population Movement Trends System.

97 Majid & McDowell, op. cit.; Human Rights Watch, 'Hostages of the Gatekeepers: Mogadishu IDPs', 2013.

98 "Degradation implies reduction of resource potential by one or combination of processes acting on land. These processes include water erosion, wind erosion and sedimentation by those agents, long-term reduction in the amount of diversity of natural vegetation, where relevant, and salinization and sodication"

99 USAID 2014, Environmental and Natural Resource Management Assessment

access to safe water and urban waste and pollution. Most land degradation is caused by soil erosion, overgrazing, illegal charcoaling, shifting cultivation, sand mining, overhunting, breakdown of traditional forms of land management, climate change[100]. It has been found out that lack of access to safe water is aggravated by inadequately planned location of boreholes and wells, lack of aquifer maps, failure to protect water sources from pollution, open defecation, overuse of water sources, climate change in addition, indiscriminate dumping of waste, lack of sewerage and liquid waste treatment, inadequate regulation of waste management sector in the country

Table 6-4 land Degradation Types and Causes[101]

Land degradation type	*Direct causes*	*Indirect causes*
Physical **Water erosion & Wind erosion** **Surface sealing and crusting**	Overgrazing Topography of grazing lands Improper farming techniques	Inadequate knowledge and skills Short-term planning horizon inadequate functional NRM structures Weak tenure and resource access rights
Biological **Loss of vegetative cover** **Loss of biodiversity** **Invasion of nuisance species** **Loss of habitat** **Deforestation**	Increased climate variability Wood harvesting Shifting cultivation Deforestation	Climate change Increased demand for resources Inadequate access to capital High reproductive rates
Chemical **Salinization & Water logging**	Poor drainage	Collapse of flood control systems on perennial water courses

Physical degradation is more prevalent in the North (Somaliland and Puntland) than in the South (Omuto, Vargas and Alim et al., 2009). The most common physical processes in the northern Somalia include water and wind erosion (Jibril, 2014), due to largely bare areas exposed to rainfall and wind actions Puntland (Hassan, 2013. The Average wind speeds in Somalia reach 0.2 to 8.5m/sec and tend to vary per year and between seasons (Muchiri, 2007). Hargeisa has the highest recorded average of 17m/sec in the months of June and July; in the South (past Lower Juba) average wind speed is 8-10 m/sec (Muchiri, 2007). Aridification is dominant in the south, and loss of vegetation in central and southern Somalia. Loss of topsoil by water erosion covered the largest area and could therefore be said to have been the most widespread type of land degradation in Somalia. The high wind speed coupled with the lack of vegetation cover to serve as windbreaks mean dust devils commonly transport tons of topsoil, further accelerating the degradation of fragile arid ecosystems. Physical degradation removes the topsoil, which reduces the available forage, affecting the diet of livestock (sheep, goats and camels). Respondents noted the loss in land cover due to both physical and biological degradation is so extreme that is has resulted in dietary changes for camels, which are normally browsers but have been forced to graze (Mohamed and Abikar, 2014).

[100] FA0-SWALIM Technical Report L-14: Omuto, C.T., Vargas, R. R., Alim, M.S., Ismail, A., Osman, A., Iman. H.M. 2009. Land degradation assessment and a monitoring framework in Somalia. Nairobi, Kenya.

[101] USAID 2014, Environmental and Natural Resource Management Assessment

Figure 6-40 Soil Erosion Caused by Run off: Xumbaybas, Puntland (Left; ADESO, 2014) () and Gebi Valley, Sanaag (Right; ADESO, 2014)

5.11.2. Deforestation

The annual rate of deforestation for Somalia (1.03%) is three times that of neighboring Kenya (0.3%) and almost twice the average rate of loss for Africa (0.62%) (FAO, 2009). It has been noted that the primary causes of de-vegetation and deforestation are overgrazing, shifting cultivation and unregulated charcoaling. Deforestation related to shifting cultivation is prominent particularly in the South. This degradation has been by aggravated prolonged conflict and rapid environmental degradation in the region.

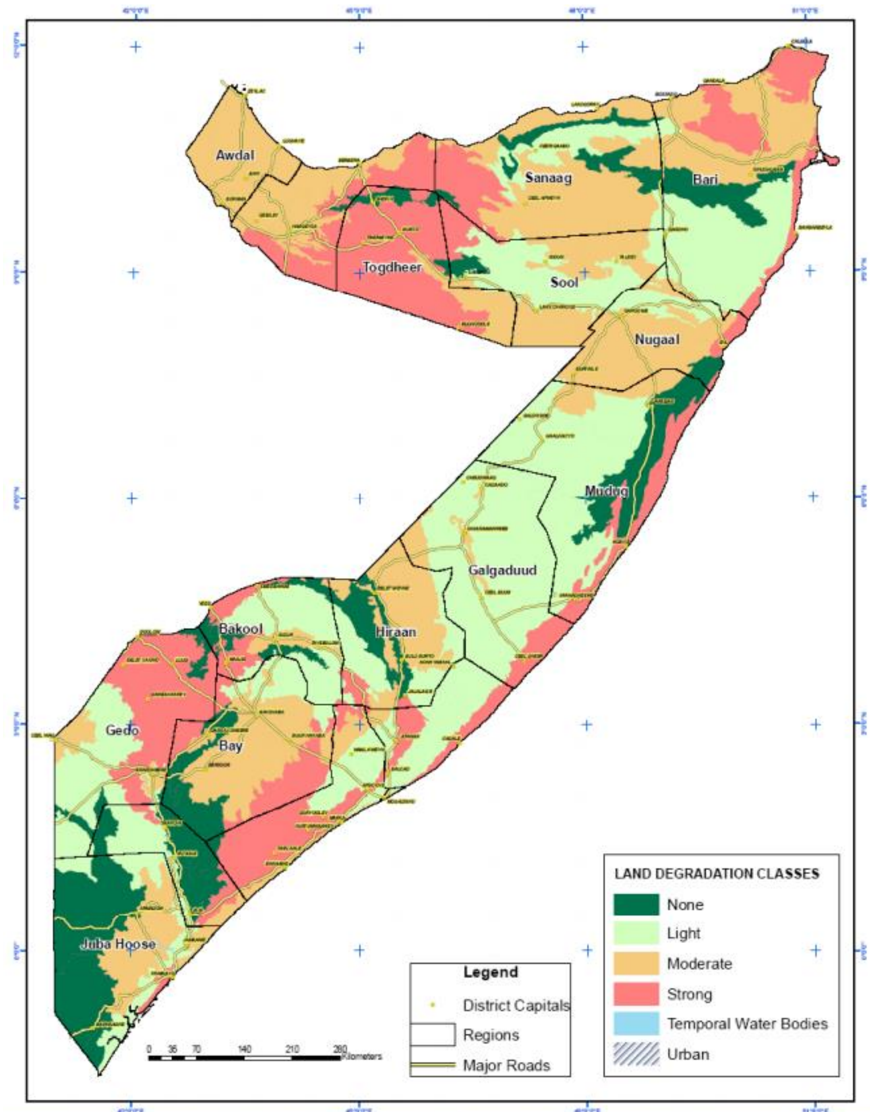


Figure 6-41 Land degradation in Somalia

Due the circumstances, the rate of land conversion and clearing forested areas for cultivation only to abandon them as they flee migrants from conflict (Ali and Mohamed, 2014), has increased[102].

The rate of species loss is not known but it has been noted that a number of palatable local grass species have disappeared leading to a decline in livestock productivity for both meat and milk per head (Hussein, Igal, Abdullahi and Ismail-Gabush, 2014; Awale, 2014; Awaley, 2014). The level of degradation and the resulting changes in landscapes have created conditions suitable for the spread of hardier, invasive species such as Prosopis Juliflora and others. The spread of invasive species has been linked to the decline in palatable grass species in grazing areas (Awale, 2014; Awaley, 2014).

[102] FA0-SWALIM Technical Report L-14: Omuto, C.T., Vargas, R. R., Alim, M.S., Ismail, A., Osman, A., Iman. H.M. 2009. Land degradation assessment and a monitoring framework in Somalia. Nairobi, Kenya.

The major cause of deforestation is the indiscriminate charcoal harvesting mainly in southern Somalia (Government of the Federal Republic of Somalia and UN Somalia, 2013). Charcoal production has been enhanced by availability of the raw materials, the minimal capital needs for charcoaling operations, the breakdown of formal and traditional governance and increased foreign demand. Extended deforestation of the fragile ecosystems in Somalia will result into the onset of desertification (Kirkland, 2011). It is estimated that about 100,000 metric of charcoal are exports from southern Somalia to the Gulf States (Kirkland, 2011). The current rate of charcoal removal exceeds the rate of forest growth. In the last 20 years Somalia has lost almost 14% of its forest cover, largely because of unregulated charcoal making (Forest Resource Assessment, 2005; Kirkland, 2011). Table 4 and table 5 below show areal extent and level of land degradation in Somalia.

Table 6-5; Areal Extent of prevalent land degradation types in Somalia[103] (source; FAO SWALIM)

Degradation Type	Area coverage (Km2)	Area coverage (%)
Soil erosion by water	217054.73	34.11
Biological degradation	241043.73	37.89
Water degradation	68865.73	10.82
Soil erosion by wind	15766.48	2.48
Chemical soil deterioration	5429.99	0.85
Urban	175.10	0.03
Temporal water bodies	186.33	0.03
None	87717.91	13.79
Total	636240	100

Table 6-6 Level of land degradation in Somalia (source; FAO SWALIM)

Land Degradation status	Area coverage (Km2)	Area coverage (%)
None	85086.39	13.43
Light	212761.78	33.58
Moderate	195070.83	30.79
Strong	140328.06	22.15
Total	633608.50	99.95

5.11.3. Responses and interventions to land degradation

There are some sustainable Land Management (SLM) Practices in Somaliland and Puntland and only hand-made soil bunds in Southern Somalia[104]. The summary of some of the responses and their distribution in the country are shown in table 6 and figure 35 below.

[103] FA0-SWALIM Technical Report L-14: Omuto, C.T., Vargas, R. R., Alim, M.S., Ismail, A., Osman, A., Iman. H.M. 2009. Land degradation assessment and a monitoring framework in Somalia. Nairobi, Kenya.
[104] FA0-SWALIM Technical Report L-14: Omuto, C.T., Vargas, R. R., Alim, M.S., Ismail, A., Osman, A., Iman. H.M. 2009. Land degradation assessment and a monitoring framework in Somalia. Nairobi, Kenya.

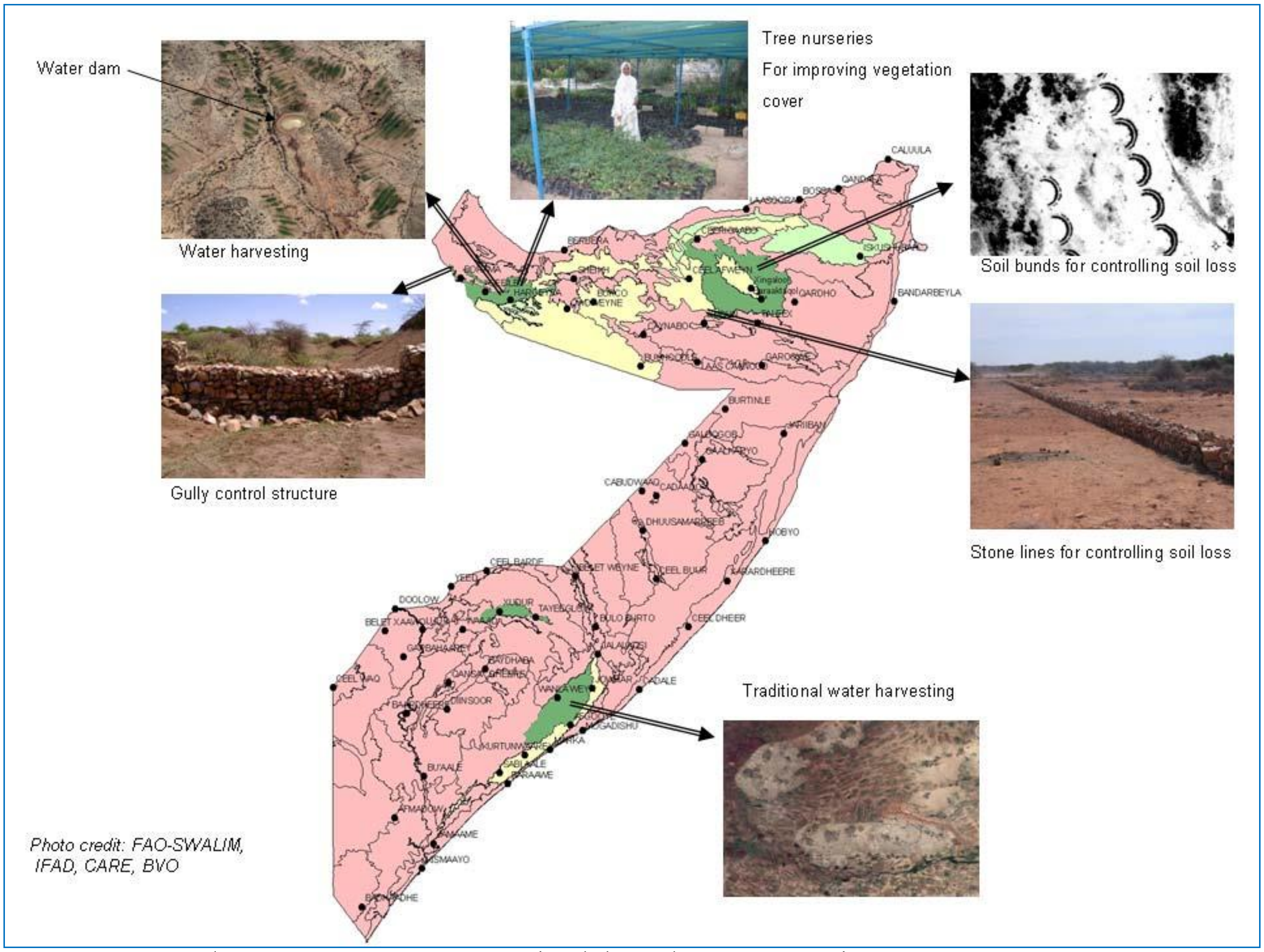


Figure 6-42; Distribution of SLM responses to land degradation in Somalia[105]

Table 6-7 Distribution of SLM practices in Somalia[106]

Presence of SLM practices	Area in Km^2	Area (%)
No SLM	523751.88	82.66
Very scattered	60411.07	9.53
Scattered	17959.55	2.83
Few	31124.57	4.91
Urban	175.10	0.03
Temporal water bodies	186.33	0.03
Total	633608.50	100.00

5.12. Somalia's Vulnerability to climate change; Loss of Biodiversity

Somalia is a biodiversity hotspot; lying in the Horn of Africa that is entirely arid and characterised with significant evolved endemism[107]. The estimated 5,000 vascular plant species, with over half endemic

[105] FA0-SWALIM Technical Report L-14: Omuto, C.T., Vargas, R. R., Alim, M.S., Ismail, A., Osman, A., Iman. H.M. 2009. Land degradation assessment and a monitoring framework in Somalia. Nairobi, Kenya.
[106] FA0-SWALIM Technical Report L-14: Omuto, C.T., Vargas, R. R., Alim, M.S., Ismail, A., Osman, A., Iman. H.M. 2009. Land degradation assessment and a monitoring framework in Somalia. Nairobi, Kenya.
[107] Ullah, Saleem and Gadain, Hussein 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia, FAO-Somalia.

species, of the hotspot are concentrated in fewer areas and Somalia is among those concentrations of plant endemism. The dominant vegetation type is Acacia – Commiphora bushland, which provided for thousands years frankincense (from Boswellia sacra and B. frereana in Somalia) and myrrh (from the widespread Commiphor myrrha and C. guidottii) to Africa and Middle eastern countries as far as Egypt. In the entire Horn of Africa biodiversity hotspot, Somalia hosts the Yeheb nut (Cordeauxia edulus, VU), an evergreen shrub or small tree with yellow flowers and edible, highly nourishing seeds. Hundreds of new species have been discovered in Somalia alone in the last 20 years, most notable among them the Somali cyclamen (Cyclamen somalense). Known only from a small area in northern Somalia[108], the plant was a surprising discovery in tropical Africa, as the genus Cyclamen is otherwise found only in the Mediterranean region. Within this context, the endemism of Somalia's biodiversity are given in the following table 7:

Table 6-8 Endemism of Somalia's biodiversity[109]

Taxonomic group	Species present in Somalia	Endemic Species	Percentage Endemism
Plants	3165*	800	25
Mammals	220	20	9.1
Birds	697**	24	3.4
Reptiles	285	93	32.6
Amphibians	30	6	20
Freshwater Fishes	100	10	10

5.12.1. Causes of biodiversity losses

The biodiversity records in Somalia are not up-to-date. However, the IUCN's Red List indicates some of the threatened species. It is important to note that habitat degradation due to unsustainable land use practices and a lack of regulation are the leading threats to the listed species. It has been noted that loss or decline of species is attributed to land degradation and the spread of invasive plants that have outcompeted indigenous plant species (; Awale, 2014; Awaley, 2014; Hussein, Igal and Abdullahi et al., 2014). Land degradation bleached ecosystem integrity and directly affects the supply of keystone species such as bees. The damage caused by charcoal production has greater impacts bee populations through the destruction of habitat and smoke pollution from kilns. In addition to destabilizing ecosystems by hindering pollination; the production of honey, a major alternative livelihoods for the rural populations is lumbered, (Osman and Mohamed, 2014). In addition, the medicinal plants that grow in association with the acacia trees have decreased due to removal of

[108] Ullah, Saleem and Gadain, Hussein 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia, FAO-Somalia.

[109] (http://www.cepf.net/resources/hotspots/africa/Pages/Horn-of-Africa.aspx)

acacia for charcoal production. Somalia has 151 plants with medicinal value that rural communities are heavily dependent on due to the lack of access to modern health care. Somalia also has 3,028 higher plants; of which 17 are threatened (World Resources Institute, 2003).

5.12.2. Essential Interventions on loss of biodiversity

The essential conservation measure worth exploring is the possibility for REDD Plus and efforts needs to focus on REDD readiness for the country. Other possible road map for the region could be preparing for UNESCO's Man & Biosphere Reserves (MAB) initiatives[110]. The overall objectives of these interventions should be divert pressure from the forest stock and associated biodiversity and provide the inhabitants with rather better & environment friendly alternatives. The energy and fodder requirements should be fulfilled through other means such as alternative/renewable energy (solar, wind, micro-hydro, etc.) and rotation grazing, etc. respectively

5.12.3. Main Drivers of Biodiversity Changes in Somalia

Changes in biodiversity and in ecosystems are caused by multiple, intertwined and interacting drivers that work over time i.e. climate change or level of organization including local zoning laws versus international environmental treaties and intermittent droughts, wars, and economic crises[111]. The most common type of interaction is synergetic factor combinations: combined effects of multiple drivers that are amplified by reciprocal action and feedbacks, (Millennium Ecosystem Assessment, 2005). The Somalia's situation depicts the true picture of these synergistically interacting drivers. The drivers of biodiversity change in Somalia are shown in the table 8:

Table 6-9; Drivers of Biodiversity Change in Somalia

Drivers of Biodiversity Loss/change	Interacting Factors
Habitat fragmentation /degradation	Deforestation, erosion, gullies formation, encroachment for agriculture and infrastructure for communication & habitation.
Invasive species	Not limited to, includes; i) The major invasive species in Somalia is Prosopis juliflora, together with Prosopis pallida and P. chilensis were initially introduced to East Africa for the stabilization of dune systems and for providing fuel wood after prolonged droughts in the 1970's (Von Maydell 1986). ii) Encroachment of only productive areas under agriculture or forestry while in the desert or semi-desert areas its infestation is rather insignificant.

[110] Ullah, Saleem and Gadain, Hussein 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia, FAO-Somalia.
[111] Ullah, Saleem and Gadain, Hussein 2016. National Biodiversity Strategy and Action Plan (NBSAP) of Somalia, FAO-Somalia.

Drivers of Biodiversity Loss/change	Interacting Factors
Over exploitation/ over-use	i) Hunting/poaching: Somalia has ratified the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), but few if any practical measures are being taken to ensure its implementation. ii) Overgrazing: Somalia's economy and livelihoods are predominantly driven by livestock sector, with grazing rather than stall feeding is the norm with overstocking iii) Deforestation: Somalia with less than 3% area covered by close canopy forests distributed in the Golis Mountains of the north and the Coastal Forest Mosaic, south off-Kismayu. Deforestation happens since 1970s for firewood, timber and charcoal making
Climate Change as driver of biodiversity loss[112]:	i) The extreme climate events; droughts and floods exacerbates deforestation for charcoal, increases hunting, and accelerates soil erosion due to deforestation, bush fires, wildlife migration and reduction of biodiversity. ii) Increased number of pests and pathogens infestation due to change of environmental factors as temperature, precipitation and flooding, soil erosion and loss of nutrients, wildlife migration, reduced aquatic reproduction and productivity of habitat and causing local extinctions.
Drivers of change for the coastal biodiversity	i) Mangrove depletion: Cutting the mangrove for timber and firewood, overgrazing and browsing, waste disposal, sand dune encroachment, flood water erosion and oil spillage[113]. annual rate of deforestation is around 1 per-cent ii) Coral Bleaching: Coral bleaching had a significant impact during the 1997/1998 El Niño[114]. iii) Coral mining: Limestone mining on the coral reef exists mainly off southern towns such as Marka and Barawe[115]. iv) Sand mining: Sand mining is very popular in all coastal towns and fishing villages in sand dunes mixed with cement, coastal soil and gravel to make bricks for construction. This activity destabilizes the coastal sand dunes (UNDP, 2011). v) Urban expansion: The civil unrest and war led to more displaced people with least waste management arrangements and increased solid waste generation and dumping of garbage directly onto the sea shore. Inadequate waste management regulation leads to all the coastal cities and towns using the beaches as garbage

[112] NAPA Somalia, 2014
[113] FAO-SWALIM, 2010
[114] Pilcher and Alsuhaibany 2000
[115] UNDP, 2011

Drivers of Biodiversity Loss/change	Interacting Factors
	dumping sites and as such suffocating given species diversity

5.13. Somalia's Vulnerability to climate change; Sahel, Drought and Desertification

The Sahel is a period of abnormally dry weather which is prolonged enough to cause serious hydrologic imbalance in the affected area. This is caused by frequent droughts, low precipitation, poorly distributed and highly variable monthly and seasonal unpredictable rainfall. Desertification becomes pounced with long spell of dry weather that is more noticeable and its rate of incidence increases abruptly. As the likelihood of droughts rises from the humid to arid regions, so does desertification especially accompanied with transformation of natural resources and land forms. Desertification is influenced by factors as rural poverty, ignorance, greed, social, civil and economic changes that may enhance protracted drought high rates of desertification.

There is mounting pressure for natural resources exploitation due to increasing drought events resulting to deforestation, expansion of reservoirs and overgrazing resulting to environmental degradation which adversely affect the livelihood of the populations. There is need therefore to device approaches for farming systems to adoption of tree planting/agroforestry and incorporation of multipurpose trees in the farming systems. Agroforestry is the most preferred resource management system to stabilize the production of food, forage, firewood and timber and protecting the environment. However, agroforestry requires development of appropriate skills, implementation capacity and the presence of institutions at the local, regional and national levels to regulate, monitor and enforce effective use of existing resources. There is also need to mobilize financial and human resources for continued development of the subsistence sector.

5.14. Somalia's Vulnerability to climate change; Water Resources

Somalia is a highly water scarce country where slightly more than 26% of the population access safe drinking water. The country has 6 cubic kilometers of renewable water resources where 97% is utilized for livestock and agriculture while the remaining 3 percent is used for urban and domestic use[116]. The main sources of surface water are the Juba and Shebelle rivers[117] with potential for irrigating the vast riverine areas of the two rivers. However, the rivers are also affected by intermittent floods. The water is extensively used for Urban, domestic, agricultural and livestock in the riverine areas. There are several boreholes, shallow wells (dug wells) and springs that are used to provide ground water for livestock and people who are not able to access the riverine regions[118]. The other source of water in Somalia is from rain water harvesting and run off catchment. Groundwater is harnessed by the rural and urban population to meet domestic and

[116] http://www.nationsencyclopedia.com/Africa/Somalia-ENVIRONMENT.html#ixzz2AsViUk3D
[117] asnyat, D. B. (2007), Water Resources of Somalia. Technical Report No W-11, FAO-SWALIM, Nairobi, Kenya
[118] asnyat, D. B. (2007), Water Resources of Somalia. Technical Report No W-11, FAO-SWALIM, Nairobi, Kenya

livestock water needs as well as for small scale irrigation Temporary watercourses, known as lachs or laks, drain the south-east sloping plateau of north-eastern Kenya into southern Somalia, the main ones being Lach Awaro, Lach Bogal and Lach Dheere (Hughes and Hughes, 1992). The other source is Cisterns (Berkads); pans or dams whose bottoms and sides are cemented and covered to ensure that water is not lost to evaporation and seepage (Amuyunzu, 1997).

5.14.1. Water quality

The utilization of Somalia's groundwater resources is hindered by water quality challenges due to high levels of salinity and minerals (iodine and fluoride). Along the coastline especially in Mogadishu and Kismayu there is Saline intrusion in shallow wells due to high demands of water that has led to excessive extraction of groundwater[119]. Due to poor sanitation practices i.e. open defecation and the absence of a system for monitoring and controlling bacteriological load the majority of open wells, berkhads and shallow boreholes in Somalia are likely to be contaminated especially in the rainy seasons.

5.15. Somalia's Vulnerability to climate change; The Health Sector

Somalia has the third highest under-five mortality rate (U5MR) in the world, after Angola and Chad. One in seven Somali children dies before their fifth birthday. The achievement in mitigation against child death rates in Somalia was slower in the Millennium Development Goals (MDG) period (1990- 2015) compared to the neighboring countries[120], as shown in figure below. This indicates that the U5MR fall short of the MDG target of two thirds reduction.

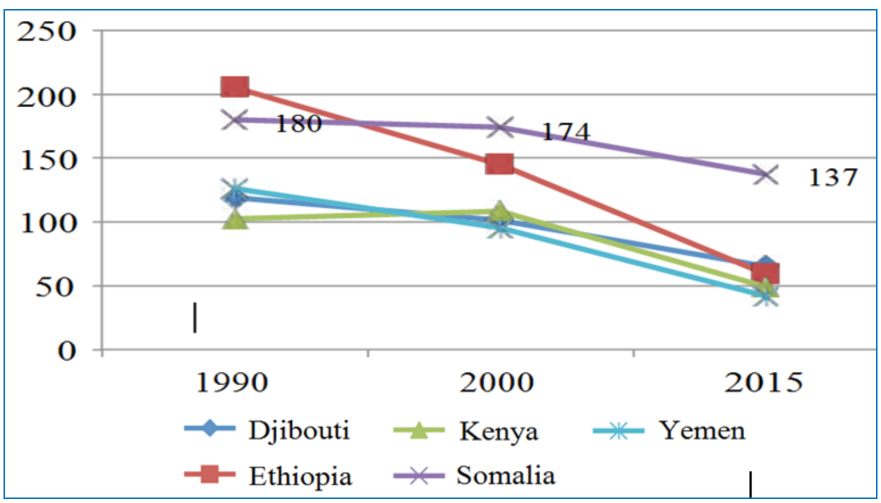


Figure 6-43 U5MR – Deaths per 1,000 live births[121]

[119] UNCEF Report 2016; Situation Analysis of Children in Somalia
[120] Levels & Trends in Child Mortality, UN Inter-agency Group for Child Mortality Estimates, 2015
[121] Two of Somalia's neighbours have met their U5MR MDG 2015 target, and the other two are close.

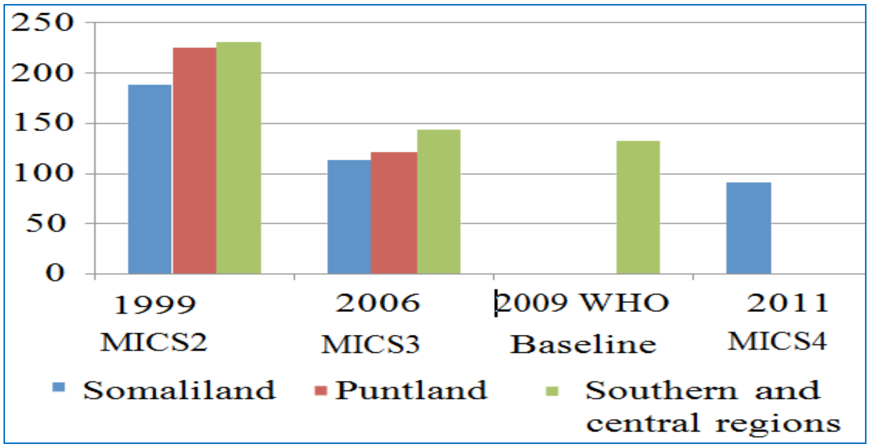


Figure 6-44 U5MR for Somalia Regions

However, studies have shown reduction in the child-mortality rate in all regions, though it remains higher in southern and central Somalia than in Puntland and Somaliland. The Multiple Indicator Cluster Survey of 2006 (MICS3 2006) indicates no significant difference in U5MR between the urban and rural populations[122]. There are multiple contributory causes high mortalities include neonatal issues, acute respiratory illnesses, diarrhoea, vaccine-preventable diseases and malaria[123].

5.15.1. Malaria Preference

In the comprehensive Malaria Indicator Survey of 2014 found the malaria prevalence was about two per cent of children under five and only slightly higher at 3 per cent in the Southern and Central regions where malaria is endemic. The findings also indicate reduction of the proportion of people infected by malaria as mainly due to the long periods of drought in 2009-2010[124].

[122] WHO, Baseline Survey for South and Central 2013-14, 2015 estimated U5MR for 2009; The sample was, however, heavily weighted for urban populations and was not representative of the whole population.
[123] This conclusion is supported by data from the HMIS (Health Management Information System), which only has data on deaths occurring at reporting health facilities, and is in line with findings from other Sub-Saharan African countries.
[124] Noor et al, Malaria estimates report, 2013

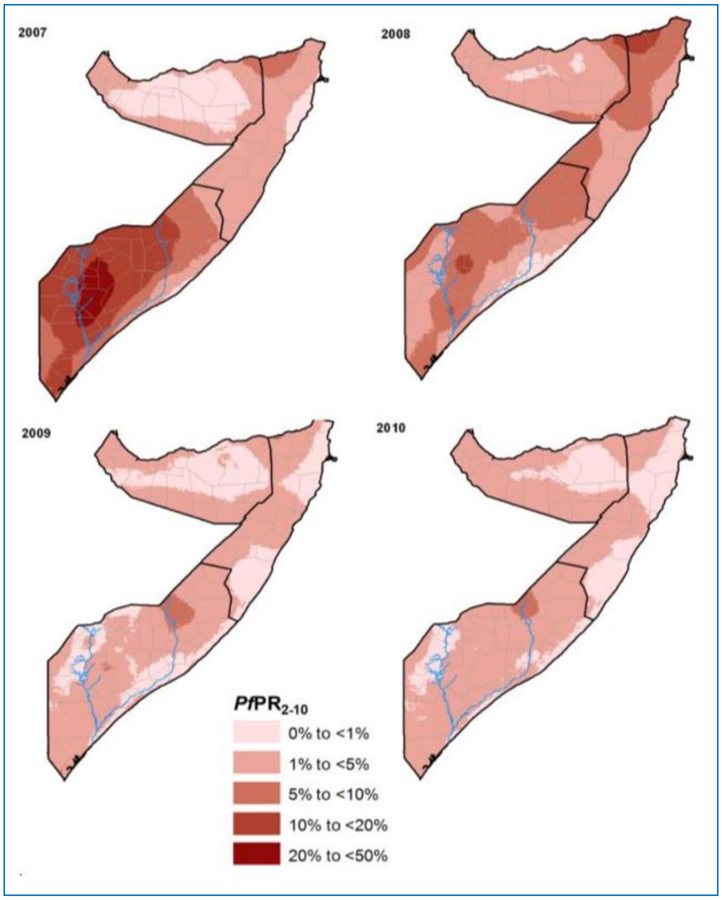


Figure 6-45 Endemicity map generated from the posterior annual mean PfPR2-10 prediction of 2007 to 2010 at 1×1 km grid location in Somalia.

The thick black lines show the zone boundaries, the thin black lines show the regional boundaries and the thin grey lines show the district boundaries. The blues lines show the location of the Juba (lower) and Shabelle (upper) Rivers. (Source: Noor et al 2013)

5.16. Inadequate Water and Sanitation

One of the main factors that determine the health of populations if the availability of sufficient and safe drinking water; without which, children in particular; suffer from poor sanitation and hygiene measures and leading to out-breaks of certain communicable diseases. In Somalia more than 70% of households (UNICEF/MOHL, 2000) lack safe drinking water. The availability of water in the urban settlements is very low about 25% of the daily demand (ibid, 1996) leading to diarrhea diseases among other endemic and epidemic communicable diseases, including Cholera. Diarrhea diseases results in high morbidity and mortality rates in Somalia where only 31% of household have been identified having safe drinking water leading to poor sanitation which also increases the incidences of internal parasites i.e. Giardiasis, Entrobmius Vermicularis and Ascaris Lumbricoides. There is a high incidence of diarrhoea in Somalia, 28 per cent in Puntland and 26 per cent in southern and central regions as of 2015[125]. Diarrhea is a major cause of child morbidity and mortality and is strongly correlated with child malnutrition, and stunting[126]. The tables 9 to 11 indicate proportions of populations with Diarrhoea in Children under Five, Utilizing Type of Sanitation Facility and practicing open defecation respectively.

[125] UNICEF, Malaria Indicator Survey, 2014. This data is an improvement over 2006 MICS3 results.
[126] FSNAU, Meta-analysis of WASH related data, 2009-2010.

Table 6-10 Incidence of Diarrhoea in Children under Five

% incidence of diarrhea in children under five	1999	2006	2011	2015
Somaliland	17	13	13	10
Puntland	27	11	10	28
Southern and central regions	25	25		26
Total	23	21		24
Urban	25	17		
Rural	23	24		
Source	MICS2	MICS3	MICS4	WASH KAP

Table 6-11 Proportion Utilizing Type of Sanitation Facility

% Utilizing Type of Sanitation Facility	1993	1999	2006	2011	2015
Use of improved Water	21	23	29		55
Urban	24	31	58		77
Rural	20	19	11		18
Nomad		12			
Use of improved sanitation	21	49	37		
Urban	42	83	78		
Rural	12	26	13		
Use of both improved water & sanitation					
Somaliland			24	29	
Puntland			16	37	
Southern and central regions			20		
Total			20		
Urban			47		
Rural			4		
Data Source:	MDG db	MICS2	MICS3	MICS4	KAP

Table 6-12 Proportion practising open defecation

% practising open defecation	1999	2006	2011	2015
Somaliland	49	44	35	20
Puntland	57	49	17	7
Southern and central regions	52	58		39
Total	52	54		29
Urban	17	8		11
Rural	73	82		44
Nomads	95			59
Source	MICS2	MICS3	MICS4	KAP

5.17. Somalia's Climate Change Vulnerable Groups

While majority of the Somalia population is vulnerable to climate change, women and youth have been identified as the most vulnerable groups. Rural populations are also particularly vulnerable to climate change impacts, as compared to urban populations. Furthermore, pastoralists, who constitute a large proportion of the country's population, are more vulnerable as opposed to other groups including agricultural farmers because they are highly dependent upon rain-fed rangeland grazing for their livestock and tend to have very few fixed assets. Finally, internally displaced peoples (IDPs) are also vulnerable because climate hazards, especially droughts, are the main cause of their migration from their initial settlements. This exerts pressure on the natural resource base in the areas where they settle. Their situation is worsened by the fact that they have limited means of survival, having sold most of their assets or lost them in conflict, making them even more susceptible to climate risks (FROS, 2013).

5.17.1. Women

Women in rural areas are identified as one of the most vulnerable groups in Somalia. This is as a result of the combined effect of sexual division of labor, unequal access to both material and non-material resources and women's diminished participation in decision-making in both political and private domains, which increases their vulnerability to the impacts of climate change. For instance, in crisis situations women are the ones who have to find ways of feeding their families and are therefore affected in different ways. Women are responsible for fetching drinking water if it is within 5-8 kilometres but if the water source is far, men take over the responsibility. Droughts either lead to women having to walk much farther, or transfer this responsibility to men. Women also suffer the most from food insecurity due to drought/floods as they often feed their children before themselves leading to malnutrition. The situation is worse for lactating mothers who suffer due to lack of protein intake when livestock are lost due to drought/flood. During migration to urban areas or IDP camps, women face physical insecurity during movement and within the IDP camps. Infections are often passed on from children to their mothers, particularly during drought when women are weak due to lack of food (FROS, 2013). When women relocate to urban areas, they have a particularly hard time in adapting to the lifestyle as they have had very limited exposure outside the rural setting. In some cases, young girls go into prostitution as a means of income for survival. Rural women make small amounts of money from selling milk, and they make decisions on how to use that small income. This income is lost when livestock is lost to drought/flood. Due to deaths from continuing conflict and disasters, the number of women-headed households has increased. Clan-based systems are used to cope with most issues surrounding natural resources and natural disasters. The clan elders meet when there is a problem, but also have regular meetings. Women do not participate in these meetings, and are only involved in making logistical arrangements such as food and accommodation. However, some women are indirectly involved by advising their husbands on topics that are discussed in the meetings (FROS, 2013).

5.17.2. Youth

Seventy-three per-cent of the population in Somalia is below the age of 30, and has been noted to be the highest in the country's history. Many young people are trapped in an environment of violence, fear, unemployment and poverty (UNDP, 2012). This not only erodes their hopes for human development but also makes them more likely to become part of conflict. Climate change often leads to increased conflicts over limiting resources. This has a particularly severe impact on youth, many of whom are unemployed. First, children and youth suffer from malnutrition due to lack of calcium intake when livestock is lost and crops are destroyed due to extreme climate events like droughts and floods.

Studies have shown an inverse relationship between the level of education and adaptive capacity (Lutz, 2010; Wamsler *et al.*, 2012; Williams *et al.*, 2015). This is particularly critical for Somalia, where there is a limited availability of schools. The problem is further complicated by the high dropout rates during times of climate crises of children enrolled in schools.

There is also a rise in youth unemployment as a result of the adverse impacts of droughts and floods on the economy. Unemployed youth are drawn into crime, drugs and other delinquent behaviour. Migration to urban areas that is partly driven by climate change, often leads to children becoming beggars or street-children to survive (IMF, 2017).

5.18. Climate change Resilience and Social Protection

The social protection systems entrenched in the traditional Somali lifestyles provides responsive opportunities to alleviate climate change and drought shocks. For instance this was exhibited; in the devastating 2011 famine that resulted to in the deaths of 258,000 people, half of whom (130,000) were children[127]. Social protection efforts can therefore be enhance at household or individual level, to provide protection during periods of extreme exposure, and promote opportunities to overcome vulnerability to shocks and stresses, and transform the societal or household relationships.

5.19. Impacts of Climate Change in Somalia

5.19.1. Climate Change Impacts on Natural resources

Somalia is one of the states in Africa with extreme vulnerability to climate change and variability, combined with a limited capacity to effectively respond to the impending impacts. Consequently Somalia risks the possibility of mass displacement and forced migration of large proportions of its population if urgent action is not taken to cushion the populations from climate stress and address the problem of dwindling resources (Meeking, 2013). Although it is considered a majorly agricultural state, with 80% of the population being dependent upon agriculture as of 2008, Somalia harbours only 2% arable land (Corfield, 2008). Of this arable land, 69% is dedicated to the grazing of low-intensity livestock and 17% is deforested. Somalia is expected to experience land degradation, declining ecosystems, water stress, threats to food security and the revitalisation of already prevalent armed

[127] Detailed analysis of the 2011 famine can be found at http://www.fsnau. org/in-focus/technical-release-study-suggests-258000-somalis-died-due- severe-food-insecurity-and-famine

conflict (Reuveny, 2007). In 2009, 250 million Africans faced significant risk of water shortages (Moss, 2009).

5.19.2. Climate Change Impacts on Coastal & Marine Resources

The Somali maritime zone is one of the largest in the western Indian Ocean and has one of the most important large marine ecosystems – the Somali Current Marine Ecosystem – in the Indian Ocean (Fielding and Mann, 1999). A prominent feature of this ecosystem is a seasonal upwelling which gives rise to high levels of biological productivity which in turn sustains rich fishing grounds, especially in the northern area between Ras Asir and Ras Mabber (TRAFFIC, 1997)[128].

Much of Somalia's population resides in low-lying coastal areas, bordering the Indian Ocean and Gulf of Aden. The observed and projected increase in temperature and the resultant sea-level rise is expected to cause an increase in extreme weather events and natural disasters. Considering the increasingly predictions of sea-level rise, migration has the potential to become one of the only options available to much of the Somali population (McLeman and Smit, 2006). Somalia has both fringing reefs and patches of coral reefs along the Gulf of Aden coast as well as in the south near the Kenyan border. Few studies have been conducted on these reefs but one off the northern coast east of Berbera highlighted extensive coral bleaching, with some reefs suffering almost total mortality (Schreyer and Baldwin, 1999). The Red Sea coral reefs off the coasts of Djibouti, Eritrea and Somalia, however, are reportedly in good pristine condition with 30-50 per cent live coral cover and the richest diversity of coral and other reef species in the entire Indian Ocean (Pilcher and Alsuhaibany, 2000).

Climate change is expected to wide spread bleaching and low recovery rate of pre-bleaching coral cover especially due to increasing sea surface temperatures and acidification. It is also expected that marine invasive will increasingly threaten biodiversity. It has been reported that Invasive alien species and Harmful Algal Blooms (HABs) are significantly threat to the marine ecosystems biodiversity that may be climate-change related in the southern coast near the border with Kenya. In the period December 2001–February 2002 the Harmful Algal Blooms (HABs) led to extensive fish mortality in (e.g. surgeon fish, snapper, and triggerfish)[129].

In addition to uncontrolled exploitation of marine resources, the sea bottom is also being damaged by heavy trawls and ships. According to one report (FAO, 1995), there is no knowledge of the extent to which illegal fishing – much of which takes place at night – is having off the Somali coastline. A more recent report from FAO (FAO, 2005b) noted that this practise continues to date.

5.19.3. Climate Change Impacts Water Resources

The seasonal and annual rainfall variability adversely affects the freshwater resources through the alternating and recurrent events of extreme flooding and drought. The available water is becoming scarce due to shifting rainfall patterns/seasons, gradual decline of rainfall amounts, higher

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[128] TRAFFIC, 1997. The Trade in Sharks and Shark Products in the Western Indian and South-east Atlantic Ocean. TRAFFIC East and Southern Africa.

[129] Obera, D. (2002). Status of Coral Reefs in East Africa. CORDIO Status Report 2002. CORDIO. East Africa.

evaporation, and rising sea level resulting from climate change. Increased temperatures and rainfall variability are likely to exacerbate the conditions already experienced and may in the future have a severe impact on water availability.

Somalia is to a large degree an arid or semi-arid country where rainfall is periodic and irregular. Water scar- city has been one of the main traditional sources of social conflict in Somalia. Traditionally such conflicts arise when local supplies are diminishing, particularly during dry periods of the year or during a drought. Nomads are commonly embroiled in water access negotiations at such times. Another source of tension, however, occurs when a new group of consumers moves into a new area – perhaps following displacement of agriculturalists by pastoralists who may lack the experience of former management systems and practices. In the coastal zone, sea level rise is expected to cause water supply and salinization problem through contamination of fresh water freshwater aquifers with saline ocean water.

5.19.4. Climate Change Impacts Agriculture and livestock

The current agricultural, agro-pastoral, pastoral and fishing livelihood practices in Somalia will significantly be affected by Climate change. These livelihoods are extremely vulnerable to climate change, due to dependencies on the gradually changing climatic conditions.

The most prominent livelihood in Somalia is Pastoralism both nomadic and sedentary herding of cattle, sheep, goats, and camels and this forms the economic mainstay of the country. Livestock is the main income inner for the predominantly rural population, and a source of meat and milk. The Somalia Nomadic System is the most market oriented with approximately 2.5 million animals exported each year; footing about 40% of the country's GDP and 80 per cent of foreign currency earnings (World Bank, 2003). However, livestock production is hampered by disease, weak public veterinary system, high export quality standards that results to bans on Somalia livestock products and complete absence of an animal health surveillance system. This is also aggravated by inadequate regulatory framework for livestock exports leading to weakened trading mechanisms largely controlled by individuals. The livestock sector is most vulnerable to climate change due to the traditional values and nomadic pastoral practices that are characterised by overstocking and overgrazing. Further, declining fertility and palatability of pastures, disease outbreaks and exposure to unpredictable rainfall patterns resulting from climate change hinder productivity.

The impacts of the recurrent droughts includes diminished pasture availability, land degradation; decreased water availability, decreased livestock disease resistance; decreased livestock productivity, emaciation and death of livestock; decreased livestock prices and household incomes; crop failure in agro-pastoral areas; food insecurity and malnutrition, abnormal community mobility; increased school drop-out due to community migration in search of pasture and water; interruption of development activities; increased human diseases and death; and increased conflicts over scarce resources.

The expected impacts of extreme temperatures include decreased pasture availability; increased water evaporation, leading to water shortages; emaciation and death of livestock; decreased livestock disease resistance and productivity; decreased livestock prices and household incomes; crop failure in agro-pastoral areas; food insecurity and malnutrition; increased human diseases; decreased human labor productivity; enhanced bush encroachment and increased conflicts over scarce resources[130].

Agriculture is the second most important livelihood system in Somalia. However, crop production is limited primarily by irregular and unpredictable rainfall, poor soil conditions and traditional practices. Southern Somalia's alluvial plains present fertile soils and the inter-riverine area suitable for crop production accounting for almost 90 per cent of agricultural produce in the country. There is a mosaic of Rain-fed and irrigation cropping are practised in the Jubba and Shabeelle river valleys, while in Bay, lower Jubba and lower Shabeelle area rain fed cropping is combined with cattle keeping (IUCN, 1997). Rain fed cropping also occurs on the sandy soils of the coastal hinterland north-east of Mogadishu while only very limited crop production is possible in the northern part of the country especially in Somaliland

Table 6-13 Potential Impacts of Climatic Disasters and Hazards on Livestock and Agriculture

Hazard	Impacts
1. **Drought** 2. **Rainfall variability** 3. **Rainfall Unpredictability**	a) -Decreased pasture availability (leading to shortage of pasture, overgrazing, and land degradation) b) - Decreased water availability (water shortages) c) - Emaciation of livestock (livestock priced weight loss) d) - Death of livestock e) - Decreased livestock productivity (milk and meat) f) - Decreased livestock disease resistance g) - Decreased livestock prices h) - Reduced incomes i) - Crop failure (mentioned in agro-pastoral communities in j) - Increased school drop-out rates (due to migration) k) - Interruption of development activities l) - Drop out of members from saving and credit cooperatives m) - Women walking longer distances in search of water n) - Increased human diseases and death o) - Increased conflicts over scarce resources
Extreme heat/increase in temperature	a) - Decreased pasture availability (leading to pasture shortages, overgrazing, and land degradation) b) - Decreased water availability (water shortages) c) - Poor condition of livestock and weight loss d) - Death of livestock e) - Decreased livestock productivity (milk and meat) f) - Decreased livestock disease resistance g) - Decreased livestock prices h) - Reduced incomes i) - Crop failure (for agro-pastoralists) j) - Food insecurity and malnutrition k) - Increased human diseases

[130]IISD Final Assessment Report 2009; Climate-related vulnerability and adaptive-capacity in Ethiopia's Borana and Somali communities

Hazard	Impacts
	l) - Decreased human labour productivity m) - Increased conflicts over scarce resources n) - Bush encroachment
Livestock diseases	a) - Livestock weight loss b) - Reduced livestock productivity c) - Reduced livestock breeding d) - Livestock deaths e) - Loss of market access f) - Loss of incomes g) - Increased household food insecurity (especially due to scarcity of stable food like milk) h) - Human deaths (due to contamination)
Conflicts	a) - Human deaths b) - Loss of husbands c) - Livestock raiding d) - Loss of property e) - Displacement f) - Increased poverty g) - Increased village instability h) - Interruption of development activities and education i) - Loss of access to markets, water sources and grazing lands j) - Difficulty in taking livestock to grazing lands in remote/border areas (leading to overgrazing and land degradation) k) - Damage to crops / farmland (mentioned in Billa)
Locust/pest infestation	a) - Crop damage b) - Food shortages c) - Damage of pasture lands
Bush /invasive species encroachment	a) - Decreased pasture availability b) - Increased presence of predators c) - Food insecurity
Land Degradation	a) - Increased local temperatures b) - Decreased water availability due to increased water runoff c) - Poor pasture growth d) - Decreased availability of forest products e) - Increased soil erosion and decreased soil fertility and productivity

5.19.5. Climate Change Impacts On Forestry and Mangrove in Somalia

There are small areas with mangrove in Somalia, particularly in the estuary of the Juba River and on the coast between, the estuary and the Kenyan border. The common species here include; Avicennia marina, Rhizophora mucronata, Bruguiera gymnorrhiza, Sonneratia alba and Xylocarpus granatum (syn X. obovatus). There are also dispersed Mangrooves in the North of Mogadishu, while major forests of mangrove occur in the Bojun Islands in the Indian Ocean and also at the entrance of the Red sea and the Indian Ocean. The mangroves, sea-grass beds of the Somalia cost form a productive ecosystem of greater ecological and socio economic importance in addition to providing sanctuary to a wide variety of terrestrial fauna and flora (UNEP/GPA and WIOMSA 200. The ecosystem is however, threatened by the rising sea level and temperatures causing coral bleaching, direct human pressures on the coastal and marine environmental pollution and mismanagement. Due to prolonged civil strife in the country the Marine Protected Areas have not been implemented in Somalia (UNEP 2006). The forests in Somalia are being over exploited for charcoaling as an alternative livelihood to the traditional agricultural, agro-pastoral, and pastoral practices are severely affected by climate changes

5.19.6. Climate Change Impacts on Social Cohesion

There is enough indication that exposure to climate change stressors influences civil unrest among the Somali clans. The trends of eruption of conflict are closely related to the trend of drought occurrence. The prolonged and recurring drought constraint the rain-fed and irrigated agrarian systems and may be a catalyst for civil conflict mainly due to limited alternative income earning opportunities outside agriculture and other forms of resilience. The geographical location of Somalia coupled with fragile environments and climate, (FSNAU 2011b); exposes the populations to severe events of droughts, aridification and desertification leading to significant ecological and socio-economic imbalances (Mutua & Zoltan 2009). The impacts of climate change induced hazards and disasters are execrated by inadequacies in formal mechanisms to cope with shocks, and insufficient public safety nets making the exposures to droughts more severe. In response, the populations having inadequate availability of water, food, and farm income opportunities forces seek alternative coping strategies during droughts, which include but not limited to selling of productive assets (Dercon & Hoddinott 2004, McPeak & Barrett 2010, Mogues 2011), clan-based support, and migration. However, migration involves an amplified competition over meagre available resources across different clans and communities leading to poverty traps, increasing household food insecurity, and ultimately humanitarian disasters (Carter & Barrett, 2006). The characteristics and impacts of drought vary significantly from one region to another depending on its severity, political and economic stability, level of preparedness and resilience of the affected communities, and access to humanitarian assistance (FSNAU 2011b). It has been noted that there is a relationship between violence and drought intensities[131] as shown in figure 37 below.

It is therefore important to note that implementation of measures against violence in Somalia cannot be isolated from dealing with the impacts climate change. The relationship of conflict to drought incidences implies that policies and investments for drought impact mitigation and resilience building are critical for both climate change adaptation and conflict prevention in Somalia. These interventions are required in the areas that are more vulnerable to droughts with high incidences civil conflict especially inter-clan based violence. It should be noted that the losses incurred from conflicts increase the levels of vulnerability of the populations in the affected areas due to intensified conflict activities resulting in civilian casualties, destruction of infrastructure, and loss of economic growth potential that

[131] Maystadt, Jean Francois and Ecker, Olivier and Mabiso, Athur, Extreme Weather and Civil War in Somalia: Does Drought Fuel Conflict through Livestock Price Shocks? (February 1, 2013). IFPRI Discussion Paper 01243. Available at SSRN: https://ssrn.com/abstract=2228878 or http://dx.doi.org/10.2139/ssrn.2228878

have not been considered in the previous estimations of climate change costs[132].

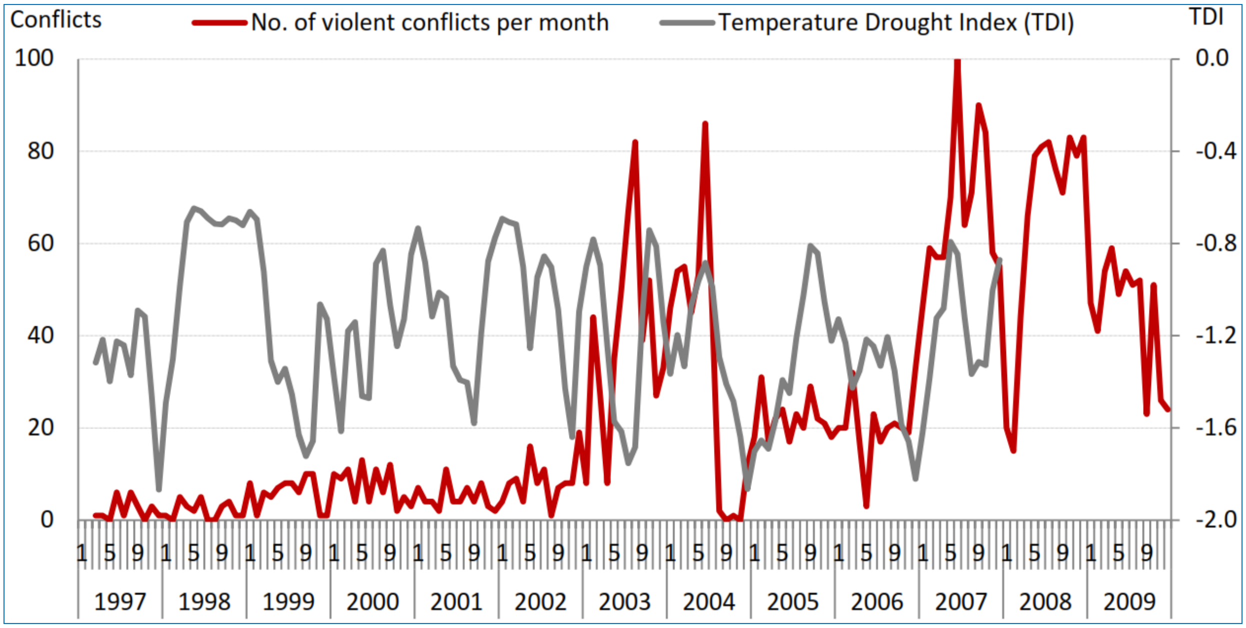

Figure 6-46: The Relationship between Conflict and Drought[133]

Many Somalis have been internally displaced, often from rural to urban areas. The strongest clans have taken over valuable agricultural land, expelling weaker clans and indigenous peoples from their traditional lands. Vulnerable people have lost their assets and livelihoods. Famine and disease have raged unchecked, causing the death of about one million people. Extensive damage to roads and other infrastructure makes it extremely difficult.

The traditional systems in Somali community demonstrate that dealing with hazards is not a new challenge owing to entrenched social systems for sharing. However, with droughts becoming more and more severe and frequent, these redistribution systems are becoming impracticable, as the number of people needing social support is increasing every year. Since drought also impacts savings and credit groups/cooperatives negatively, incomes from livestock, livestock products, crops, and activities such as petty trading, are highly reduced leading to increased drop-out of members from saving and credit cooperatives due to recurrent droughts. This also hinders effectiveness and sustainability of traditional resource management systems are also threatened by increased drought frequency, due to abnormal mobility and exacerbated by resource scarcity.

5.19.7. Climate Change Impacts on human resources

The human resource potential is usually affected by drought and other climatic exposure stressors; by hindering important to people's livelihoods, including education, health, human labor and various

[132] Maystadt, Jean Francois and Ecker, Olivier and Mabiso, Athur, Extreme Weather and Civil War in Somalia: Does Drought Fuel Conflict through Livestock Price Shocks? (February 1, 2013). IFPRI Discussion Paper 01243. Available at SSRN: https://ssrn.com/abstract=2228878 or http://dx.doi.org/10.2139/ssrn.2228878

[133] Source: Based on ACLED dataset (2011) and NASA POWER data (2011).

abilities/capabilities. It also leads to increased migration resulting to conflicts that cause to increased school dropouts. In addition, the malnutrition during drought affects human health, reduces human disease resistance, human labor productivity, and human capability to undertake different activities such as learning in schools, bush clearing, blacksmithing, masonry, and business management. Drought is however positively impacting broker/mediator activities, commercial opportunities and capabilities, since larger numbers of livestock are sold during drought.

Table 6-14: Summary of Sectoral Impacts of Climate Change in Somalia

Sector	Hazard	Impacts
Water	Drought	Decline in the amount of water in shallow wells and ground resources like boreholes resulting in death of humans and animals; Low water infiltration into soils as a result of sparse vegetation, shallow soils and steep terrains; Increased water prices; Increased communal water conflicts
	Floods	Destruction of water infrastructure, sewage systems and possible contamination of domestic water supply
Agriculture	Drought	Crop failures; Reduced yields/food shortages; High food prices; Reduced availability of irrigation waters; Crop pests and diseases; Loss of stored food
	Floods	Soil-borne diseases that affect crops; Waterlogging leading to death of crops and reduced productivity; Destruction of standing crops; Erosion of top fertile soils; Loss of agricultural land through formation of gullies
Livestock	Drought	Death of livestock leading to food insecurity, loss of livelihoods and low exports for the country; Reduced livestock productivity; High prices of livestock products; Increased conflicts over water resources and rangeland
	Floods	Degradation of rangelands due to erosion; Increased spread of animal diseases
Coastal & Marine Resources	Drought	Coral reef destruction; Salt water intrusion increasing salinity of coastal groundwater resources
	Floods	Destruction of coastal infrastructure; Displacement of coastal communities; Destruction of mangroves; Erosion of beaches
Health	Drought	Death due to starvation; Increased malnutrition due to shortage of food especially for youth and mothers; Respiratory diseases; Outbreak of water-borne diseases such as diarrhoea, dysentery, cholera; Increased cases of psychological disorders due to stress; High incidences if heat stroke, sunburns and dehydration
	Floods	Increased spread of vector-borne diseases; Outbreak if waterborne diseases
Biodiversity	Drought	Deforestation and cutting down of trees and other vegetation for charcoal; Bushfires Wildlife migration; Favourable conditions for certain pests, pathogens and weeds to thrive (high temperature)
	Floods	Soil erosion and loss of vegetation; Wildlife migration; Direct damage by floods and increased sedimentation affecting aquatic reproduction and populations; Temporary or permanent increases in groundwater leading to increased fish and other aquatic productivity

5.20. On-going initiatives to address climate change vulnerabilities

The country has developed a National Adaptation Programme of Action (NAPA) as a first step towards articulating and implementing a nationwide strategy that addresses the impacts of climate change across Somalia (FROS, 2013). The NAPA provides a foundation on which climate change adaptation can be mainstreamed into the country's development plans as the country aims to attain sustainable development and poverty reduction. Based on the country's adaptation needs, a number of possible adaptation measures against the vulnerabilities in different sectors were identified. These are summarised in Table 14 below.

Table 6-15: Selected Adaptation Measures for Somalia

Sector	Proposed Adaptation Measures
Water	1. Improve water access by supplying piped water to urban areas and IDP camps 2. Rehabilitate dams and boreholes and promote construction of new dams, reservoirs, irrigation infrastructure and livestock watering points to improve the quantity of available water 3. Improve land management to enhance water capture and natural storage 4. Improve water resource management by establishing a water management regulatory framework in collaboration with local management structures 5. Construction of water treatment plants alongside large-scale water storage projects, implementation of community-level low cost water treatment and legislation of water pollution control to improve water quality. 6. Protection of flood-prone areas through construction of water embankments, check dams and retaining walls
Agriculture and Food Security	1. Provision of incentives to farmers in form of small grants, agricultural inputs, strong institutional support and improved extension services to increase local food production and prioritize it over exports 2. Construction of water diversions from streams to farms for irrigation, establishment of boreholes to supply irrigation water and support community-level water capture and storage for agricultural use in order to improve watershed management 3. Reducing soil erosion through sustainable land management practices and reforestation 4. Establishing an agricultural credit system for farmers as well as agricultural cooperatives and associations 5. Introduction of high-value drought resistant plants and agro-forestry as well as diversifying food sources appropriate to the natural ecosystem 6. Constructing and maintaining food storage facilities and seed banks and raising awareness about food stockpiling among communities to enhance food security 7. Protecting crops and reducing risk to the farmers through Integrated Pest Management
Animal husbandry, Livestock and Rangelands	1. Establishing regulations for rotational grazing, preventing deforestation, burning new trees and protecting and supervising grazing areas to promote land management 2. Government provision of veterinary services, establishing diagnostic labs and ensuring access to remote rural areas 3. Diversifying livelihoods by supporting transition of pastoralists into agro-pastoralists or livestock farmers 4. Promoting cultivation of drought-resistant fodder 5. Supporting small-scale livestock-based industries such as hides, tanning and milk processing as well as training in marketing of animal products such as cheese and yoghurt to support livelihoods

Sector	Proposed Adaptation Measures
	6. Promoting research into animal health by providing the necessary finding and mechanisms
Health	1. Establishment and upgrading of health facilities especially for maternal and child health to improve health status and address diseases related to malnutrition 2. Expand nutrition programs at the community level 3. Establishment of early warning systems for drought and food insecurity 4. Treatment and monitoring of the quality of drinking water 5. Launching public health awareness campaigns that target rural areas in particular 6. Carrying out vaccination campaigns on a regular basis 7. Establishing a waste management system 8. Retraining of doctors and nurses to deal with climate-related health problems
Coastal and Marine Resources	1. Development and implementation of a legal framework, policy and establishing a coastguard to cease illegal fishing and dumping of wastes at sea 2. Raising awareness on the importance of marine resources, protection of coastal resources and prevention of pollution 3. Developing the fishing sector by the government through investment in coastal cold storage and modern fish processing 4. Preventing and regulating the construction of housing and infrastructure near the coast 5. Mangrove plantation and awareness raising on protection of coastal resources 6. Relocation of vulnerable coastal communities and proving the necessary tools and skills for alternative livelihoods 7. Research on biodiversity in coastal waters to improve fisheries and establish a framework for fishing that takes into account fish populations to curb overfishing
Biodiversity (forests, freshwater, aquatic, marine and invasive alien species)	1. Reduction of charcoal burning through alternative energy plans and promotion of fuel-efficient cooking stoves, alternative livelihoods and banning of charcoal burning in order to protect forests 2. Planting of high-value productive trees through large-scale tree planting programs 3. Development of legal frameworks and subsequent enforcement by rangers to protect forests 4. Awareness campaigns on the impacts of forests and natural resources destruction 5. Enacting policy measures with a particular focus on endangered species to protect biodiversity and wildlife
Natural Disasters	1. Establishment of a national-level disaster management agency to coordinate emergencies, developing early warning systems as well as drought management and emergency preparedness plans 2. Enhanced coordination and information sharing between relevant stakeholders and ministries 3. Community mobilization to enhance communities' ownership of local

Sector	Proposed Adaptation Measures
	development problems with regard to climate events to make them active participants in developing solutions that include a community-based disaster management program 4. Installation of agro-meteorological solutions 5. Utilization of local knowledge in agriculture, make weather forecasts, provide weather information to inform planning and initiatives 6. Creating a fund for disasters to be administered by the Ministry of Interior and Local government
Strengthening Climate Information and Early Warning Systems for Climate Resilient Development	1. Collecting data and undertaking systematically risk assessments especially for drought and famine carried out by FSNAU, FEWSNET and FAO-SWALIM. 2. Monitoring and predicting: Developing hazard monitoring and early warning services, including weather and hydrological monitoring equipment, improving forecast capabilities and the use of these technologies within agricultural advisories, flood risk monitoring and supply chain management, carried out by FAO-SWALIM and ICPAC. 3. Disseminating information: Communicating risk information and reliable warnings to potentially affected locations through traditional and new media, carried out by FAO-SWALIM 4. Responding to warnings: Building national and community response capabilities to act effectively when warnings are received; this aspect is very weak and needs to considered for strengthening

UNDP's Enhancing Climate Change Resilience (CCR) project for Poverty Reduction and Environment Protection Programme (PREP), in partnership with the Somali Government, has also initiated innovative project activities aimed at enhancing the climate resilience of vulnerable communities and ecosystems. The German Red Cross, working in collaboration with the local population, community organisations and authorities, is attempting to make people more resilient towards external influences. The project aims at building infrastructure, providing alternative sources of income and enhancing disaster preparedness whereby the community itself is primarily responsible for implementing the measures in the community plans. This means those affected are able in the future to identify changing weather conditions and respond adequately. A key aspect in making communities more resilient to climate change is to develop new sources of income so families are not totally dependent upon a single source in the event of a disaster. In this regard, the German Red Cross offers for example training and equipment for bee-keeping or a small-scale credit so that households can secure their existence with a small business (GRC).

5.21. Identification of Additional Options

Since the country is emerging from long term civil strife the critical need to enhance policies, institutional frameworks and government capacities to deal with the impacts of climate change as well as pilot ecosystem-based adaptation strategies (UNDP, 2015). The efforts by different stakeholders working in Somalia should focus in supporting the populations to adapt to felt climate change impacts on key development and livelihood sectors.

Considering the Somalia's agricultural productivity; considerations should focus on promoting climate-smart agricultural techniques entailing sturdier, climate-resistant crops, such as millet. Improved irrigation systems such as simple drip irrigation kits that should be affordable to readily available can to adapt to unpredictable rainfall. According to USAID, livestock can be used somewhat paradoxically to rehabilitate land degraded by overgrazing and drought in that "planned" and "bunched" grazing methods can fertilize and stir up the soil to enable plants to take root (Stimson, 2011).

Charcoal burning serves as major source of income for approximately 70 percent of poor and middle income pastoralists in Somalia. This has led to widespread deforestation in the country characterized by diminishing tree cover as more trees are cut (IRIN, 2010). To combat this problem, Somalia can tap into its rich renewable energy resources that offer both adaptation and mitigation potential to the impacts of climate change. The country has untapped hydropower, extensive geothermal energy resources, many promising wind sites, and abundant sunshine, which can produce solar power. Traditional biomass fuels such as firewood and charcoal, primarily used in rural and poor communities, account for 82% of the country's total energy consumption. However, these are unsustainable in the face of climate change. Despite the prolonged civil conflict and least development status, Somalia has a great potential to achieve sustainable development and to contribute in the reduction of Green House Gases (GHG) (FROS, 2015).

Drought and contingency planning and early warning systems will be a central strategy for long term sustainable of the environment and natural resource base and as a basis to be able to manage for and adapt to climate change. Other than the early warning systems that are in place, the necessity of risk management and adaptive strategies are not integrated in the short and long term development strategies. It is important to understand that drought not only affects livestock and the natural resource base, but also the entire social fabric of Somalia as a country as well as all aspects of livelihood that is water, health, education, food security, the economy and even national security.

There is need for a paradigm shift from emergency response to disaster risk reduction and disaster preparedness. Kull et al. (2013) have proven the effectiveness of disaster risk mitigation compared to emergency response via cost-benefit-analysis, in particular in developing countries. However, they add that only 12 percent of the total funding related to disaster management was spent on disaster preparedness activities. Most of the money was used for post-disaster actions, such as emergency response. In addition, countries affected by drought received comparably lower funding for disaster risk reduction than countries that are prone to flood risk or thunderstorms. In its adaptation efforts, it would therefore be important that Somalia prioritizes disaster risk mitigation activities as this would reduce the need for emergency response.

Development of weather-indexed crop and livestock insurance schemes for farmers could be another option to explore. These schemes help secure farmers' livelihoods and give them the capacity to invest in climate-smart technologies, thereby helping to secure their food supply. Weather index-based insurance is an attractive approach to managing weather and climate risk because it uses a weather index, such as rainfall, to determine pay-outs and these can be made more quickly and with less argument than is typical for conventional crop insurance.

In addition, it is important that the country embraces the use of drought indicators such as the Enhanced Combined drought Index (ECDI). The index design provides timely and reliable detection of drought events with regard to their spatio-temporal extent and severity. Unlike other drought monitoring initiatives, the ECDI is linked to a mobile application. This application allows the consideration of satellite-derived drought risk in relation to the assessment of people's vulnerabilities (e.g., current rates of malnutrition) and coping capacities (e.g., access to drought-resistant seeds) as well as an experimental seasonal forecasting component (Enenkel et al., 2016).

Furthermore, it is important that the country initiates a collaboration process through negotiation with Ethiopia regarding the use of the Juba and Shabelle water resources that are shared among the two countries. The rivers are located in an underdeveloped, water-scarce and conflict ravaged region of the Horn of Africa whereby Ethiopia dominates in most of the decisive terms. This leaves Somalia as a vulnerable downstream end-user that receives polluted water from its upstream, Ethiopian counterpart. The parties should seek opportunities for mutual benefits and allow for joint planning so that the river basins can give optimal utilization of its water resources for the benefit of its riparian countries and communities (Mohamed, 2012).

For instance, the upstream side that falls in Ethiopia is suitable for hydropower development while the downstream side in Somalia provides a suitable area for irrigation development that will also provide the additional benefits of flood mitigation. These are potential opportunities that can enhance common development for both countries while at the same time allowing for integration of other economic sectors such water, agriculture, livestock and energy. Following the Somalia civil war in 1991, agricultural development projects that relied on the two water sources collapsed and therefore proper negotiations on joint use with Ethiopia can help the country rehabilitate and make optimal use of the resources to boost food production, enhance food security and promote economic growth that will in turn build the community's resilience to the impacts of climate change (Mohamed, 2012).

Somalia has the longest coastline in Africa that is 2000 miles long, which has remained underutilized as far as fish production is concerned and also vulnerable to the impacts of climate change presented by sea level rise and rising water temperatures. Domestic fresh fish consumption is limited to coastal areas because of poor infrastructure, which has restricted access to fish for a large portion of the population, lack of familiarity with fish, seasonality of supply and a tradition of meat-eating among the Somali communities, are among other reasons for one of the lowest per capita fish consumption rates in the world (Beier and Eva, 2012). The fisheries sector has the potential to diversify Somalia's food supply and livelihoods through provision of adequate research and training opportunities to the fishing communities as well as implementation of regulatory framework for the sector. Risk reduction initiatives should be implemented within the fishing communities for example, for example by conservation of natural storm barriers such as coral reefs, wetlands and mangroves, putting in place early warning systems and recovery processes (FAO, 2007).

5.21.1. Proposed Strategies for Responding to Climate Change in Agro-Pastoral and Pastoral Livelihoods

The following are suggested Strategies for responding to climate change within the agro-pastoral and pastoral livelihoods;

Table 6-16 Strategies for responding to climate for agro-pastoral and pastoral livelihoods

short-term coping strategies:	short-term coping strategies:
i) Migration from exhausted pastures, hazards, disasters or find alternative livelihood	i) Modifying livestock diversity, composition and numbers: Communities suggested increasing livestock diversity and adjusting herd composition towards fewer grazers (cattle and sheep) and more browsers and drought-tolerant species (such as camels and goats).
ii) Early selling of weak and old animals while livestock prices are still good	ii) Diversifying livelihood activities: Pure pastoral should engage in farming activities and planting early maturing crops to diversify income and food sources. Also starting some irrigation agriculture if the government is able to pipe water from highland areas, rivers or dig boreholes
iii) Mass/clan support (restocking and food sharing) to those who have lost livestock or crops	iii) Hay making, collection and preservation to prepare for adverse conditions or drought periods when there no pasture is available
iv) Water infrastructure work: Rehabilitating/repairing ponds after heavy precipitation events via community mobilization	iv) Modification of rangeland management practices: scaling up pasture enclosures to feed weak animals, lactating cows and calves during dry seasons and strengthening traditional wet and dry season grazing lands. v) Bush clearing/thinning with support from government agencies and NGOs was suggested as an adaptation strategy by old men vi) Adopt new methods to control bush encroachment
v) Using donkeys for the	vii) Maintenance, rehabilitation and construction of water

transportation of grass, hay and water from remote areas	infrastructure
vi) Reducing the amount of food consumed during drought times	viii) Modification of farming practices: Agro-pastoral communities to crop species and varieties that grow within a shorter period of time and with less rainfall, like teff and beans
	ix) Establish Savings and credit mechanisms
	x) Developing and maintaining resources use conflicts resolution mechanisms
	xi) Planting tree and raising community awareness on climate change issues

5.22. General Challenges and Barriers to adaptation

According to the IUCN (2006), a number of identified challenges may present barriers to effectively addressing climate change. These include:

i. **Political Disintegration and Poor Coordination**: Particularly the existence of the three distinct regions of Federal Somalia and Puntland and Somaliland make the implementation of national programs challenging
ii. **Conflict**: The African Union Mission in Somalia (AMISOM) peacekeeping force remains active in Somalia in its battle against the Islamic clan based insurgent and terrorist group known as Al Shabaab
iii. **Climate Data Limitations**: Currently, the country has inadequate capacity to forecast potential threats of large-scale disasters and has little preparedness to respond and cope with such disastrous events. Inadequate data implies that there is no adequate information to develop detailed spatial mapping in planning for risk reduction.
iv. **Human and Financial Capacity Limitations**: There is concern that inadequate funding both at the national and international levels may limit the level of implementation of all measures identified in the Somalia NAPA
v. **Policy Gaps**: There is inadequate approved laws and regulations that are directly linked with climate change including environmental land and maritime laws, regulations and codes of conduct[134]
vi. **Infrastructure**: Poor transportation infrastructure may raise the cost of activities significantly, particularly for the most vulnerable areas

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Table 6-17 Pastoralist and Agro-Pastoralist Livelihoods Enabling Conditions and Constraints for Adaptation to Climate Change

Strategy	Enabling conditions	Constraints
Migration	a) Pastoral communities have the physical ability and willingness to move to other places within and outside internal and international boundaries to find work or better pastures i) Should be planned migration with definite routes and locations with appropriate amenities and natural resource management	a) Conflicts between tribes over pasture, water resources and new boundaries limit movement b) - Agricultural expansion limits free livestock movement in some areas c) - Negative effects which may limit continued adoption of the strategy: i) -Separation of families when men migrate ii) -Increased rural-urban migration of unskilled labour might exacerbate urban food insecurity and urban poverty
Modifying livestock diversity, composition and numbers Modifying crop diversity	a) Communities are realizing the importance of increasing livestock diversity, moving towards more browsers and drought tolerant species, and decreasing overall livestock numbers to invest in more diversified and less climate sensitive assets b) Communities are already seeing the benefits of modifying herd composition to enhance milk availability and food security c) Communities are willing to undertake other livelihood activities as seen from the recent patterns d) Drought times are favourable for brokerage activities as there are many livestock to sell during those times i) The government should support destocking in the onset of drought ii) Use EWS to plan stock management iii) Select early adapter communities and initiate modification of numbers, diversity and improvements of the animals	a) Limited awareness on the types of animals that are better adapted to the new and projected climatic conditions b) Poorer households have a low capacity to switch to better adapted livestock species such as camels(which are more expensive then sheep, goats and cattle) c) Prevailing attitudes, as traditionally, holding a large number of livestock was a source of prestige and was way to spread risks (instead of diversifying into other activities) d) Reducing livestock numbers would require i) increasing the productivity of animals, which is constrained by land degradation, droughts, lack of financial resources to buy feed, or ii) promoting other income generating activities to avoid a decrease in income levels (constraints described below) e) Limited market access and limited up- to-date market information f) Limited financial support and credit access to engage in different kinds of business activities g) Limited skills to engage in new income generating activities

	iv) Create awareness in the communities on the climate changes and appropriate responses	h) Limited water resources available for farming and irrigation in many areas i) Firewood and charcoal selling is leading to depletion of forest resources (negative effect), and because many people are undertaking this strategy, prices are very low (disincentive) j) Low or no demand for casual labour in many areas
Modifying rangeland management practices	a) Many communities will be willing and highly motivated to demarcate enclosures to save calves as well as weak and lactating animals during droughts b) Land is communal in this area, so expanding enclosures would probably not lead to any conflicts or problems. It is part of the traditional system. c) Communities are willing to support their families in enclosure activities and demarcation of enclosures as an adaptation strategy	a) Saving indigenous grass species is limited by low grass seed availability and quality, and communities cannot harvest grass seeds easily. b) Controlling bush encroachment will require new and unfamiliar methods as well as more community mobilization
Modification of farming practices	a) there are rivers available for expansion of irrigation schemes b) Harvesting of runoff by construction of water pans and properly designed dams	a) Shortage of oxen and seeds during the planting time b) Lack of seeds of drought resistant crops c) Lack of knowledge on the management of drought resistant crop species d) Limited knowledge/skills to adapt practices to the new conditions e) Over dependency on irregular rains f) Urbanization encroachment into farmland g) Limited access to pesticides and limited commitment from the government to provide pesticides on time to deal with pest infestations
Maintenance, rehabilitation and	a) Many communities are willing to maintain and rehabilitate existing water infrastructure and participate in the construction of new	a) Current water infrastructures not well maintained by communities due to lack of skills b) Government concerns over ecological problems arising from

construction of water infrastructure	infrastructure	the construction of water infrastructure (e.g. overgrazing, erosion, etc.) c) Creation of new infrastructure would require an assessment of needs and environmental suitability i.e. considering pasture availability as well as water availability.
Establishing community groups	a) Women and youth groups important for increasing adaptive capacity and resilience b) Will make it easy to target, track and monitor interventions. significant benefits in empowerment and increased adaptive capacity	a) Awareness raising will be needed b) Group meetings and activities are often interrupted during drought times and conflicts c) No uniformly organized structure facilitates the formation of youth groups d) Little attention has so far been given to youth groups in development initiatives e) In many communities, women are not used to participating in meetings/consultations.
Asset redistribution (restocking)	a) Familiar, well-accepted coping strategy that is integrated into local cultures	a) The feasibility of this strategy is declining because of recurring droughts which increase the number of people in need from year to year. b) In addition, wealthy community members' assets are declining
Bleeding animals and drinking blood as a source of food	a) Effective short term strategy to deal with food insecurity	a) Not done much nowadays because communities are aware of diseases
Raising community awareness on climate change	b) Basic awareness among community members that the climate is changing c) Willingness amongst community members (including the youth) to learn more about climate change in order to better prepare themselves	a) Most local organizations and communities have no access to seasonal forecasts and other climate information b) Awareness raising sessions and trainings organized by governments and NGOs are often only offered to elders, which would limit the involvement and contribution of youth and women in the implementation of adaptation activities
More effective, efficient and participatory management of available natural	a) Willingness amongst community members (especially the youth) to use natural resources more effectively and efficiently	a) There might be resistance amongst elders to give a voice to young people and women in natural resource management and decision making

resources		
Reducing conflicts over available resources	b) Awareness that conflicts makes them more vulnerable to droughts and other extreme weather events c) Expressed willingness to put conflict prevention and peace building strategies in place	a) Regional/clan boundaries are often changing and are not clearly defined b) There are often delays in peace making and government interventions, which often come after human deaths and destruction of resources
Hay Making	a) Many will be willing to support their family in hay making activities b) Hay can be used it in times of drought as emergency for livestock	a) In hay may be affected by the absence of rain b) It may require irrigation or fast maturing grass species
Saving and credit facilities	a) Community members of all ages and gender are interested in expanding saving and credit activities to reduce risks associated with climate change b) Communities will be interested in learning to save money in bank accounts	c) Lack of financial institutions that provide credit to engage in business opportunities.

5.23. Recommendations

5.23.1. General actions

The following are the recommendations provided

a) Support institutions to develop and implement short and longer term strategies for disaster management, and develop the capacity to do so
b) Understand existing customary coping and risk management strategies, and what natural assets survive best through drought times, and integrate the importance of such coping mechanisms into land use and environmental planning;
c) Study and assess the impacts of climate change as reduced precipitation is likely, combined with a greater frequency and intensity of droughts and floods. Integrate the findings in risk mitigation and early warning strategies, and build them into land use planning;
d) Test strategies for adapting to climate change, e.g. through the wider use of more drought tolerant grass and tree species so that a greater proportion of the rainfall is absorbed into the soil. This can be supported by a greater understanding of what species survive well through prolonged periods of drought; and can continue to supply products; and
e) Enhance the ability of early warning systems to include the impacts of climate change and be able to offer more "real time" data and analysis to users. This should include the Famine Early Warning System (FEWS), FAO's Food and Security Analysis Unit (FSAU), and IGAD's Climate Prediction and Application Centre.
f) Provide the necessary political, financial and institutional support to harness the wide range of renewable energy resources available in the country.
g) Specific drought intervention measures may be required such weather indexed crop and livestock insurance. This could be through a national effort to buy (and export) livestock before they are weakened and paying farmers a certain threshold of drought is reached causing of animals or total crop failures. It may also be important to have drought time forage reserves in place (for example along rivers, on mountains).
h) Enhance the ability of existing early warning systems (for example FEWS, FSAU) to cater for the impacts of climate change, and be able to offer more "real time" data and analysis to users.
i) Community level mapping of high vulnerability areas to risks of drought and flooding, dusts storms and strong winds, and integration into local disaster risk management plans and responses.

5.23.2. Recommendations for agriculture, agro-pastoral and pastoral livelihoods

Somalia's vulnerability to climate change ranges largely from high levels to severe especially considering the common livelihoods in the country that have very high dependency on climatic factors and natural resources. There is a critical need to address the adverse climate and poverty trends based on the stated livelihoods with special focus on the rural and nomadic populations. There should be climate smart rural and pastoral development priorities implemented by the Federal Government in collaboration with the regional states. The development strategies should be aimed at dealing with the drivers of climate change vulnerability. These measures should consider implementing poverty reduction and development policies that;

1. Protect of pastoral livelihoods and entitlements;
2. Enhance access to vital infrastructure, resources and services in pastoral areas;
3. Enhance the security of pastoralist land holdings; restore and protect the environment in rangelands;
4. Create more efficient markets; and help control population growth, particularly through women's education and empowerment.

Owing to the fact that Somalia is just recovering from more than 25 years of civil unrest and strife, with the severe impacts of climate change on the livelihoods; external support is required to build adaptive capacity and reduce the sensitivity climate change stressors. To enhance climate change resilience among the most common livelihoods; Agriculture, pastoralism and agro-pastoral communities, the current climate variability hotspots, projected climate change impacts, and climate change vulnerability and adaptation should be considered in developing and implementing programmes and projects with smart targets and objectives

5.23.3. Recommended actions

a) Establishment of agriculture, agro-pastoralism and pastoralism in the sustainable development goals for Somalia, There should be measures to protect pastoral land from encroachment and conversion to unsustainable land uses fully integrating customary and formal authority to resolve internal boundary issues and engage with traditional social institutions in conflict prevention and resolution. In addition, the government should initiate policies on land tenure systems that allow vital pastoral mobility, especially in the face of gradually and steadily increasing drought frequency.

b) The government should initiate the development and implementation of properly targeted economic development, social protection and relief strategies that enhance agro-pastoralism livelihoods. This should include;

   i) Livestock marketing support and diversification activities in the critical supply chains i.e. value added products to livestock production such as processing meat for export, milk, ghee, hides and horns contribute to increase pastoral incomes.
   ii) Support the improvement of social safety nets, while at the same time
   iii) Ensuring the availability and efficient distribution of emergency food aid and cash support.

c) The government should support and embrace EWS alerts and facilitate response mechanisms by enhancing coordination, communication, and information-sharing within the government structures on extremes regarding weather or climate and crisis or emergency information on food security. The information that may seasonal weather forecasts and early warnings for climate hazards will require formal and informal flow pathways to the local communities but in appropriate content, language and formats at every stage. In addition, climate change adaptation should be mainstreamed in all sectors with properly defined strategies and targets.

e) Capacity building and working closely with weather and climate lead agencies and institutions: This will ensure that verified data is used in decision making and tracking and monitoring of interventions is enhanced. This will also create ownership and interventions based on local vulnerability, knowledge, and community-led actions.

f) Exploiting traditional knowledge: The local communities should be actively engaged in developing adaptation strategies to take advantage of long term local knowledge, observation and experience to the effects climate change, and implementing coping and adaptation strategies.

g) Linking climate change and livelihood in intervention areas: The devised interventions should focus on the target livelihood that is acceptable to the local communities in as much as they promote climate change resilience and increase adaptive capacity. The most sensitive and less adaptive livelihood should be targeted in the priority interventions that create enabling condition.

h) Efforts should target addressing the drivers of vulnerability which include;

   i) Environmental degradation,
   ii) Population pressures, conflicts, social and gender inequalities,
   iii) Inadequate off-farm employment opportunities and skills,
   iv) Poor access to infrastructure, resources and services,
   v) Weakening of the role of traditional social and governance institutions and
   vi) Inadequate government policies, coordination and capacities.

The interventions building resilient livelihoods should encompass investment in and development of key infrastructure and services that are more adapted to pastoral mobility; these include; construction of health centres and schools, and providing appropriate staffing, and incentives. In addition there is need for improved surveillance of animal health, veterinary centres, supplies and services, to reduce livestock mortality from preventable and treatable diseases. The government should initiate development of policies that support access to markets, regulate trade and increase revenue for the benefit of pastoralists, traders and public services.

5.24. Knowledge Gaps

The following are the knowledge gaps that needs to be filled through other research activities

i) Finer or high resolution analysis of the temperature and rainfall data and trends across the migration routes of pastoral communities to identify the important impacts of climate variability/change in pastoral livelihoods and the expected coping strategies all year through.
ii) Creating linkages and synergies between the policy measures and development policies, programmes and reforms that should be explored and built on productive Safety Net Project.
iii) A deeper analysis of the influence of non-climatic factors (such as population growth, policies, land use changes, etc.) on local vulnerability to climate change.
iv) Technical and financial analysis of the resources (financial, human, etc.) required to adapt to climate change and realization of optimal adaptation benefits.
v) A quantitative analysis of climate change impacts to complement this qualitative adaptive measures i.e. technical analysis assess what an x% change in rainfall or a y% change in temperature means for rangelands and livestock numbers, amount of available and pasture clearly indicating the critical thresholds.

CHAPTER SIX

OTHER INFORMATION CONSIDERED RELEVANT FOR IMPLEMENTATION OF THE CONVENTION FOR SOMALIA

CHAPTER SIX

OTHER INFORMATION CONSIDERED RELEVANT FOR IMPLEMENTATION OF THE CONVENTION FOR SOMALIA

6.1. Introduction

Other information and activities considered relevant to the achievement of the objectives of the Convention includes (i) technology transfer, (ii) research (iii) systematic observations, (iv) information on education, training, public awareness and capacity-building and (v) efforts to promote information sharing and the role of NGOs in the implementation of adaptation and mitigation activities with local communities. Also highlighted are constraints and gaps, and related financial technical and capacity needs taking into account Article 4, paragraph 7, and Article 4, paragraphs 3 and 5, of the Convention.

6.2. Technology Transfer

6.2.1. Technology Needs Assessment for Somalia

The United Nations Framework Convention on Climate Change (UNFCCC) recognizes the importance of technology transfer as a key means to combat anthropogenic climate change. This is clearly articulated in Article 4 paragraph 5 of the Convention. Decision 4/CP.4 of the Fourth Conference of the Parties (COP 4) also urged Non-Annex I Parties to submit their priority technology needs for mitigation and adaptation.

There is need to define technology transfer[135] and mention that in relation to climate change, technology transfer primarily is realized through the implementation of mitigation or adaptation projects. The case of Somalia is unique because for a long time, the climate change related projects have not been implemented. This subsection therefore draws substantially from key assessment reports, information documentations and other official government reports, which have been seen to consistently reveal the gaps in technology transfer that, impede the mitigation, and adaptation potential for Somalia. The needs assessment studies for various sectors in Somalia, including ICT, were carried out between the years 2014 and 2016.

UNFCCC and development partners in Climate change research recognize the important role of technology transfer, as a leading method of combating anthropogenic factors that accelerate climate change. This is clearly stated in Article 4.5 of the Convention. The Fourth Conference of Parties (COP-4) by its Decision 4/CP.4 also urged Non-Annex I Parties to submit their priority technology needs for mitigation and adaptation. Like most of the developing countries, Somalia is characterized by low-level technological advancement and therefore testing and transfer. However, there is a huge potential for the adoption of technologies available in the developed and some middle income countries to facilitate mitigation options for greenhouse gases and adaptation to climate change. The cost of technology development is high in research and innovation; there is no effective mechanism which is in place to address issues related to technology development and transfer. New and clean energy technology options need to be developed and adopted in order to check GHG emissions and to address adaptation mechanisms to the implications of climate change.

[135] The collection of processes encompassing all aspects of the origins and diffusion of know-how, experience and equipment within, amongst and across institutions, organizations, countries and various regions.

6.2.2. Priority Sectors and Technology Options

The study towards this report identified various priority sectors as well as suggested GHG Emissions Mitigation Strategies, and Climate Change Adaptation Strategies. The following areas have been identified as potential investment areas, presenting partnership opportunities especially for the community, the private sector and NGOs. GHG Emissions Mitigation and Climate Change Adaptation Broad Strategies

a) The Energy Sector is dominated by the use of firewood and charcoal among households. Mitigation strategies include energy efficiency in biomass consumption as well as education on the same. The use of clean energy in wind, solar, ocean tides and generally adopting hybrid systems for power generation are recommended.

b) Agriculture is Somalia's most important economic sector, with livestock farming accounting for some 40% of GDP 136and at least half of the earnings from the entire export. In the same breath, a majority of the population are nomads and semi-pastoralists, who rely on livestock for their livelihood. Mitigation strategies such as intensification of livestock ranch management, disease surveillance, veterinary services and value addition before export are recommended.

c) Improvement is needed in the education sector, both the formal and tertiary and technical sectors. Awareness among the public will increase on the steps to mitigate GHG emissions, while learning the reality and adapting to the impacts of climate change.

d) There is the need to increase investment in the surveillance of pests and livestock diseases as well as disaster management at large.

e) Fishing is also a major economic activity in Somalia, and the impacts of climate change have not spared the fishery and aquaculture industry either. The knowledge base and climate change advisory capacity need to be strengthened. Fishing technology and fish processing too require substantial investment.

f) The nation should also be encouraged to diversify its livelihoods and income sources, in order to build resilience and adapt to climate change.

g) Access to financial services and insurance mechanisms should be boosted to increase productivity while shielding the occasional total losses.

h) The areas around Mogadishu have seen a resent mushrooming of industries, others being reopened after many years. These include dealership in fish-canning and meat-processing plants, the manufacture of confections, mineral water, plastic bags, pasta, fabric, detergent and soap and aluminum. The others include hides and skins, foam mattresses and pillows and the manufacture of fishing boats. These call for the adoption of the policy recommendations of the UNFCCC regarding industrial regulations[137].

6.2.3. Identified Barriers to Technology Needs

Various factors were identified to explain the limited technology development and diffusion in Somalia;

a) The high cost of technology as a barrier to the development, testing, adoption and subsequent transfer of key technologies is a reality in Somalia, as is in many developing countries.

[136] Too et. al, 2015

[137] UNFCCC, 2016. "CDM Project Cycle": Capacity Building Workshop on Development of CDM Activities and NAMA for Public and Private Sector in Zimbabwe Nyanga, Zimbabwe. 24–25 August 2016.

b) There are weak institutional synergies in Somalia although this is continuously being overcome as the country rebuilds. The policy framework has also been observed to be weak or inadequate, as are the various strategies and existing development plans.

c) Low education levels in Somalia as highlighted elsewhere in this report also pose a significant constraint as. There is growing consensus on stakeholders in development, on the lack of capacity in many technical fields, especially in security, malicious desire to maim and damage property by armed groups and therefore the fear of assembly by the population, emerges as perhaps the most important barriers to technology transfer in Somalia.

d) There is limited infrastructure to support technology including the Information Technology Subsector in Somalia.

e) The continuous threat to peace and high cost of internet access power supply and the telecommunication network. In fact, there is a lack of access to information on new technologies and innovations.

f) Somalia is not a member to many economic blocks and therefore the regular import and export of equipment is not as easy, adversely affecting technology transfer.

g) Certification standards required for many technological equipment are lacking in Somalia.

There are efforts by various organizations that support the development, adoption, transfer and implementation of policies, regulations and financial or organization mechanisms that accelerate mitigation technology innovation and uptake[138].

6.3. Research and Systematic Observation

6.3.1. Climate & Hydrological Monitoring

Parties to the UNFCCC have committed to Climate research and monitoring, even though developing countries still face challenges on different levels. The responsibility for monitoring climate in Somalia lies with the office of the Prime Minister, with distinct regional environment offices in the three regions. However, there is not a robust database of historical climate data due to institutional disruptions during the civil war that lasted nearly two decades. Since 2002, the FAO Somalia Water and Land Information Management (FAO SWALIM) project of the United Nations has worked with partners to provide baseline information on land and water, as well as related products to all stakeholders[139]. SWALIM has met important milestones in the recovery of lost information from different sources across the globe, and at the same time re-establish data collection networks in collaboration with partner agencies including government. As of 2007, SALIM had rehabilitated 68 weather recording stations[140].

The Swalim Project has also supported in the establishment and operation of two synoptic stations in Somalia[141]

[138] UNFCCC 2015; Implementation of the Poznan Strategic and Long-Term Programs on Technology Transfer Subsidiary Body for Implementation Forty-second session Bonn, 1–11 June 2015 https://unfccc.int/sites/default/files/resource/docs/2015/sbi/eng/ inf04.pdf.Accesed on 13/5/2018

[139] Swalim, 2007a. "Climate of Somalia".Technical Report No. W-01

[140] Swalim, 2007b. "Climate of Somalia".Technical Report No. W-03

[141] Swalim, 2010. "Product Catalogue ".

Figure 7-1 Two synoptic stations at the different government ministries as labeled. Adapted from Gadain, 2011[142]

With support from development partners, the government of Somalia currently has intensified efforts to collect and manage key datasets through the various ministries, to support education, research and policy formulation and strengthening. However, the existing climatological and hydrological observation network in Somalia is very inadequate and sustained collaborative effort is needed. The other data and information relevant for climatological monitoring and analysis include data on land use and land use change, biodiversity, ecology and wildlife. In overall, the management of the climatological, hydrological and other databases relevant to climate change in Somalia also needs strengthening and financial support.

6.3.2. Climate Research

Long-term investment in climate research and development is vital in order to enhance development, resilience, education and innovation. The challenge in Somalia lies in the gaps in available climate data. FAO SWALIM noted in their report that "There are numerous reports that showed pieces of datasets regarding the climate of Somalia, but no two reports had similar datasets for a given period."[143] This led the researchers in FAO to ignore such reports and thus data in their analyses. The global FAO climate database provides the most comprehensive database of climate data on Somalia for the period between 1963 to1990. With such parameters as sunshine fraction, minimum and maximum temperature, Potential Evapotranspiration (PET), vapor pressure as well as global radiation and wind speed for recording stations[11]. Despite the data availability challenges, climate research in Somalia continues to be done by research institutions, universities[144], agencies of the United Nations, Government departments and independent researchers. As a result, a number of research reports, peer reviewed publications and detailed thematic maps have been produced on several climate related topics. Because climate research requires many decades of consistent and reliable data, investment in the collection and archiving of such information is being prioritized by the government of Somalia.

[142] Hussein Gadain, 2011. "Somalia Water and Land Information Management – SWALIM " 2nd GEOSS Africa Water Cycle Symposium– Addis Ababa, Ethiopia, February 23-25, 2011.

[143] http://sddr.faoswalim.org/Documents_Repository/water_reports/W-03%20Inventory%20of%20Hydro%20-Meteorological%20Data%20of%20Somalia.pdf

[144] http://advances.sciencemag.org/content/1/9/e1500682.full

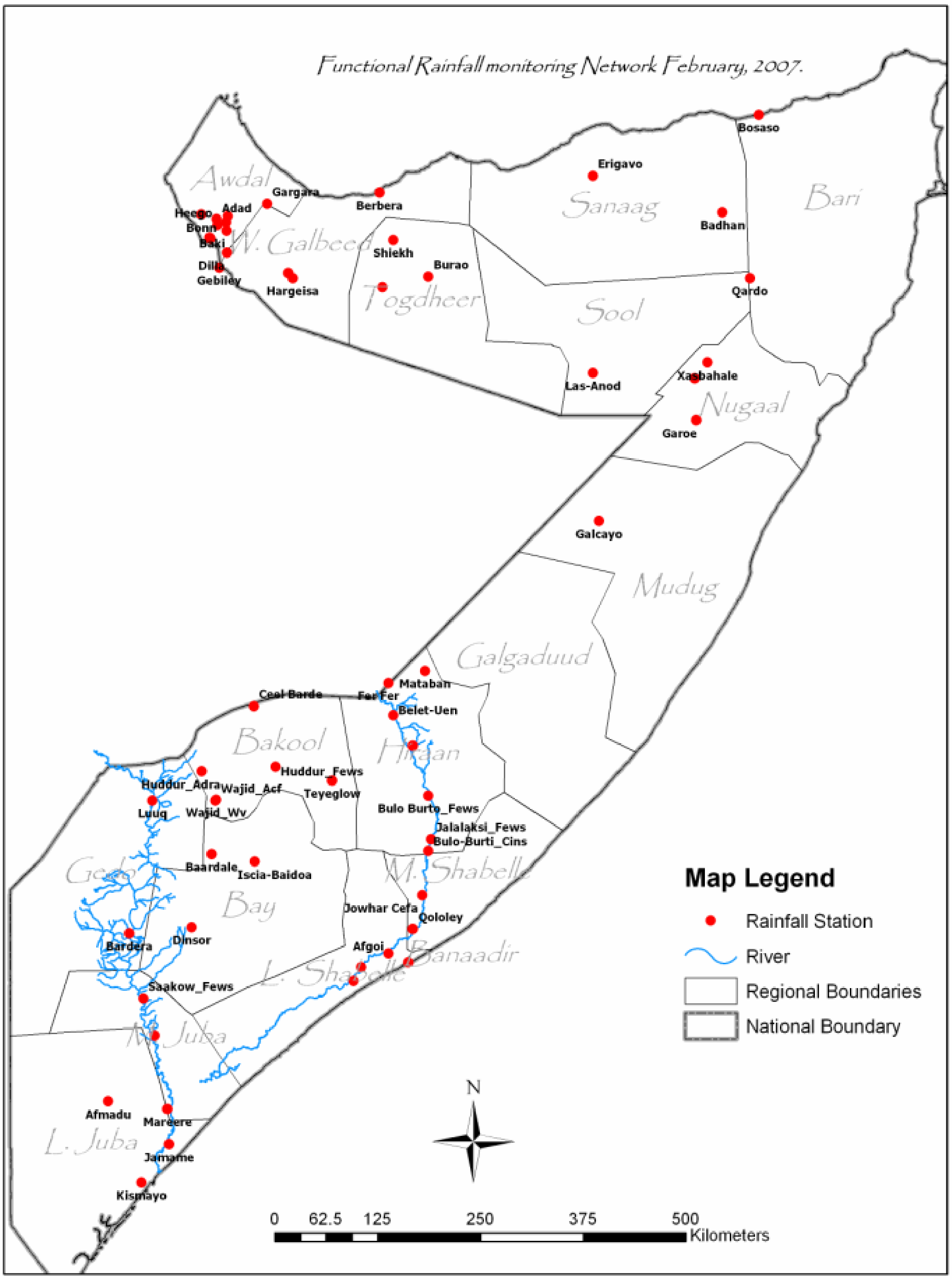

Figure 7-2 Rainfall monitoring stations in Somalia. Adapted from Swalim, 2007a.

6.4. Information on Public Education, training and awareness

The collection and reporting of information pertaining to the activities on climate change education, capacity building and public awareness can serve as a basis for the periodic review of the status of the implementation of Article 6 of the Convention. It is required that Somalia citizens are well aware of the commitments of their country under the Convention, the impacts of climate change, adaptation and mitigation options as well as about measures that can be taken at the household level to adapt to climate change, while mitigating its impacts.

Public access to such information is important for an improved environmental protection and management, as well as the promotion of any environmentally sustainable development program. This is because an enlightened community will maintain well understood standards and practices beyond the lifespan of any project. It can be achieved through the broadcasting of environmental issues via Radio and strengthening of environment clubs at schools and community centers.

The delivery of information and instruction through the radio is completely in harmony with Somali movement patterns and culture. A survey conducted in 2002 reported that radios were the second most common household items after a lantern or flashlight and further that about 40 percent of nomadic and rural households listen to radios.[145]

Civil society groups are also actively involved in conservation activities in Somalia. The Somali Ecological Society (SES),[146] a non-profit founded in 1983 seeks greater environmental awareness as is the Somali Agricultural Technical Group (SATG),[147] which strives for sustainable agricultural development.

Other relevant initiatives include climate change talks targeting environmental clubs established in schools and community centers, teacher training institutions and in environmental forums organized by GEOs and NGOs as well as radio based distance education programmes. Several technical and non-technical workshops and seminars on climate change have been organized at the local level. Climate change awareness among policy makers, professionals and the general public is crucial for the implementation of the country's obligations under UNFCCC. In this respect, press conferences and public releases on climate change have been conducted in collaboration with the mass media. The texts of the UNFCCC and the Kyoto Protocol have been translated in the Somali language, in a summarized form to ensure their accessibility in a language that is easily understood by most of the citizens, before being circulated through appropriate media.[148]

However, a lot more needs to be done to enhance environmental and climate change education and awareness in Somalia. University courses/programs should be strengthened to include climate change related courses; awareness creation among the professionals, policy makers and the general public should be enhanced. The effort to raise awareness, to create educated and skilled experts to handle climate change issues should continue through various means such as:

a) The preparation and broadcasting of information and teaching materials as well as fact sheets on climate change and its impacts;
b) The enhancement of sharing platforms for information on climate change and the environment;
c) The production and sharing of radio programs, brief articles, audio and video interviews, through the mass media.
d) Strengthening and implementation of policy on climate change.
e) Tapping on the potential in public private partnerships for environmental conservation.

[145] http://idd.edc.org/sites/idd.edc.org/files/EDC%20Education%20in%20Fragility%20Series-Somalia%20SIRIP.pdf
[146] https://muslimenvironment.wordpress.com/category/somalia/
[147] https://muslimenvironment.wordpress.com/2011/04/14/somali-agricultural-technical-group-satg-about-us/
[148] UNDP, 2012. Preparation of NAPA in Response to Cilmate Change for Somalia. Environment Finance Service, Sept. 2012.

6.5. Promotion and Level of Involvement of Stakeholders

Key stakeholders in the processes of climate change adaptation and mitigation include the various levels of government, the general public, the media, the civil society, academic and research institutions, development partners and the donor community. The crosscutting nature of the implications of climate change requires the collaboration and fostering of strong partnerships between the various stakeholders.

Civil society organizations and the media have a role to play in climate change interventions and, encourage the active participation of the members of the public in awareness campaigns regarding climate change. The ready access to climate change information and adoption of climate change interventions is especially encouraged. It is noteworthy that most civil society organizations in Somalia have a focus on security as it was, and food security as a direct impact of the former as well as harsh climatic conditions.

There are many ways in which the private sector can contribute to climate change adaptation and mitigation. These include the provision and mobilization of financial and other resources, technical assistance as well as capacity building for climate change adaptation and mitigation. The private sector can also be engaged in low carbon development initiatives. The involvement of NGOs, faith and community based organizations is noticeable in awareness creation on climate change and also in mobilization of financial and other resources to local communities for environment related initiatives. Knowledge and information sharing can be expanded by involvement of the media, commonly Somali radio stations. Scientific information on climate change and the necessary adaptation and intervention strategies should be translated and broadcast to be easily understood. This would enable people to incorporate conservation and mitigation strategies in their daily lives.

Academic institutions should include content on climate change and its impacts in their syllabi as this is lacking in primary schools, which mark the only level of education for a big majority in Somalia.

Since, important decisions regarding the interventions and adaptation actions need to be informed by scientific knowledge, research institutions and the academia need to continue playing a key role of generating such information and making it accessible to the public and decision makers. Furthermore, support from development partners working with the federal government is essential for the implementation of climate change programmes.

6.6. The Climate Change Economic Opportunities

Climate change interventions can bring economic opportunities to Somalia, including but not limited to:

i. The goals are in harmony with the current global trend to check GHG emissions, thus providing high possibilities of accessing financial support for the projects that have low carbon co-benefits. It will further be possible to access resources earmarked for specific accomplishments for instance to emerging environment financing mechanism, such as NAMAs, the green climate fund, INDC, among others.

ii. As envisaged in the NAPA final report, the government can hold follow up discussions with prospective donors and other international development partners, including Sweden, Japan, Norway, and UN agencies, GEF, EU and the AfDB on technical and financial cooperation.[149]

[149] http://unfccc.int/resource/docs/napa/som01.pdf

iii. There is an opportunity to embrace the Green Economy, which is proven to be resilient to climate shocks.
iv. At a time when most of the development agenda is new because of the overall institutional, policy and economic reconstruction, there is a good opportunity to embed mitigation and adaptation strategies in policy and witness the associated benefits in a sustainable environment and growing economy.

6.7. Financial, Technological and Capacity Building Needs and Constraints

The UNFCCC is pretty clear on the necessity of financial and technical support to the LDCs, including technology transfer and capacity development to enable them fully participate in the implementation of the Convention. As such, Somalia, which is an LCD party, that is prone to drought, flooding, desertification and other natural disasters, as a country which has mainly arid and semi-arid land, Somalia needs a special consideration in this respect as stated in article 4.8 and 4.9 of the Convention. This section highlights Somalia's priority in the areas of financial, technical and educational needs to meet her commitments under the Convention.

6.7.1. Finance Mobilization

Somalia successfully developed and submitted its NAPA in 2013, in which report it had identified the urgent and immediate adaptation needs to the effects of climate change. There are many climate mitigation and adaptation financing instruments for LDCs. According to the GEF[150] and GCF,[151] Somalia like many other LCDs has not exhausted all funding avenues under the GEF. As a country with very high vulnerability to the effects of climate change, Somali must have a national finance mobilization plan to address climate change both in mitigation and adaptation activities, and pursue the many existing funding possibilities both internally and externally.

Already with what is available and growing, there is a need for efficient and effective utilization, which can be achieved by the strengthening of project planning systems, monitoring and evaluation mechanisms, and the synchronization of the financial and procurement systems between government and development partners as best practice. Such improvements within government will attract additional funding to undertake climate change adaptation and mitigation, including the exploration of necessary off-setting opportunities in the various vulnerable sectors.

6.7.2. Data Collection and Monitoring

Historically, the civil strife that lasted over two decades resulted in the damage or total loss of most of the data collected in the previous half century as relates to land and water resources. However, the Ministry of Planning, Investment and Economic Development through the Directorate of National Statistics is working closely with the FAO SWALIM team to recover lost data, while continuously collecting and validating new data. It is therefore fair to observe that the data generation, gathering, archiving and analyzing capability of Somalia still needs to be reinforced. Climatological, hydrological, ecological, biodiversity, wildlife, land use and land cover monitoring are all essential in dealing with climate change. The National Statistics Directorate and collaborating government directorates at the various ministries need to be strengthened in

[150] http://somaliangoconsortium.org/download/583417bf3981f/
[151] GCF stands for the Green Climate Fund

terms of facilities, human resources and capacity development. In fact, capacity building in data collection and monitoring will improve the country's ability to produce timely and well processed data to meet the requirement of different the uses including climate change studies.

6.7.3. Training

One important priority for Somalia in tackling the challenge of climate change is human resource development. Training of government officials and the general public needs to be embedded in all major programs on climate change, and the following areas have been identified as useful;

a) Vulnerability assessment;
b) Mitigation and Adaptation analysis, costing and action planning;
c) GHG inventory development and management;
d) Policy Analysis and formulation;
e) Mitigation and adaptation technology testing, transfer and adoption;
f) Program development in climate change;
g) Land use planning and Land Use Change Detection;
h) Geographic Information System, and Remote Sensing;
i) Statistical analysis techniques and;
j) Scenario Creation in different key sectors.

6.7.4. Research and Studies

Long-term investment in quality scientific research is a proven avenue to finding solutions and fostering sustainable development[152]. Research and development will therefore be at the forefront in understanding and addressing the challenges of climate change across the key vulnerable sectors in Somalia. There are a number of private research institutions and non-profits actively involved in research, with a definite leaning to policy-oriented outputs. These include the Heritage Institute for Policy Studies (HIPS), the Mogadishu Centre for Research and Studies, and the Centre for Research and Dialogue. With a focus on other important research fields, two other notable local research centres are the Academy for Peace and Development (APD), and Observatory of Conflict and Violence Prevention (OCVP). While best practice in research calls for the input from the related work of others, these research institutions are hindered by lack of access to online journals and limited or slow internet connections[153].

International organizations and the United Nations Agencies have been very supportive of collaborative scientific research efforts in Somalia, and further cooperation is much needed on vulnerability and adaptation, specifically in the areas of agriculture, biodiversity, water resources and human health, in order to establish the level of the country's vulnerability to climate change and identify best adaptation options for adoption. SomaliREN, an UNDP supported membership organization of at least fourteen local universities and research centres from across Somalia is an example of how collaboration can be fostered. In conclusion, the strengthening and developing local capacity to conduct climate research is essential, and can be achieved through strengthened partnerships and collaboration.

[152] http://ctb.ku.edu/en/table-of-contents/analyze/analyze-community-problems-and-solutions/think-critically/main
[153] http://www.inasp.info/uploads/filer_public/70/97/70970d71-3157-496b-a765-df1ffeb1fed4/somali_regions_countrystudy.pdf

6.7.5. Awareness Creation

The creation of awareness about climate change and its far reaching implications is the key to reaping the benefits in mitigation as primarily initiated by policy makers, and adaptation strategies as generally widely adopted by the general public. The UNFCCC supports inclusive capacity building endeavors because of these multi-level benefits. There is great potential for climate change awareness programs in Somalia.

6.7.6. Capacity Building

Capacity building also referred to as capacity development, is a multi-dimensional activity in its making, often embedded in larger programmes as a key activity. This is because governments and development partners believe that there is a need to have in place necessary skilled manpower in all aspects of development and utilization to effectively undertake any development programs with minimum cost planning. Science and Technology is an important pillar in the present and future sustainable development of any country, as is the case in Somalia. It is important to create awareness about science and technology. This will also serve to build national capabilities not only in energy science and technology for the optimal development and supply of energy resources, but also in all sectors of the economy. Provision of sustainable and objective oriented training in the relevant areas of socio-economic is essential, as well as developing and implementing effective means to efficiently utilize and retain skilled manpower. The UNDP stands out as a supporter of multi-Sectoral capacity development in Somalia,[154] with other known leaders being FAO[155] and the government of Somalia.

6.7.7. Gender Mainstreaming

Gender mainstreaming is defined as "The process of evaluating the repercussions on all genders, any planned development activities, including programs, legislation or policies, in all areas of development and at all levels as a strategy for making concerns and experiences of both men and women to be an integral dimension of the design, implementation, monitoring and evaluation of the policies and programs in all political, economic and societal spheres[156] so that women and men benefit equally and inequality is not perpetuated". Gender mainstreaming helps achieve gender equality.[157] The relative status of men and women, the interaction between gender and ethnicity, class and ethnicity, and questions of rights, control, ownership, power and voice; all have a critical influence on the success and sustainability of every development intervention.

The basic principles of gender mainstreaming include; Capacity building for gender analysis; development of accountability mechanisms; allocation of sufficient resources; explicit, coherent and sustained attention to gender equality; targeting not just 'soft' areas for gender mainstreaming (such as health and education),

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[154] http://www.so.undp.org/content/somalia/en/home/ourwork/hiv_aids/successstories/undp-supports-multi-sectoral-capacity-building-project-.html

[155] http://www.fao.org/in-action/food-security-capacity-building/news/detail-events/en/c/238286/

[156] Mehra R. and Gupta G.R. 2006; Gender Mainstreaming:Making It Happen. https://www.icrw.org/publications/gender-mainstreaming-making-it-happen/. Accessed 15/6/2018

[157] 1997 agreed conclusions of ECOSOC See more at: http://www.unwomen.org/en/how-we-work/un-system-coordination/gender-mainstreaming#sthash.aYA5TJg2.dpuf

but also supposedly 'gender-neutral' areas, such as infrastructure development and economic policies; and strong political commitment and will[158].

According to UNDP (2014) and OECD (2016), the progress towards gender mainstreaming in Somalia is curtailed by a number of factors including; (a) Extreme poverty; (b) civil conflicts and political instability; (c) Food insecurity and extensive malnutrition cases; (d) High child and maternal mortality rates; (e) Limited access to and control of property and assets and property; (f) Punishing cultural and religious practices.

6.8.Implementation strategy and monitoring

Environmental degradation is a major problem in Somalia and the government is taking notice. According to the National Development Plan of 2017-2019,159 the federal government has a target to have:

a) A National Action Plan on Desertification developed and approved by 2019.
b) A River management policy established to protect the volume and quality of water available
c) Improved Environmental waste management in the cities
d) To exercise control over the charcoal trade.
e) To ensure the participation of local communities and strengthen their capacities in sustainable natural resource management.
f) Appropriate national institution and mechanism for river resource policy and management will be put in place.
g) Environmental standards for urban development will be established under the national land & urban management policy.
h) Air and water quality standards will be established and linked to the national land management policy.

[158] http://www1.uneca.org/Portals/ngm/Documents/Gender%20Mainstreaming/ Kenya-m-and-e-framework-for-gender-mainstreaming.pdf

[159] http://mopic.gov.so/wp-content/uploads/2016/11/SOMALIA-NATIONAL-DEVELOPMENT-PLAN-2017-2019.pdf

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