STATE OF THE ENVIRONMENT REPORT 3

UNITED REPUBLIC OF TANZANIA
VICE PRESIDENT'S OFFICE

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FOREWORD

Tanzania's development is largely dependent on her natural resources' wealth. As such, periodic assessment of the state of the country's environment is an important step in the path to sustainable development. In accordance with the Environmental Management Act of 2004, the Vice President's Office – Division of Environment is tasked to prepare and publish after every two years the State of the Environment Report (SoER) for submission to the National Assembly.

This is the Third Report following the Second Report which was published in 2014. It is hoped that this report will enable us to better harness the enormous opportunities that our environment presents and to fill the knowledge gap on the magnitude of the environmental challenges that we have to continually confront. The preparation of this SoER report was characterized by a participatory approach and a broad base of stakeholders were involved in the preparation of the report through various consultations conducted. The report was produced using the analytical framework of Drivers, Pressures, State, Impact, and Response (DPSIR).

This report establishes among others, a baseline for the attainment of the Tanzania Development Vision 2025. The primary goal of the country's long-term development vision is to transform Tanzania into a globally competitive and prosperous nation with its citizens enjoying a higher standard of living by 2025. It is envisaged that this will translate into a higher proportion of Tanzanians transitioning from crippling poverty. The report aims at addressing the challenges of environmental degradation in the country in three ways. First, the report provides a knowledge resource for researchers and the general public. Secondly, it serves as a baseline for monitoring trends in environmental change in the country. Finally, and most importantly, the report is intended to inform policy-makers about the environmental challenges facing Tanzania; outline possible future scenarios for the environment and development; and provide policy recommendations to support the country's sustainable growth. It is hoped that the Report will increase awareness of environment and natural resources, and encourage effective resource allocation for sustainable development at the local and national levels.

The underlying message of this SoE report is that long-term developmentsuch as that anticipated by the Tanzania Development Vision 2025 cannot be achieved without prioritizing environmental imperatives. It is therefore incumbent upon all people in the country to value the environment as the "goose that lays the golden egg" and support its sustainable use for the benefit of present and future generations.

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Minister of State,
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ACKNOWLEDGEMENT

The Vice President's Office is again honored to present another edition of the State of the Environment Report for Tanzania. This is the Third report since the Second one was prepared and published in 2014. The State of Environment Report has become a vital document in providing an insight to understanding the interactions between social, economic and environmental factors which are the pillars of development. It further answers many questions on what is happening to the environment in our country and what lies ahead in the future.

This report enumerates a number of issues that need to be closely monitored to prevent them from escalating to environmentalcrises. It is also hoped that the report findings will prompt the full spectrum of stakeholders to take timely actions to remedy anthropogenic activities thatdegrade our environment. Therefore, while this report is an important reference tool, it is also intended to spur institutions and stakeholders into playing their rightful roles in environmental planning and monitoring, and in taking appropriate remedial actions to restore environmental integrity.

Eng. Joseph K. Malongo
Permanent Secretary,
Vice President's Office

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ACRONYMS AND ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
AMR	Antimicrobial Resistance
BOD	Biochemical Oxygen Demand
CAG	Control and Auditor General
CBD	Convention on Biological Diversity
CC	Climate Change
CDA	Capital City Development Authority
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CPCT	Cleaner Production Centre of Tanzania
DO	Dissolved Oxygen
DoE	Director of Environment
DPSIR	Drivers-Pressure-State-Impact-Response
EAC	East African Community
EEE	Electrical and Electronic Equipment
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMA-ISP	Environmental Management Act- Implementation Support Programme
E-waste	Electronic Waste
EWURA	Energy and water Utility regulatory Authority
FAO	Food and Agricultural Organization
FYDP	Five Year Development Plan
GDP	Gross Domestic Product
GEO	Global Environment Outlook
GFW	Global Forest Watch
GHG	Greenhouse Gas
GHI	Global Health Initiative
GMO	Genetically Modified Organisms
GNP	Gross National Product
Ha	Hectare
HADO	Hifadhi Ardhi Dodoma
HBS	Household Budget Survey
HIV	Human Immune Virus
IAS	Invasive Alien Species
IBAs	Important Bird Areas
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-tropical Convergence Zone
IUCN	International Union for Nature Conservation
IWMI	International Water Management Institute

IWRM	Integrated Water Resources Management
JFM	Joint Forest Management
LDC	Leads Developing Country
LGA	Local Government Authority
LLITNs	Long-Lasting Insecticide Treated Nets
LPG	Liquefied Petroleum Gas
M&E	Monitoring and Evaluation
m.a.s.l.	Meters Above Sea Level
MCFT	Million Cubic Feet
MCM	Million Cubic Metres
MEAs	Multilateral Environmental Agreements
MNRT	Ministry of Natural Resources and Tourism
MoF	Ministry of Finance
MPAs	Marine Protected Areas
MSCFD	Million Standard Cubic Feet per Day
Mt	Metric Tonnes
NAFORMA	National Forest Resources Monitoring and Assessment
NAPA	National Adaptation Programme of Action
NBS	National Bureau of Statistics
NBSAP	National Biodiversity Strategy and Action Plan
NCA	Ngorongoro Conservation Area
NEAC	National Environmental Advisory Committee
NEAP	National Environmental Action Plan
NEMC	National Environment Management Council
NEP	National Environmental Policy
NESR	National Environmental Statistics Report
NFRA	National Food Reserve Agency
NRGI	Natural Resource Governance Institute
NSGRP	National Strategy for Growth and Reduction of Poverty
NWFP	Non Wood Forest Products
OUT	Open University of Tanzania
PFM	Participatory Forest Management
PMI	President's Malaria Initiative
POPs	Persistent Organic Pollutants
PSMP	Power System Master Plan
PSTN	Public Switched Telephone Network
RAHCO	Rail Asset Holding Company
REA	Rural Energy Agency
REDD+	Reducing Emissions through Forest Degradation and Deforestation
REMEs	Regional Environmental Management Experts
SDGs	Sustainable Development Goals
SEAPs	Sectoral Environmental Action Plans

SoE	State of the Environment
SoER	State of the Environment Report
SPM	Suspended Particulate Matter
SUA	Sokoine University of Agriculture
SWM	Solid was management
TNBS	Tanzania National Bureau of Statistics
TANDREC	Tanzania Disaster Relief Committee
TANESCO	Tanzania Electric supply Company
TAWA	Tanzania Wildlife Management Authority
TAWIRI	Tanzania Wildlife Research Institute
TAZARA	Tanzania Zambia Railway Authority
TBS	Tanzania Bureau of Standards
TCAA	Tanzania Civil Aviation Authority
TCRA	Tanzania Communication Regulatory Authority
TDBP	Tanzania Domestic Biogas Programme
TDV	Tanzania Development Vision
TEV	Total Economic Value
TFS	Tanzania Forest Services
THIS	Tanzania HIV Impact Survey
TMA	Tanzania Metrological Agency
ToR	Terms of Reference
TPA	Tanzania Ports Authority
TPDC	Tanzania Petroleum Development Corporation
TRL	Tanzania Railways Limited
TZS	Tanzanian Shilling
UNCCD	The United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
USD	United States Dollar
VPO	Vice President's Office
WHO	World Health Organization
WMAs	Wildlife Management Areas
WRMA	Water Resources Management Act
WSSAs	Water Supply and Sewerage Authorities

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EXECUTIVE SUMMARY

Introduction

This is the Third State of the Environment Report (SoER-3). It has been prepared through a participatory process involving a diversity of stakeholders under the overall coordination of the Vice President's (VPO). Preparation of this report is meant to comply with legal obligations (Section 175 (1) of the Environmental Management Act, 2004), which requires the Director of Environment to prepare and publish a SoER, which eventually is tabled before the National Assembly every two years. Further, the SoER-3 indicates the Government efforts and commitment to attain its Development Vision by 2025 through nurturing industrialization for economic transformation and human development.

The main objective of this Report is to capture the prevailing trends and patterns of the country's environment and emerging environmental issues within the reporting time, so that appropriate actions are taken to ensure a sustainable environmental, social and economic development in the country.

Preparation of this report adopted the Drivers-Pressure-State-Impact-Response (DPSIR) framework in establishing and analyzing trends and patterns of environmental change and management options.

Geography

The country is constituted by Mainland Tanzania and Zanzibar with a total area of 945,249 km^2 comprising of land area of 883,749 km^2 (881,289 km^2 mainland and 2,460 km^2 Zanzibar Islands), plus 61,500 km^2 inland water bodies. Mainland Tanzania encompasses major island of Mafia (518 km^2) and Zanzibar consists of Unguja (1,666 km^2) and Pemba (795 km^2).

The climate of Tanzania is characterized by bimodal and unimodal rainfall regimes. Annual rainfall amount varies from 550 mm in the central parts of the country to 2500 mm in some parts surrounding Lake Victoria.

Tanzania's topographical diversity gives rise to four distinct climate zones namely: 1) hot and humid coastal belt (including the Zanzibar archipelago), which has the warmest temperatures, averaging 27-30°C, and receives 750-1,250 mm of annual rainfall, with Zanzibar receiving 1,400-2,000 mm; 2) hot and arid central plateau, which receives just 500 mm of rainfall; 3) cooler semi-temperate high lakes region in the north and west which receives 750-1,250 mm of rainfall annually; and 4) highlands of the northeast (i.e. Kilimanjaro) and southwest including the coldest parts of the country with average temperatures of 20-23°C.

Socio-Economic Issues

Recent population projection (2018) indicates there is a population of 52.6 million people in MainlandTanzania, and 1.6 million in Zanzibar, bringing the national total population to 54.2 million. By year 2035, the population is estimated to have grown to 89.2 million people.

Life expectancy at birth for Tanzania is expected to increase from 62 years in 2013 to 74 years in 2035 for both male and female in Mainland Tanzania. Life expectancy at birth for

males in Tanzania is expected to increase from 60 years in 2013 to 71 years in 2035 similar to that of Mainland Tanzania, while life expectancy at birth for females will increase from 64 years in 2013 to 77 years in 2035, also the same as Mainland Tanzania.

The annual growth rate of urban population is 5 percent in Mainland Tanzania. By October, 2018, it was estimated that about 32.6% of the population (about 19,244,709 people) in Tanzania was urban while the rest (67.4%) live in rural areas. The fact that urban population is projected to grow at twice the rate of total population growth, it means that over half of Tanzania's population will live in urban areas within 25 years. By 2050, Tanzania's urban population is expected to reach 68.6 million people, which means more than a fivefold increase in a 40-year period.

The majority of urban population lives in unplanned settlements with limited or no basic services. The unplanned settlements, which make up 60-70% of Tanzania urban population, have inadequate service levels, tenure insecurity and poor hygiene and sanitation. Unplanned settlements have been increasing to include developments of hazard-prone lands such as steep slopes, flood plains, river valleys, and dump sites.

Real GDP grew by 7.1 percent in 2017, up from 7.0 percent recorded in each of the preceding three years. The main drivers of the growth were construction, transport and storage, and agriculture. Meanwhile, mining and quarrying, water supply, transport and storage, information and communication, and construction sectors grew faster than other sectors. Service activities contributed about 36 percent of nominal GDP.

Inflation has been moderate at single digit throughout 2017/18, averaging 4.8 percent compared with 5.3 percent in the preceding year. Moderation in food prices following adequate food supply in most parts of the country, prudent monetary policy, exchange rate steadiness, streamlined fiscal policy, and subdued oil prices in the world market were main drivers for the low and stable inflation.

Environmental Resources

Tanzania is endowed with various environmental resources among others, forest, water, marine and freshwater bodies, wetlands, wildlife, land, energy sources, natural gas and minerals among others.

Forests: Total forest area is about 48.1 million ha with three major types of natural forests: i) miombo woodlands, ii) montane forests and ii) mangroves. The country has more than 20 million ha of the miombo ecosystem andabout 2 million ha of montane forests. Mangrove forests (along the coastal belt from Mtwara region to Tanga Region covers more than 115,000 ha of land stretching over more than 800 km.

Water: Water is an important input into Tanzania's economy. It is used in agricultural production through irrigation and processing in agro-industries as well as in industrial production, power generation and environmental flows. The total area of freshwater cover is 54,337 km^2 which is about 6.1% of the total country's surface area. About 5.7% of the total land area of the country is covered by three important lakes in Africa, namely; Lake Victoria, Lake Tanganyika and Lake Nyasa.

Coastal and marine resources: The country has a territorial sea of 64,000 km² (6.4 million ha), an Exclusive Economic Zone (EEZ) covering an area of about 223,000 km² (22.3 million ha) and a coastline of about 1,424 km. The coastline is characterized by diverse coastal and marine ecosystems such as coral reefs, sea grass beds, mangroves, sandy beaches, rocky shores, numerous islets and terrestrial coastal forests which offer a diverse of ecosystem goods and services to the communities. Coastal and marine ecosystems occupy an area of 241,500 km² or about 20% of the total land area of the country. A wide range of important and valued species are found along the coast, including an estimated 150 species of corals in 13 families; 8,000 species of invertebrates; 1,000 species of fish; 5 species of marine turtles, 428 species of seaweeds and 44 species of marine birds.

Wetlands: There are about 115 different wetlands ecosystems occupying 10% of the total land area of Mainland Tanzania (approximately 88,300 km²) harbouring over 650 associated species, such as molluscs, crustaceans, echinoderms and fish. The major wetlands include Kilombero, Malagarasi-Muyovosi, Rufiji-Mafia, Lake Natron and Ihefu. In terms of their distribution, 60 % extend over village land while the remaining 40% is located over public land.

Land: Tanzania possesses 94,508,700 ha of territorial area, out of which nearly 89 million ha is land and the remaining is covered by water. About 44 million ha are classified as suitable for agricultural production and only 24% of arable land is being utilized. Land under medium and large-scale farming is 1.5 million ha and land under smallholder farmers is about 8.6 million ha. Generally, the urban areas occupy 2% of the total geographical area even as they are now occupied by close to 30% of population.

Wildlife: National parks in Tanzania comprise a total area of 57,424 km². Ruaha is the largest national park with an area of 20,300 km² (35.4%) of total area of national parks. Serengeti is the second largest national park with an area of 14,763 km² which is about 25.7% of the total area of Tanzania's national parks. Tanzania has a total of 28 game reserves covering an area of 117,755.4 km². Selous is the largest game reserve covering an area of 50,000 km² which is about 42.5% of the total area under game reserves.

Natural gas: As of 2017, the total amount of proven reserves in Tanzania was 57.3 TCF (equivalent to 1.6 Trillion m³ of gas).

Minerals: Tanzania has various mineral resources found on the surface of the earth and in the subsoil. These include metallic minerals such as gold (5th largest gold producer in Africa), iron, silver, copper, platinum, nickel and tin; gemstones such as diamonds, Tanzanite, ruby, garnet, emerald, alexandrite and sapphire; industrial minerals such as kaolin, phosphate, lime, gypsum, diatomite, bentonite, vermiculite, salt and beach sand; building materials such as stone aggregates and sand; and energy minerals such as coal and uranium. Mineral sector contributed 4.8% of GDP in 2016 and about 50% of the country's foreign exchange earnings from exports apart from traditional exports.

Energy sources: The national energy balance is dominated by biomass which accounts for 85%. Other sources include petroleum (9%), electricity (5%) and renewable energies (1%). Primary energy products are extracted or captured directly from natural resources such as crude oil, coal and natural gas while secondary energy products are produced by transforming primary energy products. In addition, there are various renewable energy

sources including biomass, solar, hydropower, geothermal, biogas, wind, tidal, and waves with total generation capacity being about 4.9%.

Policy, Legal and Institutional Framework

Environmental management in Tanzania is guided by broad national frameworks mainly the Tanzania Vision 2025 and the National Five Year Development Plan II (2016/17-2020/21). In addition, it is governed by the National Environmental Policy (1997), Environmental Management Act (2004), complemented by relevant sectoral policies and legal instruments as well as Multilateral Environmental Agreements.

The National Environmental Policy (1997) provides the framework for making fundamental changes that are needed to mainstream environmental considerations into decision making in Tanzania. Relevant sectoral policies with a bearing in environmental management include: National Fisheries Policy, 2015; National Agriculture Policy, 2013; National Livestock Policy, 2006; National Irrigation Policy, 2010; National Forest Policy, 1998; Wildlife Policy, 2007; National Tourism Policy, 1999; National Water Policy, 2002; National Land Policy, 1995; National Biotechnology Policy, 2010;   Mineral Policy of Tanzania, 2009; National Health Policy, 2007; National Energy Policy, 2015; Sustainable Industrial Development Policy, 1996-2020;   National Population Policy, 2006; and National Human Settlements Development Policy, 2000

The Environmental Management Act, 2004 is a framework environmental law which provides for legal and institutional framework for sustainable management of the environment and natural resources in the country. Relevant sectoral legislations which support environmental management include: Forest Act No. 7 of 2002; Wildlife Conservation Act No. 5 of 2009; Marine Parks and Reserves Act No. 29 of 1994; Fisheries Act No. 22 of 2003; Plant Protection Act No. 13 of 1997; Land Act No. 4 of 1999 and Village Land Act No. 5 of 1999; Water Resource Management Act No. 11 of 2009; Water Supply and Sanitation Act No. 12 of 2009; Local Government (Urban Authorities) Act No. 8 of 1982; Public Health Act No. 1 of 2009; and Mining Act No. 14 of 2010.

The Environmental Management Act (Cap 191) confers the overall coordination and policy articulation of environmental management in the country and provision of the central support functions to the Ministry Responsible for Environment, which is the Vice President's Office. It establishes the National Environmental Advisory Committee (NEAC) with the role of advising the Minister responsible for environment, among others. It confers the role of enforcement to the National Environment Management Council (NEMC). The Act further establishes Sector Environmental Sections in Sector Ministries and confers the environmental management role on the relevant sectors and with a view to provide a link to the Ministry responsible for environment. The Act provides for the Regional Secretariats to designate Regional Environmental Management Experts (REMEs) charged with the responsibility to advise and oversee the implementation and enforcement of the Act. Furthermore, the Act empowers LGAs (City, Municipal, District, Township) to designate or appoints Environmental Management Officers to oversee implementation of EMA at respective levels. In addition, the Act establishes Environmental Committees at different LGAs levels to advise and oversee the implementation of EMA within their jurisdiction.

Policy implementation as well as legislation enforcement in the existing institutional structure,

have faced several challenges. There is still existing low capacity (human resources and infrastructure) and inadequate financial resources in implementation, monitoring and evaluation of environmental resources at all levels including NEMC, ministerial, regional and local government levels. Capacity at local government level has been remarkably low where actual interaction between people and the environmental resources prevails. Therefore, there is a need to strengthen capacity at regional and local government, as these are more responsible for the environment at the grass-roots level.

Land Degradation

Human activities including shifting cultivation, overgrazing, deforestation, rapid population growth and inadequate land use management are the prime cause of land degradation, which changes the quality of the land. Land degradation appears in various forms including soil degradation, deforestation, and loss of vegetation cover, siltation, and loss of biodiversity that lowers land productive capacity. It is estimated that about 63% of land in Tanzania is degraded at various severity.

Despite the existing policies, strategies and legislation, the land resource is still affected by unsustainable farming and mining, wetlands degradation; overgrazing; tree and bush clearing; and wildfires. The rate of land degradation is also accelerated by some social-economic factors, including insufficient awareness and knowledge on relevant land policies and laws and proper management of land and water resources; inadequate alternative sources for energy and construction materials; insufficient number of financial institutions that support farmers in terms of credit to acquire or develop land; insufficient institutions to provide information on land availability for those in need, and guidelines/arrangements on how the landless, especially the youth can acquire land; and rapid population growth. Inadequate land use plans at various administrative levels is among the factors causing not only land and resources degradation but also land conflicts

It has been observed that the extent and magnitude of land degradation has increased from 42% in 1980, 50% in 2012 to an estimated rate of 63% in 2018. In Tanzania, the total economic value of land lost to degradation per annum is estimated at USD10.2 billion (TZS 23.6 trillion). The extent of land degradation and its respective costs are increasing, suggesting the need to have more concerted effort to address the problem at this time where the country is progressing towards an industrialized middle income nation.

Several achievements have been recorded as a result of implementation of various land degradation interventions. These achievements include: 1,749 villages have been surveyed with land use plans in 2017 compared to 800 villages surveyed in 2010; enhanced efficiency in environmental management by setting up institutional Framework for environmental management in the country which has cascaded responsibilities from the central government to local government; recognition and issuance of more than 300,000 Certificates of Customary Right of Occupancy by 2016.

Despite the efforts by the Government and other partners in curbing land degradation, still the challenge is looming. The rate of land degradation has generally been observed to pose a serious challenge to the environment and socio-economic development visions including being a sustained industrialized middle income nation. Some of the factors exacerbating land degradation include inadequate land use plans at various administrative levels;

inadequate security in land use tenure system hindering the effectiveness of controlling land degradation; low enforcement and compliance with different laws, regulations and By - laws; inadequate capacity in terms of financial resource, human resource and institutions to support interventions in addressing land degradation; unsustainable farming and mining, wetland degradation, overgrazing, tree and bush clearing; and wild fires.

Deforestation and Forest Degradation

Despite the many benefits and services accrued from forests, the forest sector in Tanzania is facing many challenges, including high deforestation rate and forest degradation mainly caused by human activities.

Main drivers of deforestation and forest degradation include poverty, population growth, and economic growth. The pressure factors include energy demand, unsustainable farming practices, climate change, wildfires, forest land tenure, and overgrazing and nomadic pastoral practices.

The Mainland Tanzania is estimated to have a total of 48.1 million hectares (ha) of forest, which is 51 per cent of the total area, with woodlands occupying about 90 per cent of the total forest area and the remainder being shared by mangrove forests, montane forests, small patches of coastal forests, and plantations of softwood and hardwood. Annual deforestation on the Mainland Tanzania is estimated at 373,000 ha which has been increasing across the country.

The total annual supply (growth) of wood at national level is estimated at 83.7 million m^3. However, only about half of this, i.e. about 42.8 million m^3 is available for harvesting at a sustainable level. The annual demand (consumption) of wood is estimated at 62.3 million m^3 exceeding the sustainable supply, causing an annual wood deficit of 19.5 million m^3. The estimate of the average demand for wood is therefore 1.39 m^3/year/capita while the annual allowable cut (the sustainable supply) is estimated at 0.95 m^3/ year/capita.

The present value of net losses from deforestation to the Tanzanian economy in the period 2013-2033 amounts to TZS 5.6trillion (USD 3.5 billion). This scenario analysis used data from Catchment Forest Reserves to account the economic effect of deforestation not only on timber resources, but also on other provisioning services, including non-timber forest products, regulating services such as water provisioning for domestic use and livestock, and supporting services such as biodiversity. This shows that the present value of net losses are an order of magnitude higher when taking into account the effect of deforestation on the full range of forest ecosystem services.

Some of the interventions undertaken to address deforestation and forest degradation include preparation and implementation of policies, legislation, plans, strategies and programmes; promotion of traditional management practices; participatory Forest Management (PFM); tree planting campaign; promoting LPG as an alternative energy for cooking; and establishment of forest plantations.

Biodiversity Loss

Tanzania is one of the twelve mega-diverse countries of the world, and the nation's biological

diversity has important economic, technological and social implications. The country has extensive diversity of species with at least 14,500 known and confirmed species and is among 15 countries globally with the highest number of endemic as well as threatened species. The country is a home to about 20% of Africa's large mammals.

Despite being biodiversity rich, the country continues experiencing a rapid loss in biodiversity mainly emanating from anthropogenic rather than natural influences. The main drivers for biodiversity loss include rapid population growth, increasing demand and trade for plant and animal species, invasive alien species, and climate change. The pressure factors exacerbating biodiversity loss include agricultural expansion, unsustainable use of agricultural inputs, nutrient loading in aquatic environment.

Tanzania has lost about one-third of important ecosystems over the past few decades undermining livelihoods of many people who depend directly on them. Forests occupy 55% of the total land area (about 48.1 million ha). Tanzania has lost about 38% of its forest cover at an annual rate of about 373,000ha and if this rate escalates coupled with demographic and economic pressures, the country may deplete its forest cover in the next 50-80 years. More than half of inland water ecosystems (rivers, lakes and dams) have been degraded and are continuing to be threatened in terms of changed water regimes, pollution and conflicts over resource use. Similarly, signs of environmental degradation and decline in coastal and marine biodiversity are becoming more obvious with the country losing about 44,000 ha of mangroves over the last 30 years (1980-2010).

The country has between 400-3,000 endemic species. Of the endemic species, the proportion of threatened species is highest for mammals and cycads while the highest number of threatened endemic species is found in amphibians.The number of threatened species in the country has almost tripled over the last decade which can be linked to habitat loss, fragmentation and degradation as well as climate change impacts. There are 914 threatened species recorded in Tanzania (accounting for about 4% of threatened species globally) and the country is among 15 countries globally with the highest number of threatened species. The proportion of threatened species is highest for plants and amphibians while the highest number of threatened species is found in plants which is more than 375 species.

Genetic diversity seems to be declining in natural ecosystems as well as in agricultural and livestock production systems. The extent of such decline and its overall impact have not been documented.

Continued biodiversity loss, unsustainable utilization and associated degradation of a wide range of ecosystem services amounts to at least five percent (5%) of the national GDP and affects most severely the poor communities who depend most directly on their immediate environment for survival.

Some of the intervention undertaken to curb biodiversity loss include ratification and implementation of relevant Multilateral Environmental Agreements (MEAs); development and implementation of relevant national policies, legislation, strategies and plans; engagement of non-state actors in biodiversity conservation and management; conservation and designation of new protected areas.

Environmental Pollution

Environmental pollution contributes to deterioration of quality of water, air and land and life in general. It results from uncontrolled/haphazard disposal of various types of wastes including municipal, industrial, mine and mineral processing and agricultural. In urban areas, the situation is aggravated by rapid urbanization, characterized by inadequate sanitation facilities, solid waste as well as storm water drainage infrastructure.

Water Pollution: This emanates from a number of point-source pollution loads (e.g. domestic, mining and industrial) and non-point pollution (e.g. land runoff and leaching of nutrients). The drivers of water pollution include population and economic growth, climate change and Poverty. The key pressure factors of water pollution include inadequate waste management, unsustainable agricultural practices, unsustainable industrial activities and unsustainable mining activities. Water pollution is a growing environmental problem in Tanzania. Pollution of water sources for most urban centres in Tanzania originates from poor disposal of solid wastes and liquid wastes–essentially discharge of raw or inadequately treated wastewater effluents to water sources. The impacts related to water pollution include: increased water-borne diseases, increased water treatment cost and decrease of water sources. In response, more than 70 industries have adopted cleaner production technologies and techniques; 325 contaminated sites which were used to serve as storage of obsolete stocks of pesticides have been identified and more than 1,200 metric tons of obsolete pesticide were properly disposed; and increased participation of local community and private sector in waste management systems. Also, various national policies and legal framework have been formulated.

Air Pollution: The major sources of air pollution in Tanzania and especially in major cities like Dar es Salaam are motor vehicles, industrial pollution and residential burning of fossil fuels. The drivers include economic growth and urbanization while pressure factors include inadequate enforcement of relevant legislation and regulations and inadequate urban planning. A study on spatial variability of ambient air pollution concentration in Dar es Salaam city revealed that the PM_{10} concentrations were higher at the suburban and landfill site compared to the urban background whereas the NO_2 concentration was lower. The traffic site had higher concentrations compared to urban background site of each of the pollutants measured. Impacts associated with air pollution include risks to human health such as respiratory diseases and lung cancer.Some of the interventions undertaken include establishment of Air Quality Standards and initiation and implementation of mass and bulk transit systems including Bus Rapid Transit system in Dares Salaam City and the on-going construction of Standard Gauge Railway (SGR) from Dar es Salaam to Mwanza.

Noise Pollution: Noise has been common in urban areas, however, of recent, it has been increasing and widespread.The drivers of noise pollution include urbanization and industrial expansion. The pressure factors for noise pollution include associated with inadequate enforcement of legislation and limited public awareness. Traffic noise is one of the environmental source of pollution in most urban areas in Tanzania due to increase in road traffic volume in all major urban centers. For example, the vehicular population in Dar es Salaam has been growing at 10% annually since 1995. In a study to evaluate noise pollution from the use of household electricity generators in a high-density residential area in Dar es Salaam city, the average noise level of 97.60 dB was recorded which exceeded the WHO value of 50 dB allowed for residential areas.Theassociated impacts include social conflicts and potential health risks. Some of the interventions undertaken include formulation and

enforcement of the Noise and Vibrations (Standards and Control) Regulations, 2013.

Deterioration of Aquatic Systems

Tanzania is blessed with abundant and significant water bodies and wide range of aquatic resources. These water bodies directly support the livelihoods of many Tanzanians and much of the country's economy as a whole. Despite their significance to human life and socio-economic development, human activities have resulted to deterioration of these ecological systems; thereby decreasing their capacity to deliver the expected benefits.

The main drivers for deterioration of aquatic systems include population growth, economic growth, poverty and climate change. Pressure factors include deforestation, destructive fishing practices, unsustainable agricultural practices and inadequate waste management. Most surface water bodies are characterized by deterioration of water quality. Mainland Tanzania has lost about 6% of its mangrove at a rate of about 479 ha per year.

Some of the impacts associated with current trends have been identified to include decrease in productivity, reduction in fish yields and biodiversity, water shortage and increase in potential health risks such as vector-borne diseases. In response to these impacts, the Government has undertaken several interventions including formulation and implementation of sseveral sectoral policies and legislation; formulating and implementing a Strategy on Urgent Actions on the Conservation of Marine and Coastal Environment, Lakes, Rivers and Dams (2008) in order to control most of the pressures threatening aquatic systems; implementing cross-sectoral initiatives to manage/combat dynamite fishing; and construction of sea walls extending 780m, 500 m and 860mseawalls at Barack Obama, Mwalimu Nyerere Memorial College in Kigamboni and Pangani, respectively; and restoration of 3,000 m^2 of coral reefs in Sinda Kigamboni and 1,000 ha of degraded mangroves in Rufiji.

Water Quality Degradation and Accessibility

Water is essential for various domestic uses and a necessary input for production in various sectors of economy including industry, mining, hydropower generation, tourism, agriculture, fisheries and livestock keeping. The main sources of water supply in the country are surface water (rivers, lakes, dams and wetlands) and groundwater.

Degradation of quality of water due to various human activities, poses a great risk to both the health of the population and on economic sectors. The main drivers for water quality degradation and accessibility include economic growth (industrial, agricultural and mining sectors), population growth and climate change. Pressure factors include improper waste management, limited capacity to invest in water supply and sanitation, increasing water demand, unsustainable human activities in water catchment basins and encroachment of water sources.

Demand for, and availability of each of these uses, drives the current and future state of the water resources in the country in both quantity and quality. The total water withdrawal in mainland Tanzania is estimated to be 5,184 million m^3. Agriculture is the largest water withdrawal sector with almost 90% of total, and in particular irrigation (85%), while the municipal sector use 10% and industry less than 1%. Several studies revealed deteriorating water quality in major lakes and river systems countrywide including Lake Victoria, Lake

Tanganyika, Lake Nyasa, Msimbazi River in Dar es Salaam city), Ngerengere River (Morogoro), Pangani River (Tanga) and Mirongo River in Mwanza region.

The high concentration of chloride (salinity) in groundwater is the main problem especially in the coastal and central regions of the country (like Singida, Shinyanga, Lindi and Mtwara). In Lindi and Mtwara regions, there is high carbon dioxide in groundwater resulting in pH values of 4.0 which causes groundwater to be corrosive. High iron content in groundwater has been observed in Mtwara and Kagera regions while high nitrate levels are found in the Dodoma and Singida. High fluoride concentrations (exceeding 14 mg/L) occur in both the Rift zones in Northern and South-Western Tanzania including Shinyanga, Tabora, Dodoma, Singida, Mbeya, Arusha and Kilimanjaro Regions.

Impacts associated with water quality degradation include increased waterborne diseases whereby about 60–80% of outpatient cases are due to consumption of unsafe water and poor sanitation; burden on time spent to fetch water whereby in rural areas, the proportion of the population with access to improved sources of water within 30 minutes is less than 50%; and water use conflicts have been experienced in almost all water basins in the country as a result of competition for water resources.
Some of the intervention undertaken to address water quality degradation and accessibility include implementation of the Water Sector Development Plan II (2014-2019), among others, to enhance access to water supply; implementation of relevant policies, plans, legislation, strategies and programmes; exploration and development of new water sources; identification, demarcation and protection of water sourceswhereby between 2014 and 2018, a total of 298 water sources were identified and conserved whereas 18 of the have been gazzetted as protected water sources; and environmental inspection and water quality monitoring.

Climate Change

The impacts of climate change and variability are consistently and increasingly felt at the global, national and local scales. These impacts are manifested through increasing temperature, decreasing rainfall, and increasing frequency and intensities of extreme weather and climate events, particularly strong winds, floods and droughts, which are often associated with devastating socio-economic and ecological implications.

The main drivers of climate change include economic development in terms of industrial development and transportation with respect to developed countries; and dynamics of land use, land use change and forestry. Rapid population growth and poverty are exacerbating the impacts of climate change.

In recent years, Tanzania has experienced an increase in frequency and intensity of extreme events such as strong wind, heavy rainfall, hailstorm and higher temperatures. These extremes are normally associated with devastating socio-economic impacts including loss of life and properties, and destruction of infrastructure. The last four years, 2015, 2016, 2017 and 2018 have also been characterized by record breaking extreme events, consistent with global observation and trends as documented in IPCC report. For example in November 4th2015, Tukuyu Meteorological Station recorded 327.8 mm of rainfall in 24 hours, which is the highest ever-recorded 24 hours rainfall since the establishment of the station in 1928. On 9thApril 2016, Mbambabay, Ruvuma region recorded 247.6 mm of rainfall in 24 hours,

which is the highest amount on record since the station was established in 1951. On 8th May 2017, Tanga station recorded 316 mm of rainfall in 24 hours, the highest ever, since the establishment of the station in 1968.

It is projected that future climate change could be much worse, leading to significant economic costs to the country. The study on economics of climate change revealed that current climate change variability already costs Tanzania around 1% of GDP annually and it could go up to 2% of GDP by 2030; an additional 0.3 million to 1.6 million people will become vulnerable to sea level rising by 2030; about USD 500 million is required annually to reduce current vulnerability to climate change, and a further USD 100-150 million per year will be required to build capacity and enhance resilience to future climate change. The agriculture sector in Tanzania is particularly vulnerable to climatic change because it is customarily dependent on rainfall. Since more than 60% of Tanzanian population directly rely on agriculture for their livelihoods; thus, 10% decrease in rainfall would make most of areas unsuitable for cultivation. It is projected the number and costs of additional cases of cholera that can be attributed to climate change by 2030 in Tanzania for a 1 and 2 degree increase in temperatures, respectively. The total costs of cholera attributable to climate change are shown to be in the range of 0.32 to 1.4 percent of Tanzanian GDP in 2030.

Various initiatives have enabled the country to build resilience to climate change impacts including: implementation of national policies, legislation, regulations, strategies, plans and guidelines; implementation of various projects including construction of 780m sea wall at Barack Obama Road, 500 m long wall at Mwalimu Nyerere Memorial College in Kigamboni, Restoration of 792 ha degraded mangrove areas in Rufiji, and restoration of 3,000m^2 of coral reef in Sinda Kigamboni. Furthermore, the National Carbon Monitoring Centre at SUA Morogoro was established being responsible for developing, maintaining, analyzing and updating carbon database which facilitate taking stock of country contribution in sequestering carbon dioxide, and developed Tanzania Forest Reference Emission Level in 2018 which makes the country to qualify and benefit from REDD financing mechanism.

Emerging Issues

The selected emerging environmental issues include nanotechnology and antimicrobial resistance (AMR) in the environment.

Nanotechnology refers to the science of manipulating, modifying and utilizing of functional materials, devices and systems through control of matter on the nanometre scale (1–100 nm) and exploitation of novel phenomena and properties (physical, chemical, biological) at that length scale. Concerns have been raised that the very properties of nanomaterials that make them so attractive could potentially lead to unforeseen health or environmental hazards. With its limitless potentials, there are many environmental, health and safety related concerns due to extremely ambivalent effects of nanomaterials. In Tanzania and Sub-Sahara Africa in general, nanotechnology is still new and thus at its infancy. Indeed, there is so far minimal understanding and appreciation of the potential benefits and opportunities of nanotechnology application. Only recently, using nanomaterials, an innovative low-cost water filtration prototype has been developed that provides affordable, safe and clean drinking water. The Nanofilter is a sand-based water filter whereby the sand traps debris, the nanomaterials remove heavy metals, fluoride and biological contaminants.

The environment is increasingly being recognized for its potential role in the spread of clinically relevant antibiotic resistance. Three main pathways for introduction of AMR in the environment include through animal waste; human waste; and industrial waste. Few studies have reported occurrence of antibiotics in water resources, effluent from industries, sludge, manure, soil, plants and organisms across the country. One of the studies suggest that the conventional treatment of municipal wastewater by Waste Stabilization Ponds (WSPs) is insufficient for removal of antibiotics from wastewater implying that WSPs could be an important source of antibiotics pollution surface water.

Scenario Analysis

Scenarios analysis explores different policy approaches and societal actions towards a sustainable future, based on available data, past trends and models concerning how the future could unfold for the purpose of improving decision making.

In this report, three scenarios have been considered in the analysis of the situations and policy actions which include Business as usual, Policy Reform and Sustainability scenarios. *The Business as Usual Scenario* entails retaining the current status quo assuming that even the existing environmental degradation will not be mitigated. BaU scenarios have long been considered as a baseline to compare alternative scenarios. *The Policy Reform Scenario* assumes a situation whereby policies are reviewed and or revised while new policies and guidelines are issued to accommodate new and emerging issues in the environmental governance arena. *The Sustainability Scenario* presents a situation whereby environmental planning tools such as Strategic Environmental Assessment, Environmental Impact Assessment, participatory planning, Public Private Partnership are effectively put into use while financial resources is secured to ensure sustainability of the interventions.

Policy Options for Action

The Chapter presents recommendations on appropriate measures that are necessary to curb the identified environmental challenges. Specific options for intervention and the responsible entity for implementation have been identified against each specific environmental issue namely Land degradation, Deforestation and forest degradation, Loss of biodiversity, Environmental pollution, Deterioration of aquatic systems, Water quality degradation and accessibility, Climate change and Antimicrobial Resistance in the Environment.

CHAPTER ONE

INTRODUCTION

1.1 Background

This document presents a Third State of the Environment Report (SoER-3). It has been prepared through a participatory process involving a diversity of stakeholders under the overall coordination of the Vice President's (VPO). Preparation of this report is meant to comply with legal obligations (Section 175 (1) of the Environmental Management Act, 2004), which requires the Director of Environment (DoE) to prepare and publish a SoER, which eventually is tabled before the National Assembly every two years.

This report responds to the government's desire and needs to fulfill the requirements of the National Environmental Action Plan of 2013-2018 (URT, 2013), Tanzania Development Vision, 2025; and Environmental Management Act (Cap. 191). It is also in response to Government's desire to continue implementing The Second Five Year Development Plan (FYDP II), 2016/17–2020/21 (URT, 2016) and the need to contribute to strengthening the science-policy interface for sustainable development as also discussed in the United Nations, Global Sustainable Development Report (UN, 2016). The report is also in line with the UN Sustainable Development Goals, as it calls to action to end poverty and to protect the environmental resources as well as ensuring prosperity in the country. The specific objectives of the report are aligned with the country's economic growth requirements and aspirations of achieving middle-income country (MIC) status by 2025 as also outlined in the ruling party manifesto.

The first SoER which was published in 2008 provided environment trends in key sectors and areas taking into account considerations in socio-economic, political and cultural issues such as demography, production and consumption, poverty, trade, globalization and financing. The second SoER provided an update and State of Environment up to the year 2014. This SoER-3 presents information for the reporting period from 2014 to 2018 and considers changes since the SoER-2.

1.2 Efforts towards implementation of Second State of the Environment Report (SoER-2 - 2014)

As part of implementation of recommendations from the Second State of the Environment Report (SoER-2), several sectoral policies which have bearing on environmental conservation have been revised to, among others, mainstream explicitly issues of environmental conservation. These include ICT Policy (2016), Fisheries Policy (2015), National Petroleum Policy (2015); and National Energy Policy (2015). Other sectoral policies which are under review include National Environmental Policy (1997), National Land Policy (1985), National Forest Policy (1998), National Tourism Policy (1999) and National Water Policy (2002).

Sectoral strategies, plans and programmes that have been developed and implemented include Strategy and Action Plan for Conservation of Great Ruaha River Ecosystem (2017); Fisheries Sector Development Strategy (2018); Tanzania Climate Smart Agriculture Programme (2015); Tanzania Agriculture Climate Resilience Plan (2014); Agricultural Sector Development Strategy (2016); National Implementation Plan for the Stockholm Convention

on Persistent Organic Pollutants (POPs) (2018); and National Biodiversity Strategy and Action Plan (NBSAP) (2015).

Some of the project level interventions include Developing Core Capacity to Address Climate Change in Productive Coastal Areas (2012-2018); Implementing Concrete Adaptation Measures to Reduce Vulnerability of Livelihoods and Economy of Coastal Communities (2012-2018); Ecosystem Based Adaptation for Rural Resilience (2018-2022); Reversing Land Degradation Trends and Increasing Food Security in Degraded Ecosystems of Semi Arid Areas (2018-2022); Sustainable Management of Lake Nyasa Catchment in Tanzania (2018-2020); Tanzania Strategic Cities Project (TSCP); and Sustainable Management of Mineral Resources Project (SMMRP) Phase II (2015-2018).

Despite of these efforts during this period, generally the state of the environment has not improved to the desired level. This has been due to challenges related to inadequate financial resources, institutional capacity and enforcement and compliance of relevant legislation; and participation of stakeholders' particularly private sector. This calls for government and other stakeholders to take rigorous measures to improve the state of the environment.

1.3   Objectives of the Report

The main objective of this Report is to capture the prevailing trends and patterns of the country's environment and emerging environmental issues within the reporting time, so that appropriate actions are taken to ensure a sustainable environmental, social and economic development in the country. The specific objectives are to:

i) Establish current status of the environment and evaluate environmental changes;

ii) Inform the public on the state of the environment in the country, particularly on the importance of natural resources to society;

iii) Indicate major trends, as social and economic development pressures increase on the environment and natural resources and identify areas that need intervention and improvement;

iv) Improve understanding of the causes and effects of environmental change, and recommend appropriate responses and enable evaluation of achievements in global goals and targets;

v) Provide data for developing and monitoring the implementation of sustainable development strategies, programmes and projects/plans; and

vi) Provide inputs in the planning and implementation of government activities and initiatives in environmental management, its achievements and constraints, goals and opportunities for collaboration.

1.4   Analytical approach

Preparation of this report adopted the Global Environment Outlook (GEO) approach which utilizes the Drivers-Pressure-State-Impact-Response (DPSIR) framework. The DPSIR framework analyses the impacts of the environmental change on human well-being and management options. According to the DPSIR framework, there is a chain of causal links starting with 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritization, target-setting, indicators). The DPSIR framework model used for the development of this report is elaborated/presented in Figure 1-1.
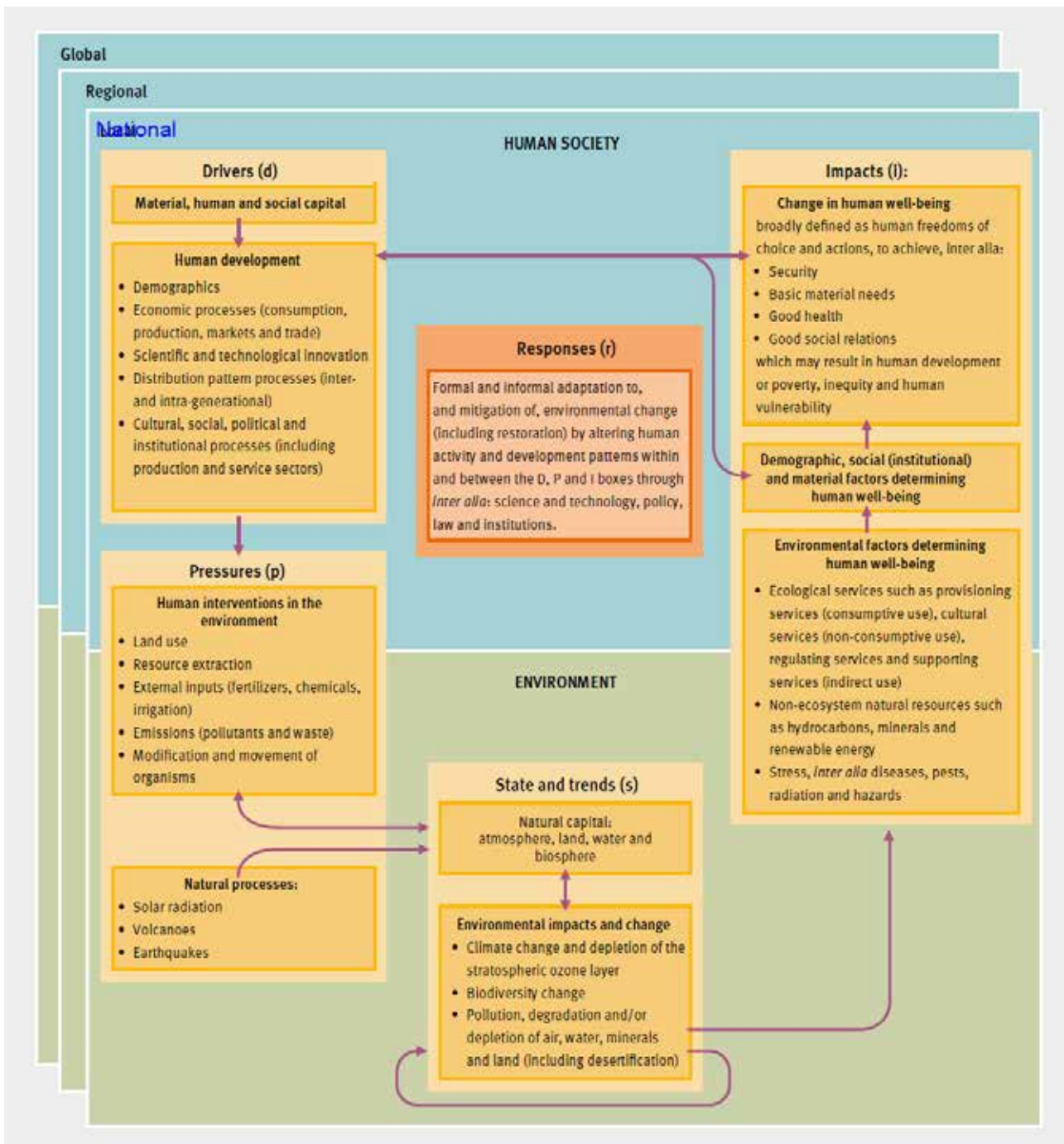
Figure 11: The DPSIR Framework Model (UNEP, 2012)

1.5 Preparation Process

Preparation of this report adopted the following stages namely; i) Preparatory stage and ii) Drafting. The preparatory phase established consensus on the scope as well as issues related the management of the whole process including formulation of Technical Review Team which had a role of reviewing the work of Consultant and provide further guidance and inputs.

It also involved appointment and engagement of the consultant for the actual execution of the assignment. The key output of this phase was essentially development and agreement on the Terms of Reference (ToR) including a road map for completion of the report and

engagement of the Consultant and team of experts.

Drafting Phase involved literature sourcing and review as well as draft report preparation. This was done under the coordination of the VPO. The draft report was subjected to validation through stakeholders' consultation.

1.6   Structure of the Report

The Report is organized in fifteen (15) Chapters. Chapter one provides general introduction including the objectives of report, while Chapters two to four presents highlights on baseline information focusing on country's geography and location, social economic issues and environmental resources. Chapter five is dedicated to policy, legal and institutional framework that provides guidance on environmental matters in the country. Discussion on various environmental issues including: Land degradation, deforestation and forest degradation, loss of biodiversity, environmental pollution, Deterioration of aquatic systems, Water quality degradation and accessibility and climate change are addressed in chapters six, seven, eight, nine, ten, eleven, twelve and thirteen, respectively. A discussion on currently Emerging Environmental issues is provided in chapter fourteen. The last two chapters, (fourteen and fifteen) present scenario analysis and policy options for action respectively.

CHAPTER TWO

GEOGRAPHY

2.1   Location

Tanzania is located in Eastern Africa between longitudes 29^0 and 41^0 East and latitudes 1^0 and 12^0 South. The most Northerly point is Mutukula (1^0 01' S and 31^0 25' E), most Southerly point Mtalika (110 32' S and 370 05' E. The most Westerly and Easterly points are Kigoma (4^0 52' S and 29^0 38' E) and Msimbati (10^0 21' S and 40^0 26' E).Mainland Tanzania is bordered on the north by Kenya and Uganda; on the west by Rwanda, Burundi and Democratic Republic of the Congo; on its south western side by Zambia and Malawi; in the south by Mozambique and in the east by the Indian Ocean (Figure 2-1).

The country is constituted by Mainland Tanzania and Zanzibar with a total area of 945,249 km^2 comprising of land area of 883,749 km^2 (881,289 km^2 Mainland and 2,460 km^2 Zanzibar Islands), plus 61,500 km^2 inland water bodies. Mainland Tanzania encompasses major island of Mafia (518 km^2) and Zanzibar consists of Unguja (1,666 km^2) and Pemba (795 km^2).

Figure 21: The Map of Tanzania showing regional and international boundaries (URT, 2017)

2.2 Physical Features

2.2.1 Topography

The Tanzania terrain comprises plains along the coast; a plateau in the central area that ranges between 1,000 and 1,500 meters above sea level (amsl.); highlands in the north-east and south west are characterized by mountain ranges and peaks; river and lake basins and the Great East African Rift Valley.

i) Coastal Plains and features

The coastline of Mainland Tanzania extends 1424 km from the border with Kenya in the North to the border with Mozambique in the South. About two thirds of the coastline has fringing reefs, often close to the shoreline, broken by river outlets such as the Rufiji Delta, Pangani, Ruvuma, Wami and Ruvu. The continental shelf extends to 5.8–10 km offshore, with exception of the Zanzibar and Mafia channels where the shelf extends for more than 25 km. The area of the shelf to the 200m depth contour for both mainland Tanzania and Zanzibar combined is about 30,000 km^2. The islands within the continental shelf include Unguja, Pemba and Mafia as well as numerous small islands, islets and sand dunes surrounded by reefs. Unguja and Mafia are limestone islands on the continental shelf and were probably part of a Pleistocene inshore coral reef system now separated from the mainland by relatively shallow water channels of about 30– 50 m in depth.

ii) Plateaux

Plateau is in the central area of the country, which is part of the East African Plateau. It ranges between 1,000 and 1,500 meters above sea level (m.a.s.l.) and is characterised by gently sloping plains and plateau broken by scattered hills and low-lying wetlands. The southern half of this plateau is grassland within the Eastern Miombo woodlands ecoregion, the majority of which is covered by the huge Selous Game Reserve. Further north the plateau is arable land and includes the national capital, Dodoma city.

iii) Highlands and mountains

Tanzania is characterized by highlands with several mountain ranges and peaks. The northeast border with Kenya is dominated by Mt. Meru (4,565 m.a.s.l.) and Mt. Kilimanjaro (5,895 m.a.s.l.) the latter being the highest point in Africa. Both of these mountains are dormant volcanic mountains. In the eastern part of the country there are two important block mountains (the Usambara and Pare), famously known as the Eastern Arc Mountains. In the south, the country is dominated by the mountain range of the Southern Highlands which separates the Eastern plateau from the rest of the country and they include Livingstone, Kipengere, Udzungwa and Uluguru. Southwards, is the Central Plateau reaching elevations 2,000 m.a.s.l.

iv) River and lake basins

Tanzania is divided into five major drainage systems: the Indian Ocean Drainage System; the Internal Drainage of Lakes Eyasi, Natron and Bubu Depression Complex; the Internal Drainage of Lake Rukwa; the Atlantic Ocean Drainage; and the Mediterranean Sea Drainage System. These systems have been further divided into nine river and lake basins. The nine

drainage water basins are Pangani Basin, Wami/Ruvu Basin, Rufiji Basin, Ruvuma and the Southern Coast Basin, Lake Nyasa Basin, the Internal Drainage Basins of Lake Eyasi, Manyara and Bubu depression, Lake Rukwa Basin, Lake Tanganyika Basin, and Lake Victoria Basin. Lake Tanganyika forms the lowest point in the country (358 meters below sea level). Tanzania's main rivers include the Pangani, Rufiji, Wami, Ruvu and Ruvuma. Details of Tanzania Drainage Water Basins are discussed in Chapter 4.

v) *Rift valley*

The Great Rift Valley that runs from north-east of Africa through Central Tanzania, is another landmark that adds to the scenic view of the country. The rift valley runs to south of Tanzania splitting at Lake Nyasa; The Eastern Rift Valley runs through central Tanzania dotted with lakes such as Lake Natron, Manyara and Eyasi, while the Western branch runs from Lake Nyasa along Lake Rukwa and Tanganyika and ends to the western part of Uganda. Volcanics and carbonatites are associated with both the Eastern and the Western Rift. Lacustrine sediments fill large parts of the rift valleys.

2.2.2   Soils

According to the World Reference Base for Soil Resources (WRB), Tanzania has 19 dominant soil types. These are dominated by Cambisols (35.64%), Acrisols (8.63%), Leptosols (8.11%), Luvisols (7.26%), Ferralsols (6.32%), Vertisols (5.02%) and Lixisols (4.95%). Figure 2-2 shows major soil groups of Tanzania.

2.2.3   Vegetation

Tanzania vegetation ranges from grasses to shrubs, miombo woodland and montane to rich forests that contain more than 2,000 plant species. The most typical vegetation is the dry grassland scattered with thorny scrub and acacia that is found along the Eastern Plateau, which makes up most of the country's land area. This area includes open grasslands, savanna as well as woodlands and comprises the Serengeti Plains. Most of the Tanzania forest is montane vegetation which is located on the Eastern Arc Mountains, forming an unbroken range between 50 and 200km inland. A belt of miombo woodland stretches in southern and western Tanzania and is characterised by brachystegia, acacia and baobab trees. Along the coast, mangrove swamps are fairly common, with alpine moors on the slopes of Mount Kilimanjaro and Meru. These ecosystems are famous habitats for diverse types of wildlife.

2.2.4   Geology

The general geology of Tanzania comprises mainly of the Precambrian. The Precambrian rocks underlie most of central and western Tanzania. Archean granite and greenstone rock assemblages form the central nucleus of the country, the Tanzania Craton. The craton is surrounded by Proterozoic belts: the PaleoproterozoicUsagaran-Ubendian belt, and the MesoproterozoicKibaran (Karagwe-Akolean). The Neoproterozoic Mozambique Belt occurs in the eastern part of the country. Parts of the Usagaran-Ubendian belt were rejuvenated during the Neoproterozoic to early Cambrian Pan-African thermo-tectonic event. Shallow water sediments of the Neoproterozoic (900-800 million years) Malagarasi Super group underlie parts of western Tanzania. The Karoo basin crosses southern Tanzania in a north-easterly direction. Mesozoic and younger marine sediments occur along the coast of Tanzania.

TANZANIA - MAJOR SOIL GROUPS

| | Regional centre |
| | Railway |

Map code	Major soil group	Sq km	Percent	Map code	Major soil group	Sq km	Percent
AC	Acrisols	81642.50	8.63	LX	Lixisols	46888.61	4.95
AN	Andosols	15904.46	1.68	LV	Luvisols	68706.15	7.26
AR	Arenosols	21926.33	2.32	NT	Nitisols	21001.11	2.22
CM	Cambisols	337353.69	35.64	PH	Phaeozems	22190.10	2.34
CH	Chernozems	4734.96	0.50	PL	Planosols	28197.84	2.98
FR	Ferralsols	59852.62	6.32	RG	Regosols	1196.15	0.13
FL	Fluvisols	26223.13	2.77	SC	Solonchaks	2750.92	0.29
GL	Gleysols	1486.19	0.16	SN	Solonetz	19626.46	2.07
HS	Histosols	3791.45	0.40	VR	Vertisols	47497.85	5.02
LP	Leptosols	76738.02	8.11	Water bodies		58836.73	6.22

Figure 22: Major soil groups of Tanzania(URT, 2014)

2.3   Climate

2.3.1   Climatic Conditions

The climate of Tanzania is characterized by bimodal and unimodal rainfall regimes (Figure 2-3). The northern part of the country including areas around Lake Victoria Basin (Mwanza, Kagera, Mara, Shinyanga, Geita and Simiyu), North-Eastern Highlands (Kilimanjaro, Arusha and Manyara) and the Northern Coast (Dar es Salaam, Tanga and Northern Morogoro) experience two main rain seasons (bimodal) namely, long rains (Masika) which normally begins in mid-March and end at the ends of May and short rains (Vuli), which begins in mid-October and continues to early December (Figure 2-3a). The Central part of the country (Dodoma and Singida), the Southern part (Ruvuma, Lindi and Mtwara), the Western areas (Kigoma, Tabora, Katavi and Rukwa) and South-western Highlands (Mbeya, Njombe, Iringa and Southern Morogoro) have a prolonged unimodal rainfall regime that start in November and continues to the end of April These rain seasons are associated with the southwards and northwards movement of the Inter-tropical Convergence Zone (ITCZ). Annual rainfall amount varies from 550 mm in the central parts of the country to 2500 mm in some parts of surrounding Lake Victoria as indicated in Figure 2-4.

Tanzania's topographical diversity gives rise to four distinct climate zones namely: 1) hot and humid coastal belt (including the Zanzibar archipelago), which has the warmest temperatures, averaging 27–30°C, and receives 750–1,250 mm of annual rainfall, with Zanzibar receiving 1,400-2,000 mm; 2) hot and arid central plateau, which receives just 500 mm of rainfall; 3) cooler semi-temperate high lakes region in the north and west which receives 750–1,250 mm of rainfall annually; and 4) highlands of the northeast (i.e., Kilimanjaro) and southwest including the coldest parts of the country with average temperatures of 20–23°C (USAID, 2018).
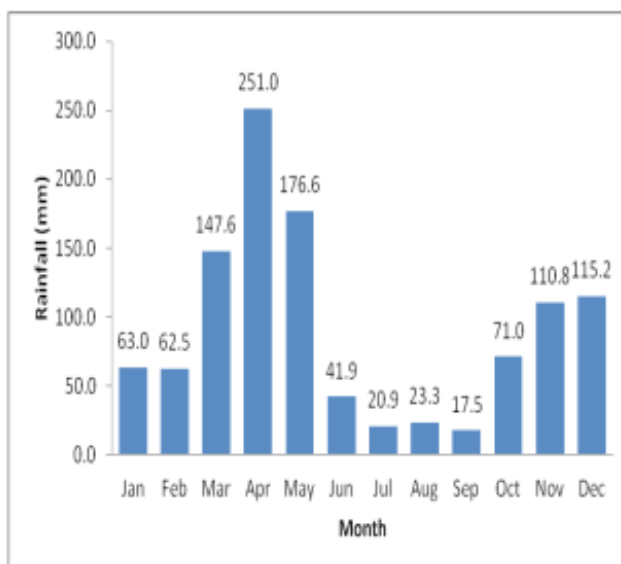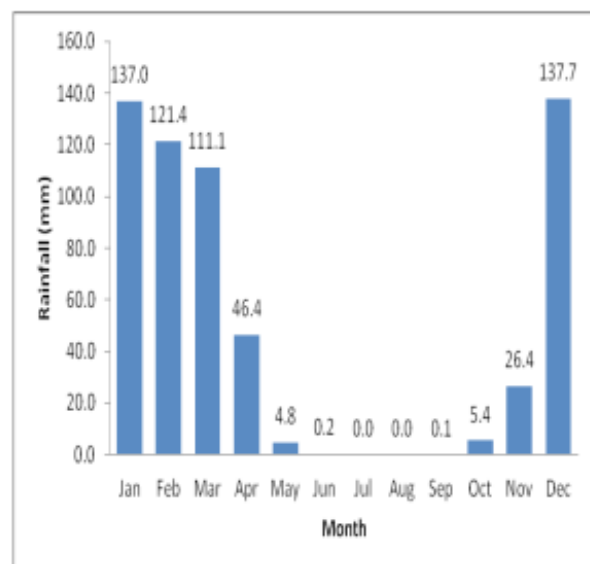
Figure 23: Annual Cycle of Rainfall for 2 Selected Stations, (a) Bimodal (b) Uni-modal(URT, 2018)
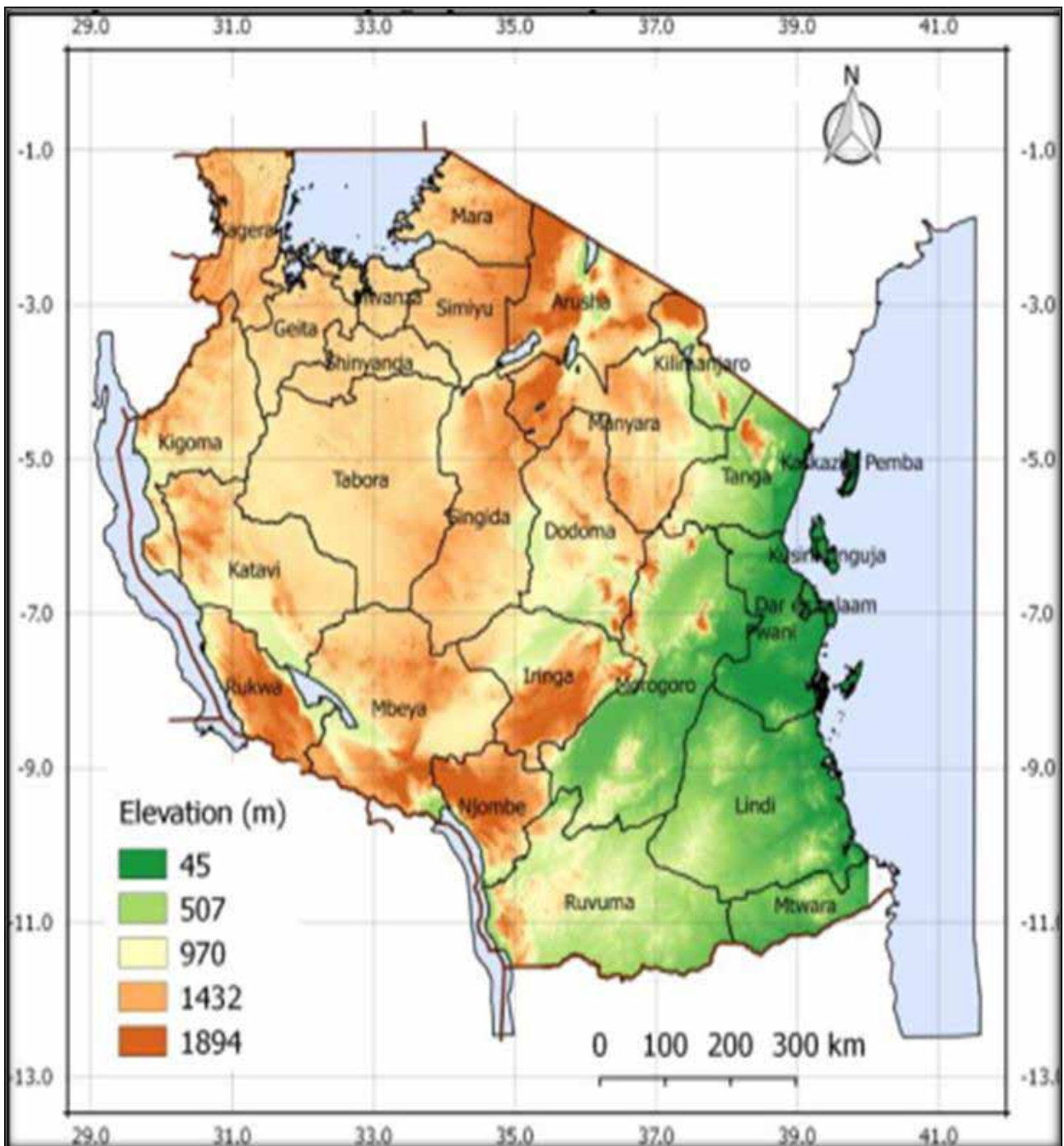
Figure 24: Tanzania's climatic zones(URT, 2018)

2.3.2 Rainfall

The rainfall distribution and variability in the country is driven by multiple factors including East African Monsoon, Elnino Southern Oscillation (ENSO), and Westerlies from Congo, Tropical Cyclones, and Inter-Tropical Convergence Zone (ITCZ). ITCZ and its migration north and south across the equator are among the main factors affecting distribution and variability of rainfall in Tanzania and the entire East Africa. The migration of ITCZ lags behind the overhead sun by 3-4 weeks over the region. The ITCZ migrate to southern regions of Tanzania in October-December, reaching southern part of the country in January-February and reverses northwards in March, April and May (URT, 2017).

Due to this movement, some areas experience single and double passage of the ITCZ. The

areas that coincide with single passage are known as unimodal areas. These include the southern, southwestern, central, and western parts of the country, which receive rainfall from November to April or May (NDJFMA, also known as Msimu rains). Areas that experience double passage are known as bimodal, and include northern coast, northeastern highlands. Lake Victoria basin, and the Island of Zanzibar (Unguja and Pemba). These regions receive two distinct rainfall seasons; the long rain season (also known as Masika in Swahili), which starts mainly in March and continues through May (MAM) and the short rainfall season (also called vuli in Swahili) which starts in October and continues through December (OND). January and February is the transition period (relatively dry) for bimodal areas while June, July, August, and September are dry months for the entire country (URT, 2017).
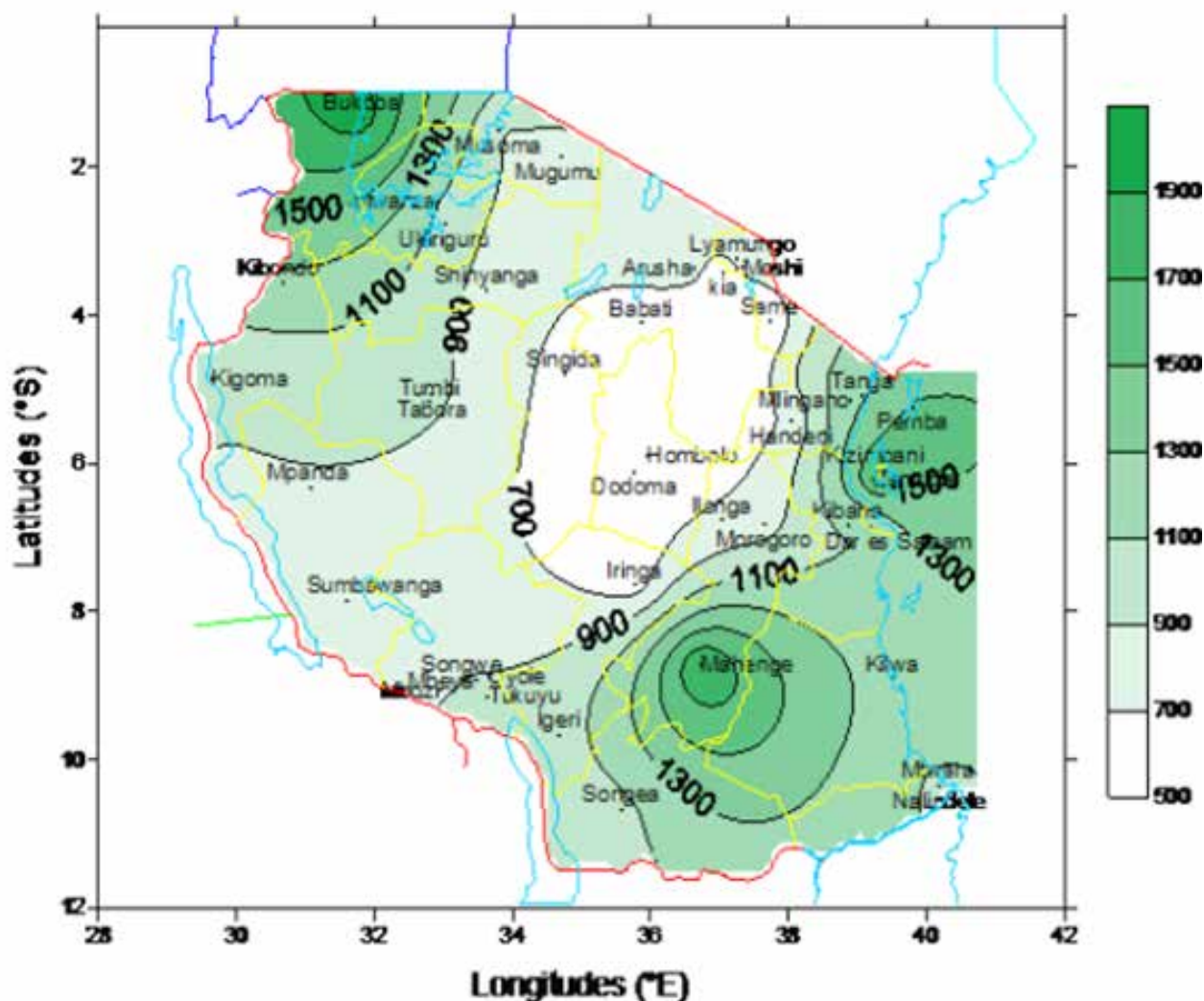
Figure 25: Tanzania Annual Mean Total Rainfall Distribution for 30 Years, 1981-2010(TMA, 2018)

2.3.3   Temperature

Along the coast and in the off-shore islands the average temperatures ranges between 27°C and 29°C, while in the central, northern and western parts temperatures range between 20°C and 30°C. Temperatures are higher between the months of December and March and coolest during the months of June and July. In the Southern highlands and mountainous areas of the north and northeast, temperature occasionally drops below 15°C at night, and in the cold months on June and July sub-zero temperatures can also be experienced.

Distribution of minimum temperature (Tmin) is identical to that of maximum temperature (Tmax), lower values of Tmin are centered on south-western and north-eastern highlands. Mbeya, Iringa, Njombe, Arusha and Kilimanjaro are the coolest regions characterized by mean annual Tmin values which are less than 15°C. Coastal areas including Dar es Salaam, Tanga, Mtwara, Zanzibar and Pemba are characterized by relatively higher values (>20°C) of mean annual Tmin.

Annual mean maximum temperature for Tanzania for the period of 2012 to 2016 (Table 2-1) was 28.5°C. The results further indicate that, the highest mean maximum temperature observed was 32.2°C recorded at Julius Nyerere International Airport (JNIA) meteorological station in Dar es Salaam in 2012. The lowest mean maximum temperature was 23.7°C recorded at Mbeya meteorological station in 2014. Available statistics show that, annual mean maximum temperature variations from station to station are small.

Table 21: Annual Mean Maximum Temperature (°C), 2012 – 2016

Station	2012	2013	2014	2015	2016	Mean
Bukoba	26.5	26.5	26.4	27.3	26.2	26.6
Mwanza	28.6	27.3	28.3	28.6	28.9	28.6
Musoma	28.7	28.9	28.2	29.7	28.6	28.8
Kigoma	29.5	29.2	28.1	29.9	30.0	29.3
Tabora	30.3	30.2	29.5	30.3	30.5	30.1
Dodoma	29.2	29.6	29.1	29.6	29.4	29.4
Iringa	27.8	27.4	26.4	27.4	27.2	27.0
Arusha	26.2	25.7	25.8	26.5	26.6	26.3
Kilimanjaro (KIA)	30.8	30.3	29.7	30.4	30.1	30.1
Dar es Salaam (JNIA)	32.2	32.1	32.0	32.0	31.3	31.8
Mtwara	30.6	31.0	30.7	31.1	30.9	30.9
Songea	26.7	27.3	26.7	27.7	28.0	27.5
Mbeya	25.1	24.6	23.7	26.2	24.0	24.6
Mean	**28.6**	**28.5**	**28.0**	**29.0**	**28.6**	**28.5**

(Source: TMA, 2018)

The comparison of temperature between the shorter period (2012 - 2016) and long term mean temperature indicates that, the temperature for the period (2012 - 2016) are higher than long term means for all months (URT, 2018).

The annual mean minimum temperature was 18.0°C from 2012 to 2016. In addition, the highest mean minimum temperature was 23.2°C observed at JNIA meteorological station in Dar es Salaam in 2016 while, the lowest minimum temperature was about 11.7°C observed at Mbeya meteorological station in 2012 (Table 2-2).

Table 22: Annual Mean Minimum Temperature (°C) for Stations, 2012 – 2016

Station	2012	2013	2014	2015	2016	Mean
Bukoba	17.9	18.1	18.4	18.6	18.9	18.6
Mwanza	17.9	17.5	18.6	18.9	18.6	18.7
Musoma	18.2	18.7	17.9	18.3	17.7	18.0
Kigoma	19.2	19.4	19.9	19.7	19.8	19.8
Tabora	17.7	17.6	16.9	16.9	15.9	16.6
Dodoma	17.7	17.8	17.9	17.7	17.7	17.8
Iringa	15.3	14.7	15.5	15.3	15.2	15.3
Arusha	15.1	14.6	15.3	15.5	15.3	15.4
Kilimanjaro	18.0	17.6	17.1	17.6	18.6	17.8
Dar es Salaam	22.4	22.3	22.5	23.1	23.2	22.9
Mtwara	21.5	20.9	21.2	21.5	21.4	21.4
Songea	14.9	14.2	15.7	12.2	15.6	14.5
Mbeya	11.7	20.9	14.1	12.0	14.4	13.5
Mean	**17.8**	**18.2**	**17.9**	**17.8**	**18.1**	**18.0**

(Source: TMA, 2018)

2.3.4   Winds

The climate of Tanzania is influenced by the monsoon winds, the southerly monsoons and the northerly monsoons. The southerly monsoons begin in April ending in September and they are usually strong and predominantly southerly. They are characterised with lower temperatures (approximately 25^0C) and bring the long rains (Masika) from March to May. The northerly monsoons begin in November ending in February. These are lighter winds and are predominantly northerly. The northerly monsoon are characterised with high air temperatures (>30^0C) and bring the lighter rains (Vuli) from November to December.

2.3.5   Humidity

The mean relative humidity in Tanzania for an average year is recorded as 44.6% and on monthly basis, it ranges from 30% in September and October to 58% in March. The coastal areas are more humid compared to the rest of the country.

CHAPTER THREE

SOCIO-ECONOMIC ISSUES

3.1   Demography

3.1.1   Population size and growth rate

Recent population projection (URT, 2018) has indicated year 2018 population of 52.6 million people in Tanzania-Mainland. By year 2035, the population is estimated to have grown to 89,204,781 people (URT, 2019). National projections show that the Tanzania population growth rate will decrease from 3.1% in 2013 (with a population of 46,356,279) to 2.8% in 2035 (with a population of 89,204,781). For the Mainland Tanzania population growth rate will also decrease from 3.1 in 2013 (with a population of 45,007,503) to 2.8% in 2035 (with a population of 86,871,546). Infant Mortality Rates (IMRs) in Tanzania are expected to decline for both sexes from 43 deaths per 1,000 live births in 2013 to 13 deaths per 1,000 live births in 2035.

3.1.2   Human Settlement Pattern

In Mainland Tanzania, development of human settlements has not been sustainable because it has not adequately combined socio-economic development with environmental conservation and protection and thereby aggravating urban and rural poverty. Rapid urbanization which has taken place over the last few years has increased and will continue to increase the proportion of the country's population living in urban areas.

Rapid urbanization rate transforms the country's settlements pattern that is characterized by numerous scattered small villages to that of large villages, towns, municipalities and cities. At the same time, the provision of shelter in urban and rural settlements of Tanzania is inadequate and lacking infrastructure and services. This situation leads to non-sanitary conditions that threaten the health and productivity of people in both settings. The majority of urban population lives in unplanned settlements with limited or no basic services. Unplanned settlements have been increasing to include developments of hazard-prone lands such as steep slopes, flood plains, river valleys, and dump sites.
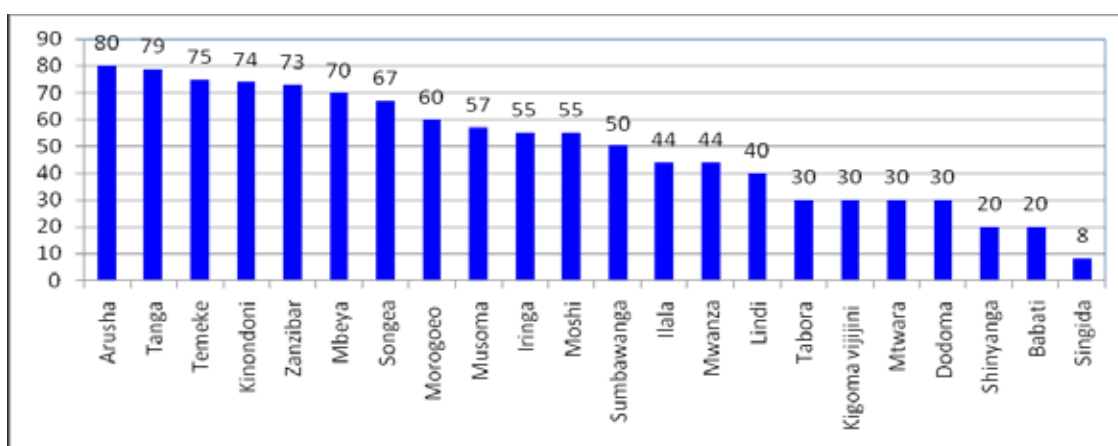
Figure 31: Percentage of Urban Population Living in Unplanned Settlements (URT - NBS, 2018)

The proportion of urban population living in unplanned settlements for selected regions in Tanzania shows Arusha (80.0%) and Tanga (79.0%) regions having the highest proportion of urban population living in unplanned settlements in 2015 (Figure 3-1). Singida (8.0%) and Babati in Manyara region (20.0%) had comparatively lower proportions of population living in unplanned urban settlements.

Rapid urbanization and inadequate capability to cope with the housing needs of people in urban areas have contributed to the growth of unplanned settlements. Living in these settlements often poses significant health risks caused by poor sanitation and drinking water quality which exposes inhabitants to a wide range of pathogens, as houses act as breeding grounds for vectors.

3.1.3   Urbanization Trends

Urbanization trends involve a series of estimates and projections of the urban population for each country, region, and major area over a defined period of time. Projections indicate that by 2018, almost a third of the population in Tanzania is urban. By October, 2018, for example, 32.6% of the population (about 19,244,709 people) in Tanzania was urban. The rest (67.4% of the population) lives in rural areas. This is different from the data reported by 2012 Population Census whereby, equivalent to 73.7% of the total population then lived in rural areas, while 11,378,015 people equivalent to 26.3% lived in urban areas (URT, 2012). Urban annual population growth in Tanzania was reported at 5.3077% in 2016. With this urban population growth rate, Tanzania had the 6th highest rate of urban population growth globally in 2015.

Increasing trend of migration of people from rural to urban areas for socio-economic reasons results into the rapid growth of unplanned settlements. The rapid growth of cities and towns puts an ever increasing pressure on the urban infrastructure (transport, housing, water, and sanitation, energy, etc.). Urban housing is a good example of the pressures that fast population growth will exert on the social and physical infrastructure in towns and cities.
The fact that urban population is projected to grow at twice the rate of total population growth, it means that over half of Tanzania's population will live in urban areas within 25 years (see Figure 3-2).

By 2050, Tanzania's urban population is expected to reach 68.6 million people—which means more than a fivefold increase in a 40-year period. Major urban centers/cities and towns will include Dar es Salaam, Arusha, Mwanza, Mbeya and Morogoro as illustrated in Figure 3-3.
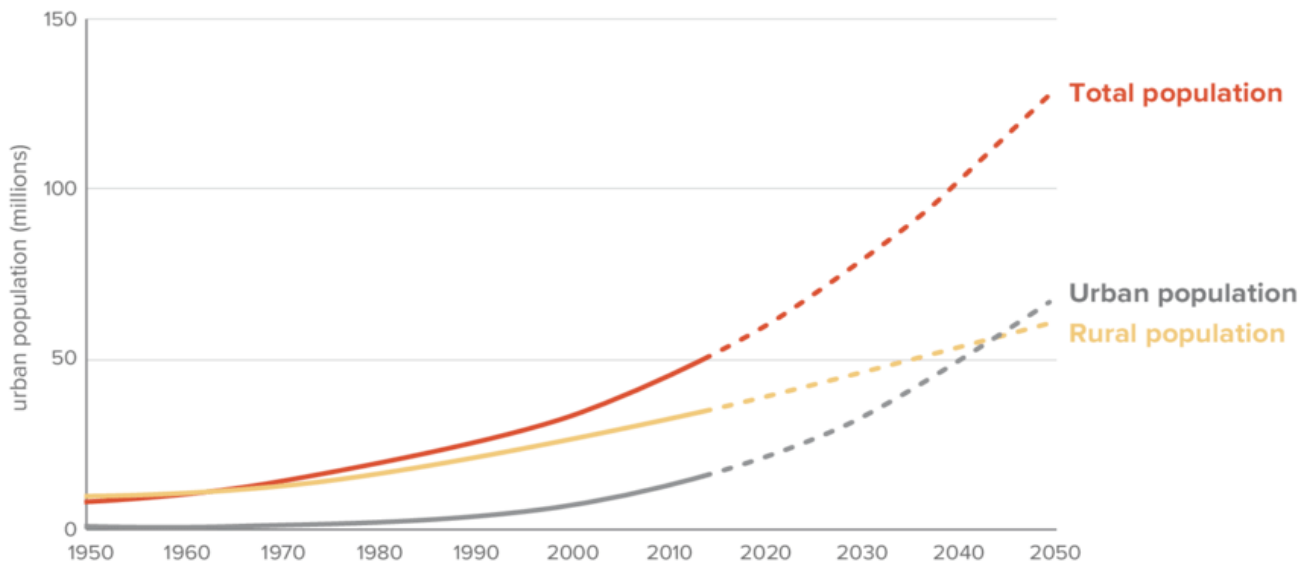
Figure 32: Tanzania's total population, rural population and urban population, 1950-2050

As would have been expected Dar es Salaam is the biggest city of Tanzania and also biggest city in East Africa in terms of population. The city population grew from 4.36 million people in 2012 to 4.5 million people in 2013, 4.78 million people in 2014 and about 5.29 million people in 2016.
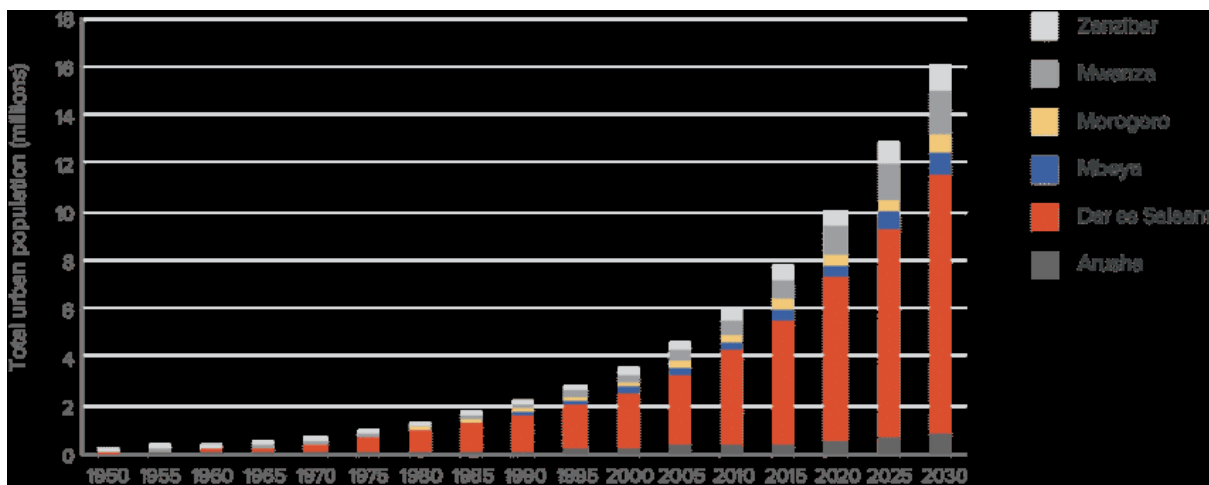
Figure 33: The population of Tanzania's six largest cities, 1950–2050

3.2   Housing and housing Conditions

Housing characteristics as revealed by type of building materials, available facilities and services available in the housing units such as source of energy, water, sanitation and garbage disposal. Earth and sand are the most common flooring materials in Tanzania (57 percent), followed by cement (38 percent). Earth or sand flooring issued in three-quarters of Mainland Tanzania rural households (77 percent), while cement is the most common flooring material in Mainland Tanzania urban households (69 percent).

3.3   Social Services

3.3.1   Water Supply

Currently available data indicate that about 59.7% of the population in Tanzania get drinking water from improved sources (Table 3-1). Nearly 9 out of 10 Mainland Tanzania urban residents obtain their drinking water from improved sources (URT, 2018) Mainland's urban populations that get water piped directly into their dwellings/yards/plot stands at 25.6%, while those who collect their water from piped connections into their neighbours' yards are 23.7%.

Table 31: Percentage distribution of the population using an improved drinking water

Characteristic	Urban	Rural	Total
Population using improved drinking water source	86.4	47	58.6
Piped into dwelling/yard plot	25.6	3	9.6
Piped to neighbor	23.7	3.5	9.4
Public tap/standpipe	11.7	16.5	15.1
Tube well or borehole	5	4.4	4.6
Protected dug well	14.2	15.1	14.8
Protected spring	2.8	3.3	3.1
Rain water	1.2	1.3	1.2
Bottled water, improved source for cooking/washing	2.3	0	0.7

(Source: URT - NBS, 2018)

3.3.2   Waste Management
   i)   Solid Waste Management

In Tanzania, the quantity of municipal solid waste generated countrywide amounts to about 10,000 tonnes/day and the waste generation rate varies from 0.4-1.0 kg/cap/day (URT, 2018). As much as 80–90% of solid waste (SW) generated in urban areas is not collected and most of the domestic waste, which accounts for about 60% of the total SW generated daily, is disposed of by burning or burying. Generation of waste from mining and quarrying sector is of a small amount compared to the other sectors like manufacturing, agriculture and other economic activities (URT - NBS, 2018).

   ii)   Wastewater Management

The proper management of liquid waste has become one of the most pressing and challenging environmental problems in the country. The Urban Water and Sewerage Authorities (UWASAs) are responsible for managing liquid wastes in the urban areas. In rural areas, management of wastewater is left to households and is mainly onsite.

   Onsite sanitation

In Mainland Tanzania, about 19.0 % of population were using improved sanitation facilities by year 2015.16. Toilet facilities are considered improved if they were not shared by two or more households. Improved sanitation facilities are more common in urban areas (41.9 %) than in rural areas (9.5 %). Pit latrines with slabs are the most common improved sanitation

facility in Mainland Tanzania (8.3 %) (URT - TNBS, 2018).

Sewerage System

Available information (URT - TNBS, 2018) indicate that by 2016, only 10 towns/cities in Tanzania had central sewerage systems, which covered only 20% of total urban population. This shows that sewerage services in urban areas need more attention. Figure 3-4 shows the trends in Sewerage Connections in Regional Water, Sewerage System Authorities (WSSAs) and Dar es Salaam, which suggest increasing trend regional WSSA from 2012 to 2015, followed by a decreasing trend between 205 and 2016.
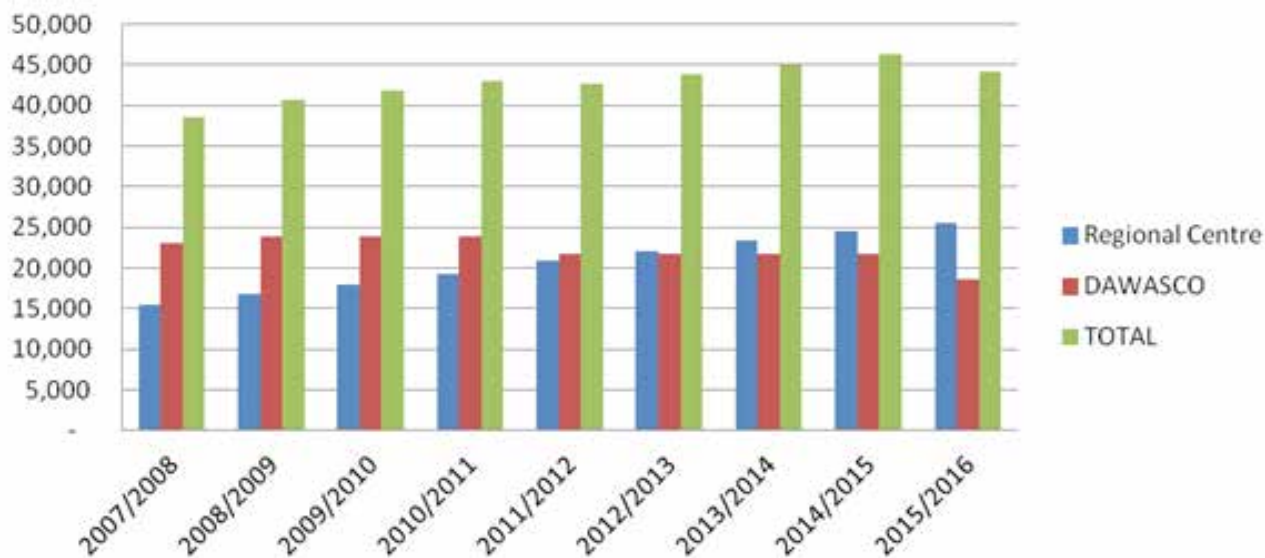
Figure 34: Trends in sewerage connections in Regional WSSAs and Dar es Salaam (Source: URT - NBS, 2018)

3.3.3 Transport Services

Transport and Communication sectors are important in the whole process of socio-economic development and poverty alleviation. Their effectiveness, appropriateness and adequacy contribute to the successful implementation of socio-economic activities. Important infrastructure for the transport sector include roads, railways, air and water transport services, and communication systems.

a) Surface Transport (Road and Railway Transport)

By the year 2015, Mainland Tanzania had a total of 441,773 km of road network (Table 3-2). Out of this network, 8.9 % was paved and 91.1% unpaved. More than a half (61.4%) of the road network was local roads. Trunk roads constituted the least proportion of 13.9 % of the road network.

Table 32: Road network in kilometres by status, 2010-2015

Year	National Roads						Local roads		
	Trunk Roads			Regional Roads			District, Urban and Feeder Roads		
	Pav*	U n - pav*	Total	Pav	Unpav	Total	Pav	Unpav	Total
2010	5,377	6,822	12,199	780	20,490	21,270	842	56,798	57,640
2011	5,377	6,822	12,199	780	20,490	21,270	746	52,603	53,349
2012	6,219	5,987	12,206	1,067	20,990	22,057	1,031	53,348	54,379
2013	6,292	5,912	12,204	1,082	21,047	22,129	966	52,241	53,207
2014	6,565	6,221	12,786	1,240	20,974	22,214	988	51,676	52,664
2015	29,830	31,764	61,594	4,949	103,991	108,940	4,573	266,666	271,239
%	13.9			24.7			61.4		

* Pv-paved; Unpav - unpaved

(Source: NBS, 2018)

It is worth noting that in Tanzania railway transportation is the second important surface transport system in the country. It comprises of Tanzania Railways Limited (TRL) and Tanzania and Zambia Railway Authority (TAZARA). The total length of the two railway systems in Tanzania is 3,700 km of which approximately 2,700 km single track network of 1,000 mm gauge is owned by Rail Asset Holding Company (RAHCO) and operated by Tanzania Railways Limited (TRL) along the Central Corridor between Dar es Salaam and Kigoma with branch lines i.e. to Mwanza and Arusha, and approximately 980 km single-track 1,067 mm gauge operated by Tanzania–Zambia Railways (TAZARA) linking Tanzania and Zambia. It crosses the border at Tunduma, and is connected to the Zambian railway system at Kapiri Mposhi approximately 1,850 km from Dar es Salaam. The newly Standard Gauge Railway line is expected to improve significantly surface transportation in Tanzania and neighbouring countries.

Together, the railways serve 14 of the 25 Regions on the Mainland Tanzania. They also serve neighbouring countries of Zambia, Democratic Republic of Congo, Burundi, Rwanda, Uganda and Malawi. Between the years 2010 and 2016, railway lines in Mainland Tanzania transported about 2.7 million tons of freight out of which 54.5% was transported through TAZARA. It is worth noting that increased railway transport has a good bearing on the environment as it reduces transport carbon related emissions. The freight tonnage transported by both railways was at its peak in 2010 when 805,000 tonnes were transported. This is equivalent to 29.2% of the total tonnage of freight transported in all seven years starting from 2010. The lowest freight tonnage of 160,000 (5.8%) was recorded in 2014. On the other hand, over the reference period a total of 6,854,400 passengers were transported by both railways of which more than half (51.9%) travelled by TAZARA and 48.1% by TRL. The highest number of passengers, 2,147,000 persons (31.3%) was recorded in 2016, while the lowest number of passengers, 457,000 persons (6.7 %) was recorded in 2014 (URT - TNBS, 2018). Details are presented in Table 3-3.

Table 33: Freight and passengers transported by railway, 2010-2016

Type of Transport	2010	2011	2012	2013	2014	2015	2016	Total			
Railways								Freight (000')		Passengers	
TRL								Tons	%	('000')	%
Freight(000 tons)	265	138	154	185	127	282.6	102	1,253.6	45.5	-	-
Passengers (000)	284	227	339	373	170	196.4	1,707	-	-	3,296.4	48.1
TAZARA											
Freight(000 tons)	540	248	259	245	33	81	96	1,502	54.5	-	-
Passengers (000)	758	414	678	654	287	327	440	-	-	3,558.0	51.9
Total- Freight (Both Railways)	805	386	413	430	160	363.6	198	2,755.6	100.0	-	-
Percent (Freight)	29.2	14.0	15.0	15.6	5.8	13.2	7.2	100	-	-	-
Total-Passengers (Both Railways)	1042	641	1017	1027	457	523.4	2,147	-	-	6,854.4	-
Percent (Passengers)	15.2	9.4	14.8	15.0	6.7	7.6	31.3	-	-	-	100.0

(Source: URT - NBS, 2018)

b) Water way Transport

Tanzania has one large international seaport (Dar es Salaam), and two medium sized coastal ports (Tanga, and Mtwara). There are also a number of smaller coastal ports with smaller throughputs, these include Pangani, Kilindoni (Mafia), Kilwa Masoko and Kilwa Kivinje, Rushungi, Lindi and Mikindoni. Tanzania Port Authorities (TPA) is responsible for the ports in Tanzania, thus e.g. to develop and manage the ports. The ports on Lake Victoria, Tanganyika and Nyasa are also important for local and international trade. From 2010 – 2016, a total of 14,587 ships were operating in three ports of Dar es Salaam, Tanga and Mtwara. Among them, 82.0 % were operating in Dar es Salaam port followed by Mtwara (11.9 %) and Tanga ports (6.5 %). The highest number of ships 4,257 (29.2 %) of the total ships in the seven years period was recorded in 2015 while the lowest number of 1,173 ships (8.0%) was recorded in 2013 (URT - NBS, 2018).

From 2010 – 2016, Dar es Salaam port recorded the highest proportion of cargo (92.1%) followed by Tanga port (5.7%) and Mtwara port (2.2%) (Table 3-4). The highest share (20.0%) of all cargo was recorded in 2016, while the lowest was recorded in 2010 at 9.3%. It is also indicated that a total of 5,071,000 passengers used ships for travelling. Almost all the passengers (99.3%) used Dar es Salaam port and there were no passengers travelling through Mtwara port. The highest number of passengers 1,748,000 (34.5%) travelled in 2016 whilst the lowest number of passengers, 228,000 persons (2.2%) were recorded in 2010 (URT - NBS, 2018).

Table 34: Marine Transportation of Cargo and Passengers, 2010-2016

Marine Transport	2010	2011	2012	2013	2014	2015	2016
Dar es Salaam Port							
Ships (Number)	1,274	1,232	1,600	742	1,426	4,028	1,600
Cargo ('000' DWT)	4,954	5,432	10,122	5,547	9,082	9,369	10,814
Passengers (000)	228	312	375	347	1,000	1,023	1,748
Tanga Port							
Ships (Number)	215	201	232	92	64	63	87
Cargo ('000' DWT)	529	508	608	271	536	475	500
Passengers (000)	0	23	13	2	0	0	0
Mtwara Port							
Ships (Number)	58	129	498	339	428	166	113
Cargo ('000' DWT)	107	112	178	144	248	125	379
Passengers (000)	0	0	0	0	0	0	0
Total- Ships	1,547	1,562	2,330	1173	1,918	4,257	1,800
% (Ships)	10.6	10.7	16.0	8.0	13.1	29.2	12.3
Total- Cargo	5,590	6,052	10,908	5,962	9,866	9,969	11,693
Percent (Cargo)	9.3	10.1	18.2	9.9	16.4	16.6	19.5
Total- Passengers	228	335	388	349	1,000	1,023	1,748
% (Passengers)	4.5	6.6	7.7	6.9	19.7	20.2	34.5

(Source: URT - NBS, 2018)

c) Air Transport

The vision of the Tanzania Transport policy is "to have an efficient and cost-effective domestic and international transport service to all segments of the population and sectors of the national economy with maximum safety and minimum environmental degradation" (URT, 2018).

Air transport in Tanzania has received a revived attention of the 5th Government following purchase of various flights to boost the sector through ATC.

There are 368 aerodromes in Tanzania owned, managed and operated by different entities. Tanzania Airport Authorities (TAA) is responsible for 58 airports on mainland Tanzania. Out of the 4 international airports 2 are managed by TAA (Mwl. J. K. Nyerere and Mwanza Airports), one is leased to a private operator since 1998 (Kilimanjaro), and one is operated by The Revolutionary Government of Zanzibar (Zanzibar International Airport). Other types of airports are strategic airports (Arusha, Lake Manyara, Mafia and Ngara), major domestic airports (Mtwara, Dodoma, Kigoma, Tabora, Mbeya, Songwe, Songea, Lindi, Shinyanga, Musoma, Bukoba, Sumbawanga, and Tanga) and other airports.

For the past five years since 2012, number of operations in Airports have increased in terms of number of passenger and Aircraft operations. Numbers of passenger have increased from 2,895,869 in 2012 up to 3,455,246 in 2015. Increase in number of passenger has implications on impact to the environment such as increase in waste generation, noise and air pollution (URT, 2018).

3.4 State of the Economy

3.4.1 Economic Performance

The economic growth in Tanzania was strong and on track in 2018/2019, despite slow private sector credit growth. Real output grew by 7.1 percent in 2017, up from 7.0 percent recorded in each of the preceding three years (Figure 3-5). The main drivers of the growth were construction, transport and storage, and agriculture. Meanwhile, mining and quarrying, water supply, transport and storage, information and communication, and construction sectors grew faster than other sectors. Service activities contributed about 36 percent of nominal GDP.

Given the diversity of the economy, real growth of output is expected to remain strong in 2018 and beyond, reinforced particularly by increased public investment particularly in infrastructure and power supply, and improved capacity utilization at ports. The resurgence of high private sector credit growth observed towards the end of the year is also expected bolster growth, especially in the wake of implementation of various initiatives to improve business environment (URT - BoT, 2018).
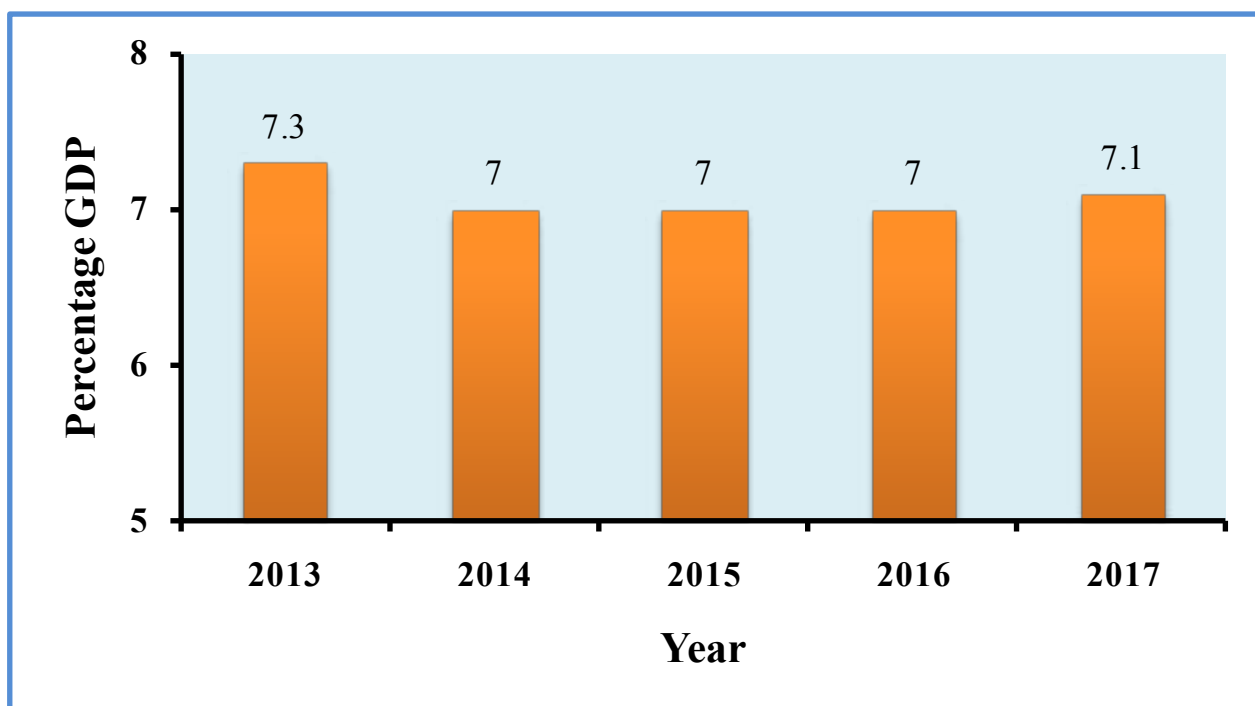
Figure 35: Percentage of real GDP growth, 2013-2017
(URT - BOT, 2018)

3.4.2 Sectoral Contribution to the national Gross Domestic Product (GDP)

Agricultural sector, broadly defined to include crops, livestock, forestry and fisheries, had 30.1 percent shares of GDP in 2017 compared to 29.2 percent in 2016. Manufacturing and construction activities contributed 26.4 percent in 2017 against 24.9 percent in 2016. Service sector (including trade and repairs, transportation and storage, Hotel and accommodation, information and communications, finance and insurance, rental houses, health and education) accounted for 37.5 percent in 2017 falling from 39.2 percent recorded in 2016. The increase in industrial activities is a testimony that concerted government efforts

aimed at building an industrial economy are picking up pace with positive results in improved manufacturing sector production and productivity. Among other things, this achievement is reflective of continuous improvements in provision of infrastructure, particularly in energy and transportation (URT, 2017).

3.4.3 Inflation

Inflation was moderate at single digit throughout 2017/18, averaging 4.8 percent compared with 5.3 percent in the preceding year (URT - BOT, 2018). Moderation in food prices following adequate food supply in most parts of the country, prudent monetary policy, exchange rate steadiness, streamlined fiscal policy, and subdued oil prices in the world market were main drivers for the low and stable inflation. It is expected inflation will remain in single digits in 2018/19, mostly supported by adequate food supply, and prudent monetary and fiscal policies. The seemingly build-up of pressure on global oil prices is expected to be partially offset by the increasing utilization of gas in electricity generation (URT - BOT, 2018).
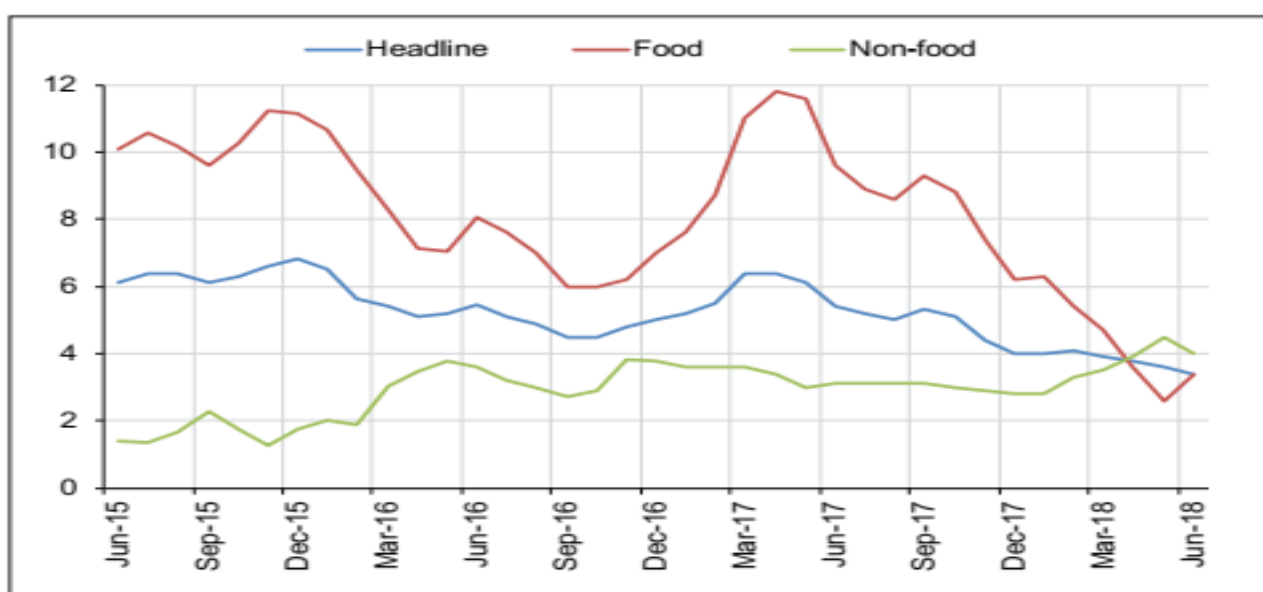
Figure 36: Inflation trends in Tanzania
(URT - BOT, 2018)

3.4.4 Employment

The findings on employment profile reveal an increase in total employment in the formal sector from 2,334,969 employees in 2015 to 2,599,311 employees in 2016; which is an increase of 308,951 employees (URT - TNBS, 2018). The majority of employees are employed in the private sector (1,748,695 private and 850,616 public) (Table 3-5). Proportion of regular employment has increased from 88.2 percent in 2015 to 92.9 percent in 2016, while casual employment has decreased from 11.8 percent in 2015 to 7.1 under the same span of time. Education industry had the largest share of total employment with 18.5 percent followed by manufacturing industry (18.1 percent); and public administration and defense, compulsory social security industry with 13.6 percent of total employment (URT - TNBS, 2018).

It is also indicated that there are more adult employees under regular employment (63.2 percent) compared to youth employees who accounted for 36.8 percent of the total regular employees. With regard to disability status, the results indicate that, there were 3,935 employees (about 0.2 percent of total employment in the formal sector) with various types of

disabilities. The results also show that, Dar es Salaam region had the largest proportion of employment, with 31.2 percent of all employees, followed by Morogoro region (10.9 percent) and Arusha region (6.8 percent) (URT - TNBS, 2018).

Table 35: Distribution of Total Employees by Category

Category of employment	2015				2016			
	Private	Public	Total	%	Private	Public	Total	%
Regular	1,304,653	755,360	2,060,013	88.2	1,568,022	848,010	2,416,032	92.6
Casual	263,512	11,444	274,956	11.8	180,673	2,605	183,279	7.1
Total	1,568,165	766,803	2,334,969	100	1,748,695	850,616	2,599,311	100.0

(Source: URT - NBS, 2018)

3.4.5 Poverty

Apart from the reduction of basic needs poverty, the Government's intention is to ensure that the number of Tanzanians who either cannot certainly afford a single meal per day or live on one meal per day is reduced from the current level of 9.7 percent to 5.7 percent and 4.4 percent by 2020 and 2025 respectively (URT, 2017). Tanzania has recorded improved ratings according to the Human Development Index since the beginning of the new millennium, until a slowdown in 2010. Improved health outcomes have driven this progress, along with robust gains in education and incomes.

Despite the notable progress made, poverty rates in rural areas are still high compared to urban areas. Rural poverty has declined marginally from 39.4 percent in 2007 to 33.3 percent in 2012, meaning that rural poverty though declining, is above the national average of 28.2 percent to imply that, the high rate of economic growth has not benefited the largest segment citizens, particularly in the rural area where most of them depend on farming, livestock keeping and fishing. And this is true because the productivity in and growth of these sectors, the basis for the livelihood and welfare of the rural population have stagnated below average for the entire period. The Government target is to reduce the average rural poverty from the current level of 33.3 percent to 19.7 percent and 15 percent in 2020 and 2025, respectively (URT, 2017).

Notwithstanding this reduction, poverty among Tanzanians remain the challenge, exacerbated by high population growth at a rate of 2.7%. Poverty is overwhelming in rural areas where about 33.3% of people are below poverty line. Majority of people particularly the poor in rural areas drive their livelihood from natural resources including forest, fishing and small scale mining (HBS, 2011/2012). Poverty pose serious ramifications on the environment, evidence shows that, due to inadequate survival options, poor people deplete resources and degrade environment at rates that are incompatible with long-term sustainability. This tendency eventually sets a downward spiral, by further reducing the income and livelihoods of the poor.

CHAPTER FOUR

ENVIRONMENTAL RESOURCES

Tanzania is endowed with various treasures of unique environmental resources. These include: forest/woodlands, water, marine and freshwater bodies, wetlands, wildlife, land, energy sources, natural gas and minerals. Some of these resources are found in protected areas and contribute to the tourism industry in terms of foreign exchange earnings. Tanzania's rich natural resources are also fundamental for the country's growth and economic development. Among important environmental resources found in Tanzania include forest, water, land, coastal marine ecosystems, wildlife, natural gas and minerals.

4.1   Forest

In Tanzania forests are managed by Tanzania Forest Services (TFS), which is a semi-autonomous Government Executive Agency. The 2015 TFS Forest Inventory, established forests and wooded areas coverage in Tanzania to be over 48.1 million hectares of land. Forest ecosystems are important not only for supplying timber and other economically important products, but also for generating indirect benefits such as controlling soil erosion, supporting soil fertility, providing shade, and buffering hydrological cycles. Forests and woodlands are important for many reasons including: i) use as sources of wood for construction and energy, ii) provision of water retention capacities of catchment areas, iii) provision of a high biodiversity as well as forest products including Non-Wood Forests Products (NWP) such as thatch grass and forests and iv) use as sources of food and income in times of scarcity.

The three types of natural forests in Tanzania include: i) miombo woodlands, ii) montane forests and ii) mangroves. These forests are further categorized by type of vegetation cover, usage and legal status, and that with regard to type of vegetation cover, 44.6 million ha or equivalent to 93% of the total forest area in Tanzania is covered by woodlands, followed by Lowland forests (3.4%), Humid Montane forest (2.0%), Plantation Forest (1.2%) and Mangroves (0.3%).

In terms of usage, the productive forest area comprised 60.3% of the total forest area while 39.7% of the forest area accounts for by protected forest areas most of which are catchment areas and natural reserves. Production forest is an area of land covered by forest, reserved or used principally for purpose of sustainable production of timber and other forest produce while protection forest is an area of land covered by forest, reserved or used principally for purpose of protection of watersheds, soil, and the protection of biodiversity. About 23.3% of the forest area is under wildlife-protected areas. Figure 4-1 shows Forest eco-regions of Mainland Tanzania.
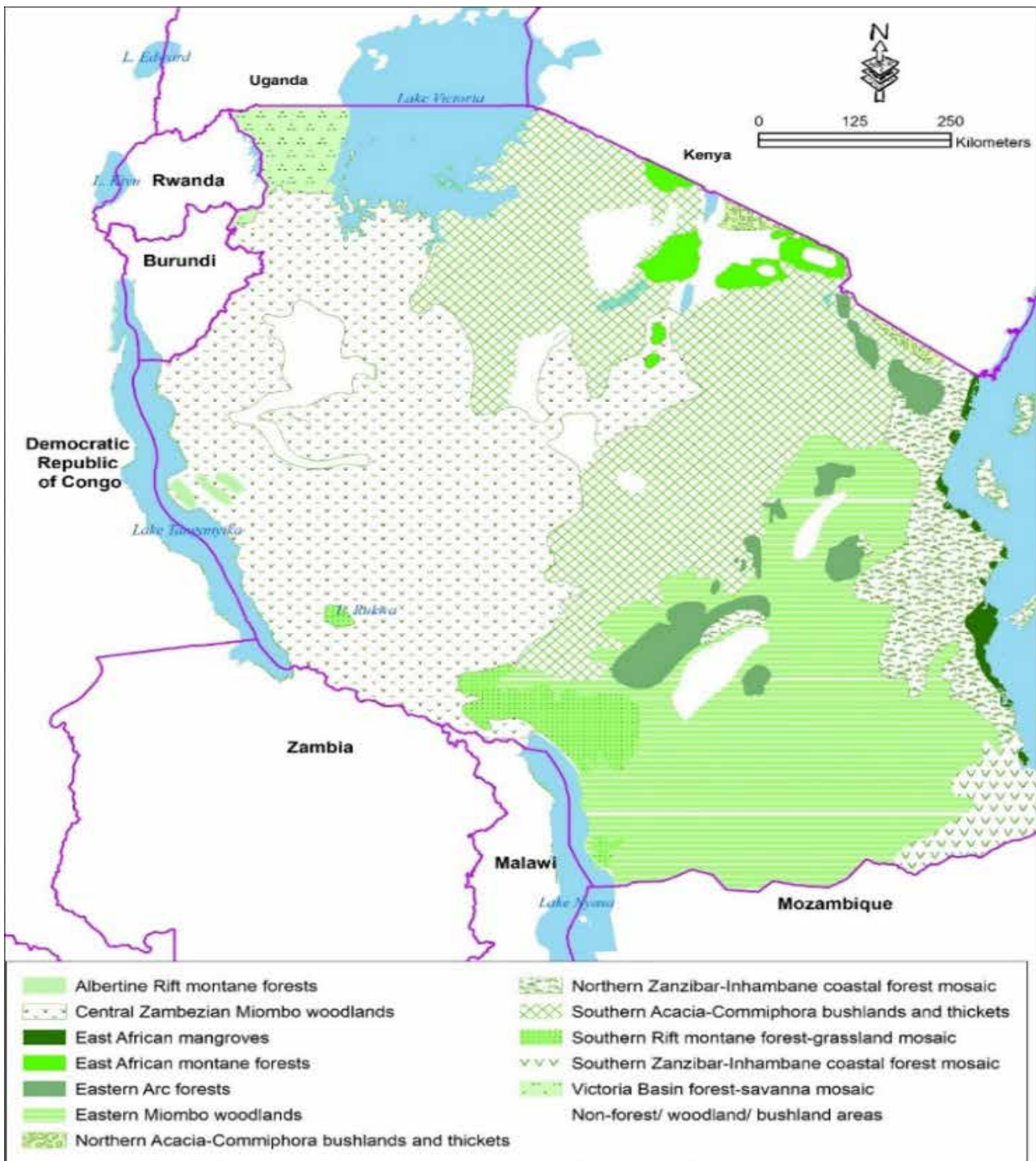
Figure 41: Forest eco-regions of Mainland Tanzania

Forest nature reserves include: Amani Nature Reserve (8,380 ha), Chome nature forest (14283 ha), Nilo Nature reserve (6225 ha), Minziro nature reserve (25,000 ha), Uluguru Forest Nature Reserve (24155 ha), Kilombero Forest Nature Reserve (134, 511 ha), Rungwe Forest Nature Reserve 13652 ha), Magamba Forest Nature Reserve (9283 ha), Mkingu Forest Nature Reserve (23388 ha), Udzugwa scarp Forest Nature Reserve (32763 ha), Rondo plateau Forest Nature Reserve (14,000 ha) and Mount Hanang Forest Nature Reserve (5871 ha). As can be noted, Kilombero is the largest forest nature reserve covering an area of 134,511 ha which is about 43.2% of total area under forest nature reserves. The second largest forest nature reserve is Udzugwa with an area of 32,763 ha, equivalent to 10.5% of the total forest nature reserves area. Mt. Hanang is the smallest, covering an area

of 5,871 ha. Forest area planted with trees is showing an increasing trend, from 189,741.7 ha in 2013 to 206,074.0 ha in 2016 (Table 4-1). It is also observed that, in the same period, there has been a general decrease of forest areas affected by fires from 9,872,485 in 2013 to 8,349,727.7 in 2017.

Table 41: TFS Forest Area (in Ha) Distribution by, 2013-2017

Forests	2013	2014	2015	2016	2017
Total	**48,100,000.0**	**48,100,000.0**	**48,100,000.0**	**48,100,000.0**	**48,100,000.0**
Natural	28,814,258.3	28,811,252.0	28,807,497.0	28,802,853.0	28,797,926.0
Planted	189,741.7	192,748.0	196,503.0	201,147.0	206,074.0
Protected forest	19,096,000.0	19,096,000.0	19,096,000.0	19,096,000.0	19,096,000.0
Forest area affected by fire	9,872,485.0	10,255,576.7	7,884,130.1	9,667,395.5	8,349,727.7

(Source: URT, 2018)

4.2   Water Resources

Water resources which are an important input into Tanzania's economy include rivers, lakes, wetlands, springs, reservoirs and groundwater aquifers. These resources are used in agricultural production through irrigation and processing in agro-industries as well as in industrial production and power generation. Adequate water flows support country's forests, grasslands, and coastal resources, which provide services (such as food, fodder, fuel wood, timber and other products) and other services (climate regulation, cultural and supporting services). Water which flows in national parks and protected areas support the tourism sector which is a key foreign exchange earner for the country.

Other important support services provided by water include fishing in both freshwater and marine environments, and paving way to improve community livelihoods. Freshwater fisheries account for 85% of the total country's fish production whereas the remaining 15% is from the marine waters. Some of the water resources are shared with neighbouring countries. The total area of freshwater cover is 54,337 km^2 which is about 6.1% of the total country's surface area.

4.2.1   Water basins

Tanzania is divided into nine hydrological zones or river basins for purposes of water resources management. These basins are: (i) Pangani; (ii) Wami/Ruvu; (iii) Rufiji; (iv) Ruvuma and Southern Coast, all of which drain into the Indian Ocean; (v) Lake Nyasa; (vi) Lake Rukwa; (vii) Lake Tanganyika; (viii) Lake Victoria; and (ix) the internal drainage basin. The country's hydrological water basins including their coverage/size (km^2) are presented in Map 4.2. As can be noted the most extensive is Rufiji water basin which covers an area of 182,708.1 km^2, followed by Lake Tanganyika (167, 732.23 km^2) and internal drainage basin (143,697.76km^2), respectively. The smallest is Lake Nyasa basin which covers an area of 32,266. 09km^2.
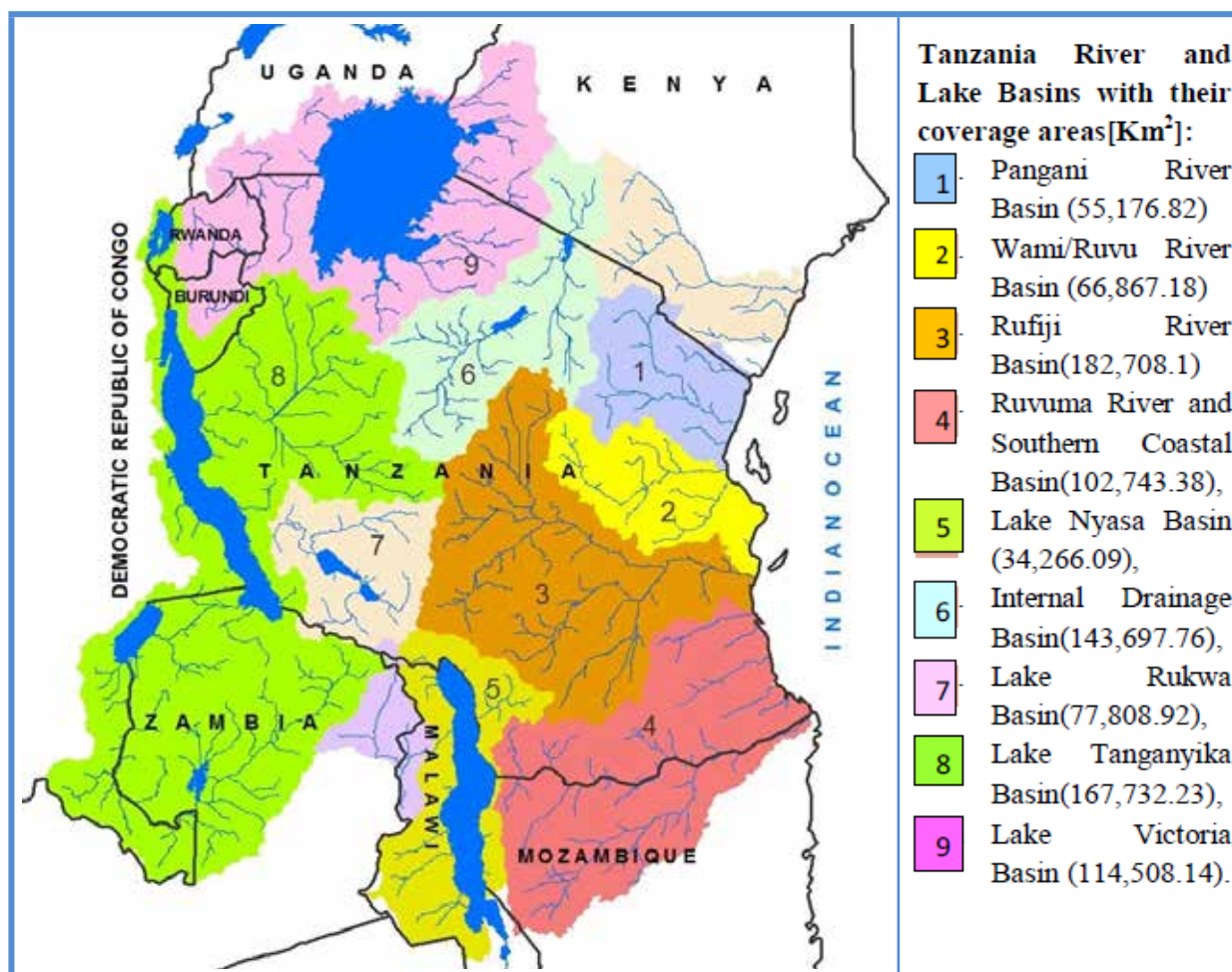
Figure 42: Water Basins and their hydrological boundaries in Tanzania

Available information indicate that, rapid growth of agriculture, industries and urbanization as well as population growth is placing increasing demands on the basin's water resources and thus renewable water resources in Tanzania. High climate variability involving droughts and floods, climate change also intensify the existing challenges on renewable water resources. This is perhaps the reason behind the decreasing trend of per capital water resources in Tanzania from 7,862 m³per person in 1962 to 1,800 m³per person between 1962 and 2015, respectively as shown in Figure 4-1.
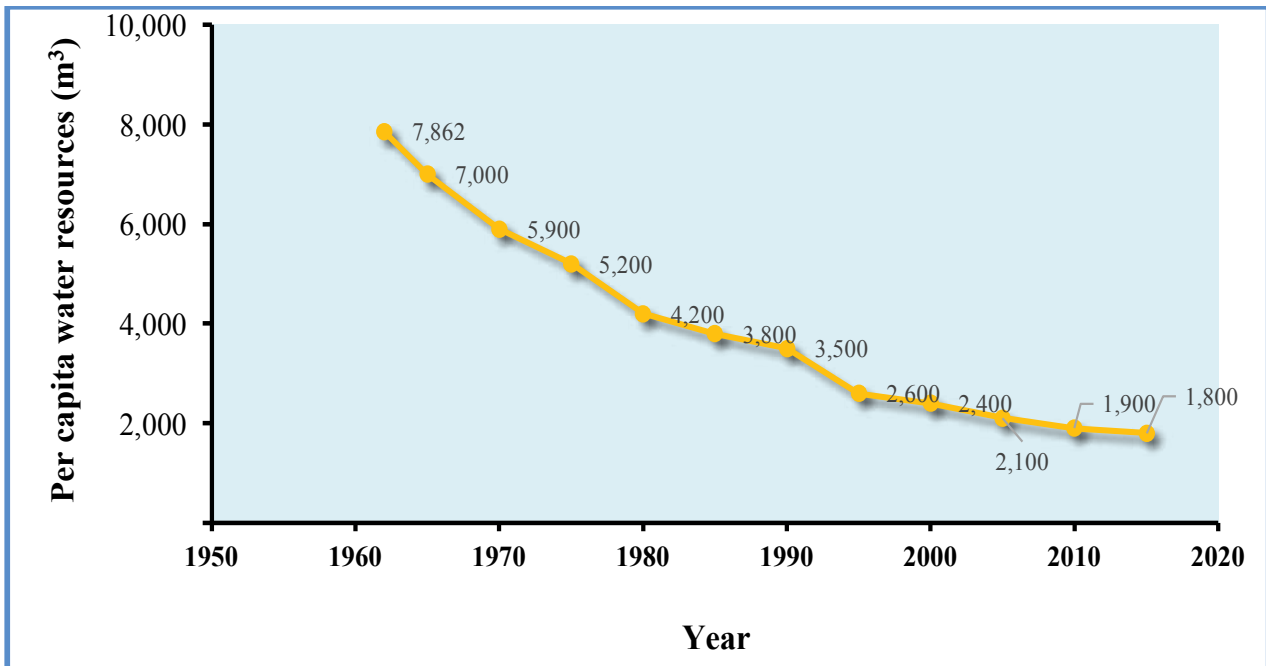
Figure 43: Trends in per capital water resources in Tanzania, 1962-2015

4.2.2 Fresh water systems

Tanzania has relatively abundant fresh water resources, compared to other countries in East and Southern African region. Fresh water systems/resources that exist in Tanzania include lakes, rivers, springs, man-made reservoirs, natural ponds and underground sources. The unique biodiversity of these freshwater systems form the basis for economic survival and livelihoods of riparian communities.

Lakes

About 5.7% of the total land area of the country is covered by three important lakes in Africa, namely; Lake Victoria, Lake Tanganyika and Lake Nyasa. Tanzania shares other lakes and rivers with other countries. These include Lakes Chala and Jipe and Rivers (Kagera, Mara, Ruvuma and Songwe). Table 4-2 shows details of the country's main water bodies. Lake Victoria is the second largest lake in the world, while Lake Tanganyika is the second deepest water reservoir (1,470 m deep) in the world. On the other hand, the most well-known feature of Lake Nyasa is its species-rich assemblage of fishes.

Table 42: The country's main water bodies' distribution

Water body	Total Area (km²)	Tanzania share (area in km²)	% of the Total area in Tanzania
Lake Victoria	68,800	35,088	51
Lake Tanganyika	32,900	13,489	41
Lake Nyasa	30,800	5,760	20
Marine (Territorial sea)	64,000	64,000	100
Exclusive Economic Zone (EEZ)	223,000	223,000	100
Other water bodies (lakes, minor lakes, dams, rivers, ponds and wetlands)	5,000	5,000	100

Rivers

Tanzania is home to many great rivers which run across her vast landscapes. The rivers provide habitats for multiple plant and animal species. Economic activities such as fishing and farming thrive along some of the rivers. The rivers are also used for hydro-power generation. Conservation agencies are involved in the management of these rivers. Map 4.3, indicates some river resources in Tanzania, while Table 4-3 provides details of some selected major rivers in Tanzania including lengths, drainage area, outflow, countries in the drainage basin and the Tanzanian regions in the river drainage basins.

Table 43: Major rivers in Tanzania

River	Length (km)	Drainage area (km²)	Outflow	Countries in the drainage basin	Tanzania Regions in the drainage basin
White Nile River	3,700	1,800,000	Confluence with Nile River	Tanzania, Sudan, DRC, South Sudan, Rwanda, Uganda	Kagera, Mara, Mwanza
Rufiji River	600	177,429	Indian Ocean	Tanzania	Dar es Salaam, Morogoro
Great Ruaha River	475	83,970	Confluence with Rufiji River	Tanzania	Iringa
Kagera River	400	13,000	Lake Victoria	Rwanda, DRC, Burundi, Tanzania	Kagera
Ruvuma River	800	155,500	Indian Ocean	Tanzania, Mozambique	Dar es Salaam
Wami River	490	43,946	Indian Ocean	Tanzania	Pwani, Morogoro
Malagarasi River	475	130,000	Lake Tanganyika	Tanzania, Burundi	Kigoma
Mara River	395	13,504	Lake Victoria	Tanzania, Kenya	Mara
Pangani River	500	43,650	Indian Ocean	Tanzania	Kilimanjaro, Manyara, Tanga

Figure 44: Some major rivers in Tanzania

4.2.3 Coastal and Marine Systems

Tanzania's coastal and marine ecosystems occupy an area of 241,500 km^2 or about 20% of the total land area of the country (URT, 2015). A wide range of important and valued species are found along the coast, including an estimated 150 species of corals in 13 families; 8,000 species of invertebrates; 1,000 species of fish; 5 species of marine turtles, 428 species of seaweeds and 44 species of marine birds (URT, 2014). On the other hand Mangroves forest cover 115,500 ha of Mainland Tanzania and 18,000 ha on Zanzibar (URT, 2015). As for

Marine Protected Areas, Mainland Tanzania has a total territorial sea of 32,000 km^2 of which, the gazetted area as Marine Protected Areas (MPAs) is 2,173 km^2. These areas include three (3) Marine Parks and fifteen (15) Marine Reserves.

4.2.4   Tanzania's Exclusive Economic Zone (EEZ)

An exclusive economic zone (EEZ) is an area which is beyond, and is adjacent to, a given country's territorial seas, and extends no more than 200 nautical miles (370 km) out from a country's own coastlines. The United Republic of Tanzania EEZ covers over 240,000 km^2 and a coastline of about 800 km (Figure 4-4). The EEZs have got economic importance as they do not only set the boundaries, but are also the source of livelihood for many because of their fisheries, natural gas reserves, and tourism. The scientific importance of EEZs includes carrying out of scientific research on varied marine creatures, and the sampling of the seabeds for oil and natural gas purposes. In Tanzania, Ministry of Finance and Planning (2018), reports on the ample opportunities to increase the contribution of the fisheries sub-sector to the national economy and households'food security if underexploited Deep Sea and EEZ fisheries resources is properly exploited.

According to (URT, 2016), the marine fisheries are conducted within territorial waters, which extend up to 12 miles, and in the EEZ. Almost all of the activities takes place in water depths of less than 500 metres and within 40 miles from the coast. The coastline has a length of 1,424 km, with almost all coastal communities engaged in fishing to some extent. Main commercial marine species are sardine, tuna and Tuna-like species, which together forms 30-50% of the total fish landing. Other fish species being landed include:- Emperors/Scavenger (*Changu*), Snappers *(Fuatundu)*, Parrotfish *(Pono)*, Carangidae *(Kolekole)*, Rabbit fish *(Tasi)*, Tuna *(Jodari)*, Kingfish *(Nguru)*, Mackerel *(Vibua)*, Sharks *(Papa)*, Rays *(Taa)*, Lobster *(Kamba kochi)*, shrimps *(Kamba miti)*, Sardines *(Dagaa)*and Octopus *(Pweza)*.
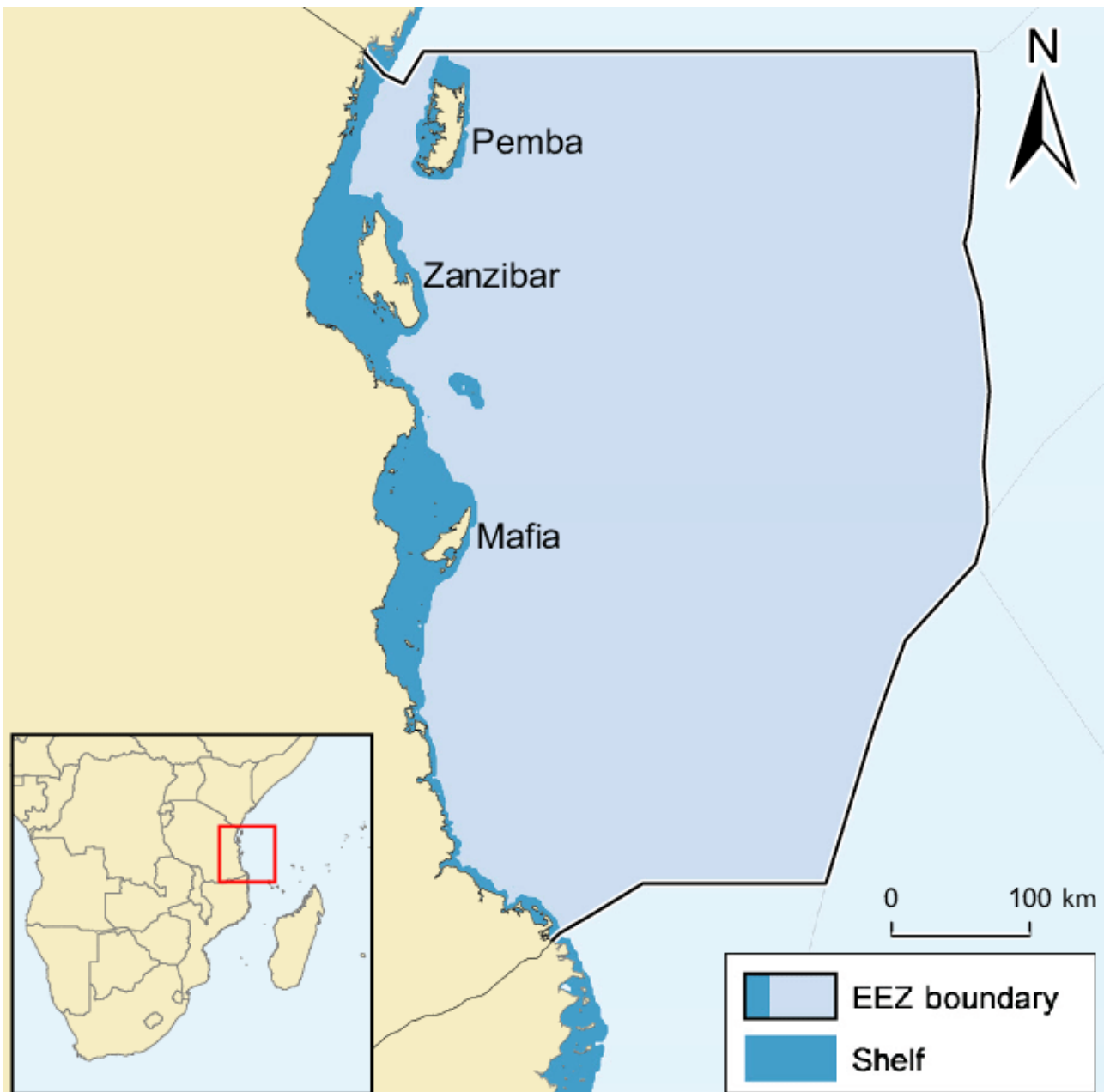
Figure 45: Map of the Tanzanian Exclusive Economic Zone (EEZ)

4.3 Wetlands

There are about 115 different wetlands ecosystems occupying 10% of the total land area of Mainland Tanzania (approximately 88,300 km^2) harbouring over 650 associated species, such as molluscs, crustaceans, echinoderms and fish (URT, 2015). The major wetlands include Kilombero, Malagarasi-Muyovosi, Rufiji-Mafia, Lake Natron and Ihefu. In terms of their distribution, 60% extend over village land while the remaining 40% is located over public land. Map 4.5 illustrating distribution of wetlands in Tanzania.

In Tanzania, millions of poor people depends on wetlands for fishing, agriculture, livestock keeping and collection of a multitude of minor wetland products. The wetlands further provide essential services in the form of purifying water, flood control and ensuring year round flow of water for human consumption, irrigation and hydropower generation. Wetlands finally provide important eco-tourism destinations and contain significant biodiversity values.

4.4   Land

4.4.1   Land use

Tanzania possesses 94,508,700 ha of territorial area, out of which nearly 89 million ha is land and the remaining is covered by water. About 44 million ha are classified as suitable for agricultural production and only 24% of arable land is being utilized. Land under medium and large-scale farming is 1.5 million ha and land under smallholder farmers is about 8.6 million ha. Generally, the urban areas occupy 2% of the total geographical area even as they are now occupied by close to 30% of population.

The percentage shares of total land area for agricultural land constitute 43.7%, forest (37.3%) and other land uses (19%) as presented in Figure 4-2. Agricultural land is further divided into i) arable land which amounts to 14.3% of the total agricultural land and used for cultivation of crops like wheat, maize, and rice that are replanted after each harvest, ii) land for permanent crops which constitute 2.3% of the agricultural land and used for cultivation of crops like citrus, coffee, and rubber that are not replanted after each harvest, and includes land under flowering shrubs, fruit trees, nut trees, and vines, and iii) land for permanent pastures and meadows (27.1%).
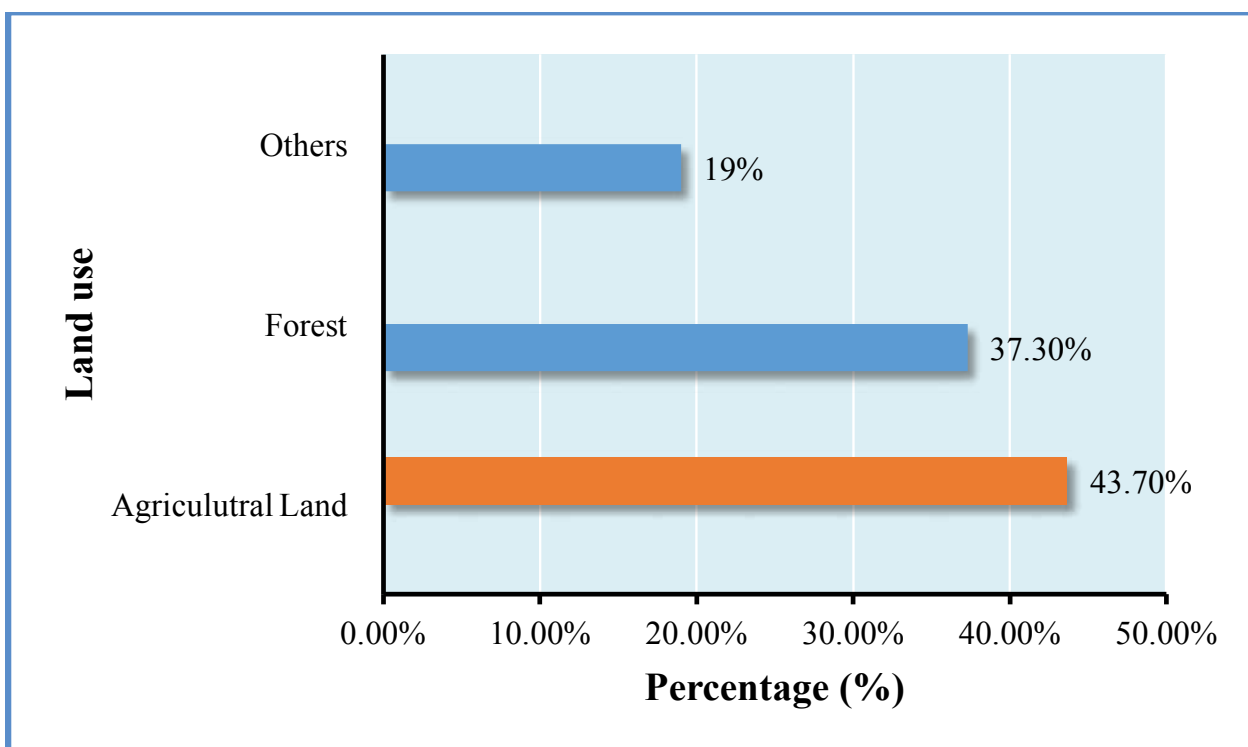
Figure 46: Major land use categories in Tanzania

National Land Use Framework Plan (2013-2033) has classified major land use including i) intensification (settlements, cultivation and grazing), ii) expansion and intensification (settlements, cultivation and grazing), iii) coastal settlements and ecological functions, iv) community ranching v) open land uses and ecological functions vi) water resources use vi) community conservation and conservation as presented in Figure 45.
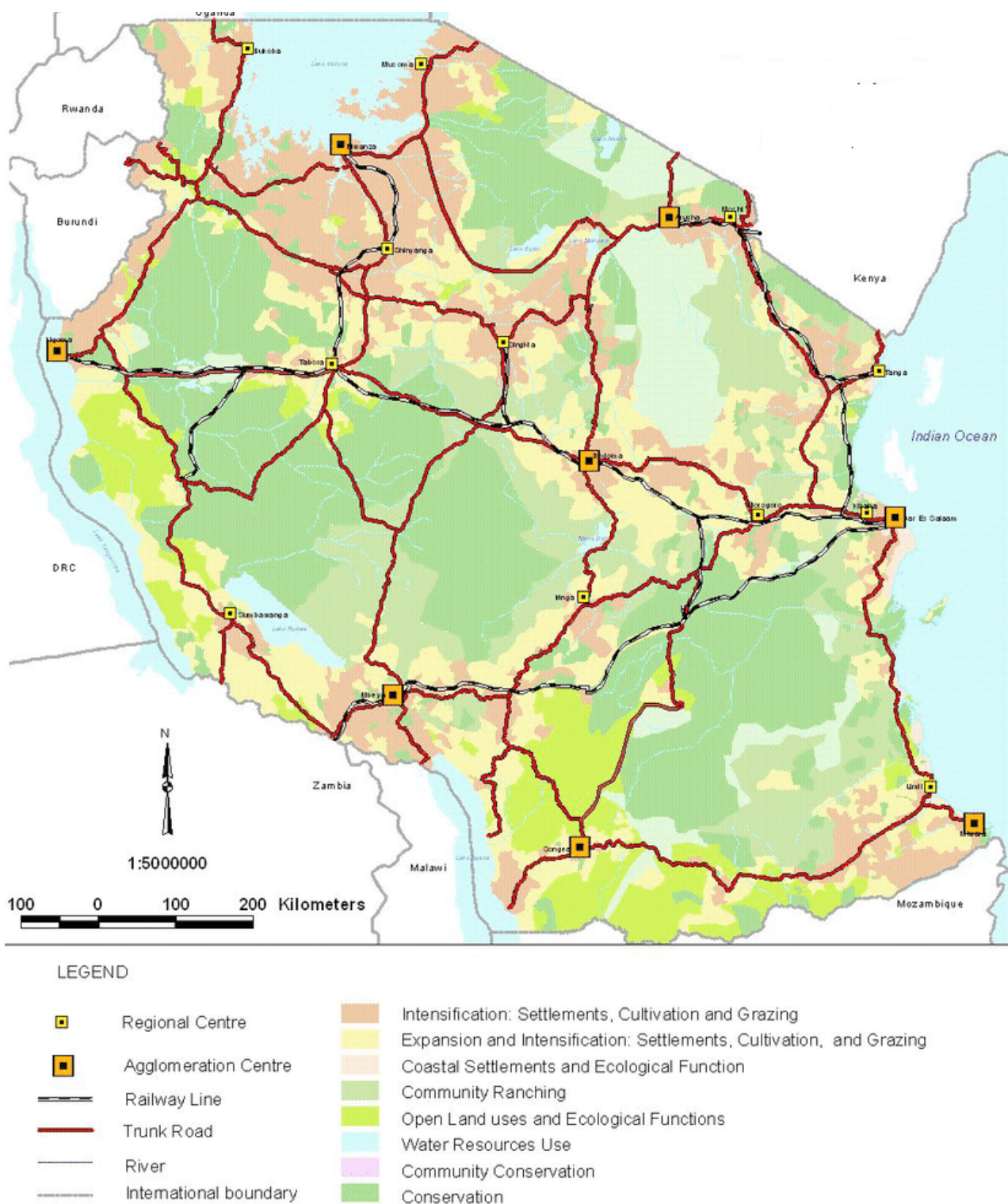
Figure 47: Tanzania's proposed land use plan (2007-2027) (URT, 2017)

4.4.2 Potential area for Irrigation

By the year 2017, Tanzania's total irrigation development potential was around 29.4 million ha, of which 2.3 million ha are classified as high potential; 4.8 million ha as medium potential; and 22.3 million ha as low potential (Table 4-4). Out of this potential area, only 468,338 ha (1.6 %) of the potential irrigation area is under irrigation and contributes about 24 % of the national food requirement. The area under irrigation comprises of 2,418 irrigation schemes

distributed across the country, of which 124 are fully operational (URT, 2018).

Table 44: Potential Irrigation Areas in Tanzania

Item	Quantity
Total potential area for irrigation (million ha)	29.4
High potential area for irrigation (million ha)	2.3
Medium potential area for irrigation (million ha)	4.8
Low potential area for irrigation (million ha)	22.3
Area under irrigation (ha)	468,338
Total number of irrigation schemes as of July 2017	2,418
Improved and Operational irrigation schemes	124

4.5   Wildlife

Tanzania is endowed with unique diverse wildlife attractions which include National parks, Game reserve, Game Controlled Area, Marine Parks and forest and nature reserves. Tanzania has a total of 17 gazzetted national parks which comprise a total area of 61,950 km^2. These include: Arusha National Park, Gombe Stream National Park, Katavi National Park, Kilimanjaro National Park, Kitulo National Park, Lake Manyara National Park, Mahale National Park, Mikumi National Park, Mkomazi National Park, Ruaha National Park, Rubondo Island National Park, Saadani National Park, Saanane Island National Park, Serengeti National Park, Tarangire National Park and Udzungwa Mountains National Park. Ruaha is the largest national park with an area of 20,300 km^2 (35.4 %) of total area of national parks. Serengeti is the second largest national park with an area of 14,763 km^2 which is about 25.7% of the total area of Tanzania's national parks. Saanane is the smallest national park covering an area of 50 km^2. Figure 4-8 indicates location of national parks and major protected areas in Tanzania.
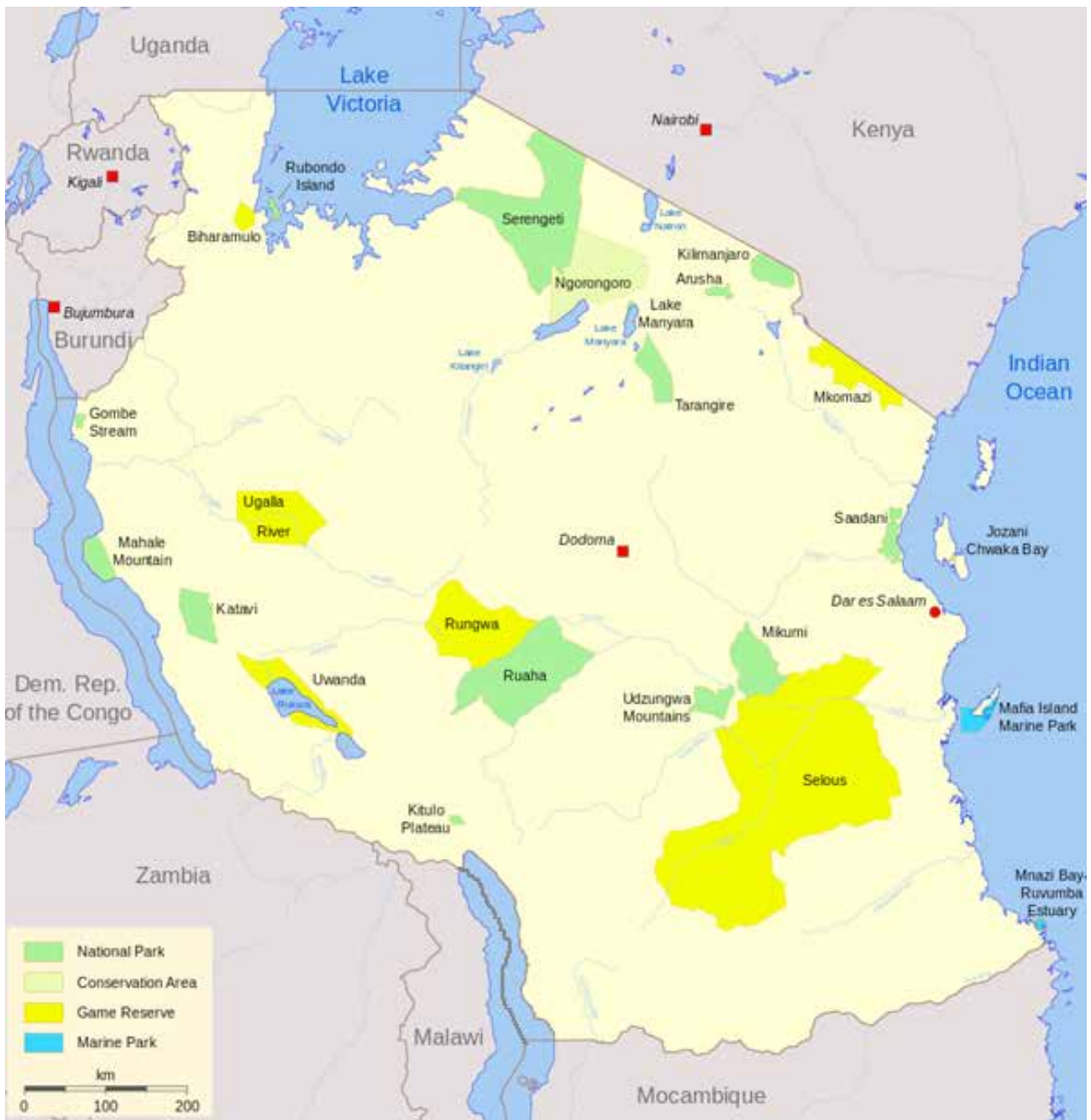
Figure 48: National Parks and major protected areas in Tanzania

Tanzania has a total of 28 game reserves covering an area of 117,755.4 km^2. Game reserves are wildlife protected areas which are declared for the purpose of conservation. Consumptive and non-consumptive wildlife utilization is allowed after obtaining permits. These game reserves are famously known in Africa as areas for variety of activities. Selous is the largest game reserve covering an area of 50,000 km^2 which is about 42.5% of the total area under game reserves. The remaining game reserves individually constitute less than 10% of the total game reserve area. Details of Game reserve and protected areas in Tanzania are presented in Table 4-5

Table 45: Distribution of Game Reserves

S/N	Game Reserve	GN	Area (km²)	Bordering Region	Year Gazzetted
1	Biharamulo	-	1,300.0	Kagera	1959
2	Burigi	-	2,200.0	Kagera	1972
3	Grumeti	214 of 1994	2,000.0	Mara	1993
4	Ibanda	-	200.0	Kagera	1972
5	Ikorongo	214 of 1994	3,000.0	Mara	1993
6	Kigosi	-	7,000.0	Shinyanga/Tabora	1983
7	Kijereshi	215 of 1994	300.0	Mwanza	1994
8	Kimisi	-	1,026.2	Kagera	2005
9	Kizigo	-	4,000.0	Singida	1972
10	Liparamba	-	571.0	Ruvuma	1959
11	Lwafi	-	2,228.0	Rukwa	1993
12	Lukwati	459 of 1997	3,146.0	Rukwa	1997
13	Lukwika-Lumesule	-	444.0	Mtwara	1995
14	Maswa	-	2,200.0	Shinyanga	1969
15	Mkungunero	-	700.0	Dodoma/Manyara	1996
16	Moyowosi	-	6,000.0	Kigoma	1981
17	Mpanga-Kipengele	-	1,574.3	Iringa	2003
18	Msanjesi	-	210.0	Mtwara	1995
19	Muhesi	217 of 1994	2,000.0	Singida	1994
20	Pande	216 of 1994	12.0	Dar Es Salaam	1994
21	Rukwa	-	4,000.0	Rukwa	1995
22	Rumanyika	-	800.0	Kagera	1965
23	Rungwa	-	9,000.0	Singida/Tabora/Mbeya	1951
24	Selous	-	50,000.0	Pwani/Morogoro/Lindi/ Ruvuma	1920
25	Swagaswaga	-	871.0	Dodoma	1996
26	Ugalla	-	5,000.0	Tabora	1965
27	Uwanda	-	5,000.0	Rukwa	1959
28	Piti	-	2,972.9	-	2012
TOTAL			117,755.4		

(Source: URT, 2018)

4.6   Natural gas

Tanzania counts on four tectonic groups of natural gas basins (coastal, Karoo rift, the East African valley and cratonic sag basins) of which, so far, only two have become productive. These corresponds to the fields at Songo Songo Island in Lindi and those of Mnazi Bay in Mtwara. As of 2016, the confirmed quantity of discovered gas was 57.25 Trillion Standard

Cubic Feet (TSCF), which was an increase of 4% compared to the previous year.

The amount of gas extracted in both basins, according to (URT, 2016), rose to 48.6 Bcf/year, and is growing following the gas to power demand of the generators and some key industrial demands in Dar es Salaam city. So far the production capacity with some 20 productive wells in both sites goes well beyond 200 mmscfd (which means over 75 Bcf/year) providing enough capacity to supply the increasing demand expected for the short and mid-term scenarios. The trend reveals an increase in natural gas production, from 36,905.15 MCFT in 2012 to 51,041.21 MCFT in 2017, which is equivalent to an increase of 38.3%. Songosongo field has been the major contributor in natural gas production from 2012 to 2017 with more than 55% of annual production.

At present, natural gas is being used in several power plants (TANESCO and Songas) and to about 30 industries that are using gas as replacement fuel of other refined products. The TPDC system is serving a cement factory and a ceramic factory installed near the path of the main line (Mtwara–Dar es Salam pipeline). There is also a small amount of around 70 household end users that are linked to the network and using natural gas for cooking and hot water heating.

4.7   Minerals

Tanzania is endowed with vast quantities and types of minerals whose extraction has been central to the country's economic growth, GDP growth and employment opportunities. The country has various mineral resources found on the surface of the earth and in the subsoil. These include metallic minerals such as gold (4th largest gold producer in Africa), iron, silver, copper, platinum, nickel and tin; gemstones such as diamonds, Tanzanite, ruby, garnet, emerald, alexandrite and sapphire; industrial minerals such as kaolin, phosphate, lime, gypsum, diatomite, bentonite, vermiculite, salt and beach sand; building materials such as stone aggregates and sand; and energy minerals such as coal and uranium (URT, 2018). The minerals are distributed in different localities depending on geomorphological features and type of rocks (Figure 4-9).

The mineral sector contributed 4.8% of GDP in 2016 and about 50% of the country's foreign exchange earnings from exports apart from traditional exports. The mining industry experienced an estimated 8.5% growth in 2017 to stand at an estimated valued of USD 960m, compared to year 2006 growth of 3.09% and a value of USD 880m.

Table 4-6 shows the cumulative reserves of different minerals available in Tanzania since the commencement of mining activities until 2015. Details of mineral production and export are discussed in the subsequent sections.
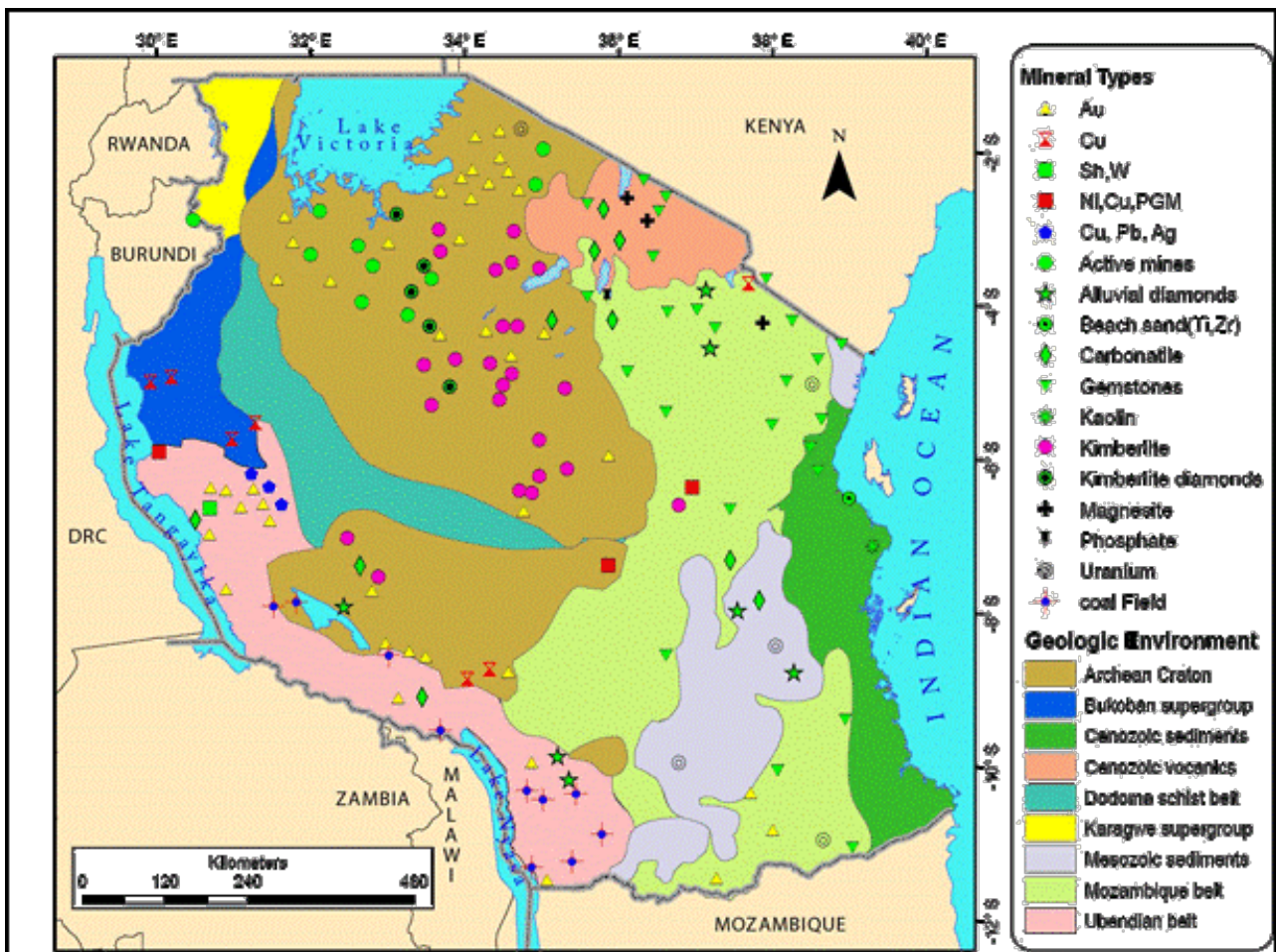
Figure 49: Minerals distribution in different localities depending on geomorphological features and type of rocks in Tanzania

Table 46: Tanzania Mineral Reserves for Selected Minerals, 2015

Type of Mineral/ Indicator	Unit of Measurement	Reserve Quantity
Gold	million troy ounces	28.57
Tanzanite	million carats	109
Tsavorite	million carats	1.4
Diamonds	million carats	33.1
Nickel	million tonnes	107
Cobalt	tonnes	9,240
Uranium	million pounds	156.12
Coal	million tonnes	588.4
Iron Ore	million tonnes	219
Titanium	tonnes	175,000
Vanadium	tonnes	5,000

(Source: URT, 2018)

The analysis of the 2013-2016 mineral production data shows that Gold production increased by 1.5%, Diamond (6.8%), coal (22.1%), Silver (11.8%) and Copper (6.2%). Average sand

production from 2013 to 2016 shows an increase of 18.5% as further detailed in Table 4-16.

4.8   Energy

The Tanzania national energy balance is dominated by biomass which accounts for 85%. Other sources include petroleum (9%), electricity (5%) and renewable energies (1%). In energy statistics, two types of energy production namely; primary and secondary energy are distinguished. Primary energy products are extracted or captured directly from natural resources such as crude oil, coal and natural gas. Secondary energy products are produced by transforming primary energy products.

4.8.1   Energy production and consumption

According to the Ministry of Energy, the total share of Biomass in Primary Energy Supply is expected to decrease by 49% by 2040 due to increase of modern energy supply and services.

Energy consumption pattern in Tanzania indicates the highest energy consumer to be the residential/domestic uses (73%), followed by industry (14%) and transport (6%) as indicated in Figure 4-3.
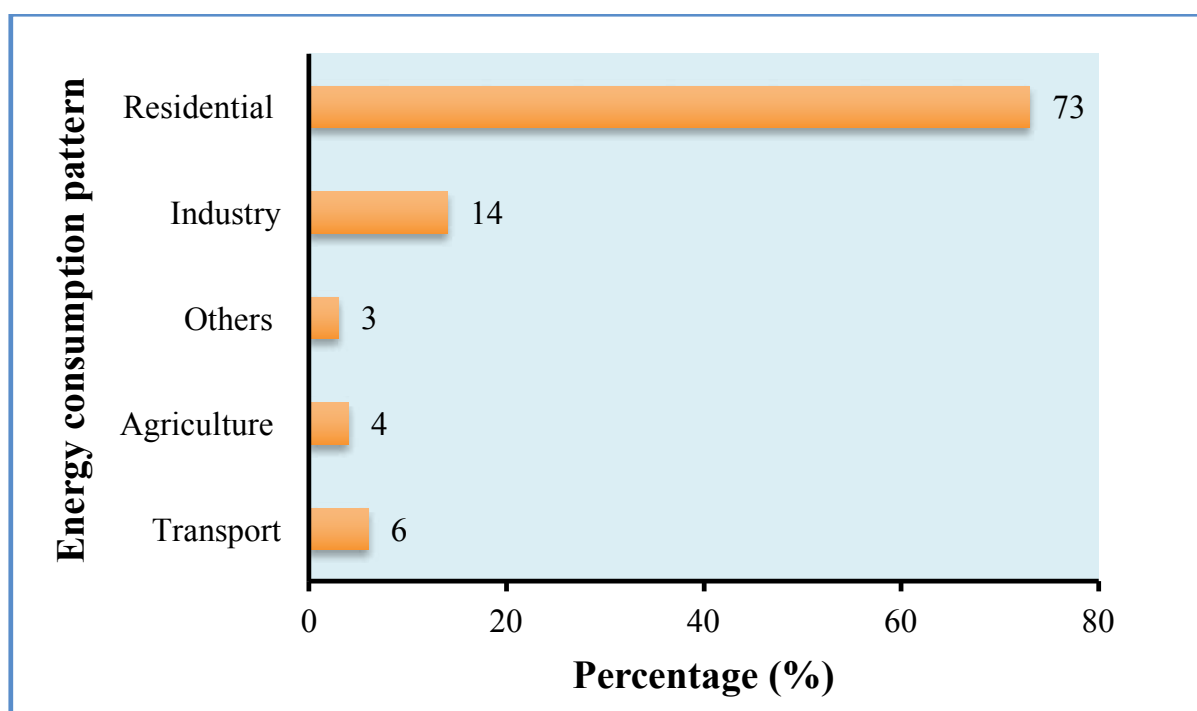
Figure 50: Energy consumption pattern in Tanzania

4.8.2   Electricity Generation

Electricity generation from 2011-2017 was largely dominated by natural gas, which accounted for 21,817.4 GWh (51.3 %), followed by hydro power with 14,972.9 GWh (35.2%). Diesel/HFO/GO accounted for 5,649.4 GWh (13.3 %) and Biomass 116.9 GWh (0.3 %). It is also revealed that, electricity generation increased from 5,057.6 GWh in 2011 to 7,006.6 GWh in 2017. Table 4-7 shows statistics on electricity generation by type of fuel and consumption by different groups.

Table 47: Electricity Generation (GWh) by Type of Fuel, 2011-2017

Fuel Source	2011	2012	2013	2014	2015	2016	2017	Total
Gas	2,265.0	2,664.0	2,872.2	2,624.0	2,873.8	4,196.4	4,322.0	21,817.4
Hydro	1,992.6	1,769.9	1,721.3	2,613.5	2,124.4	2,382.1	2,369.1	14,972.9
Diesel/HFO/GO	781.1	1,083.5	1,133.2	784.9	1,183.2	389.1	294.4	5,649.4
Biomass	19.0	20.4	6.2	6.6	14.5	29.1	21.1	116.9
Total	**5,057.6**	**5,537.8**	**5,732.8**	**6,029.0**	**6,195.9**	**6,996.7**	**7,006.6**	**42,556.5**

4.8.3 Electricity Consumption in Tanzania

By June 2017, the average electricity consumption per capita in Tanzania was 138 kWh/year. This is very small compared to 2,500 kWh/year global average and 550 kWh/year for Sub-Saharan Africa. The average growth rate for electricity demand in Tanzania ranges between 10% and 15% per annum. Electricity consumption statistics show that the largest user group in 2017 was general use (T1) which accounted for 36.7% of total electricity consumption. This is followed by high Voltage use (T3) which accounted for 35.8%. The lowest electricity consumption group was domestic use (D1) which accounted for 3.6% of total consumption in the year. Table 4-8 shows Electricity consumption in GWh for the period of 2011-2017.

Table 48: Electricity Consumption (GWh), 2011-2017

User	2011	2012	2013	2014	2015	2016	2017	Total
Domestic Use (D1)	331.2	320.8	279.8	217.3	229.8	324.5	324.7	2,028.1
General Use (T1)	1,283.5	1,510.2	1,737.6	1,921.9	2,012.7	2,080.9	2,348.1	12,894.9
Low Voltage Supply (T2)	517.7	549.4	562.9	580.7	580.9	598.6	622.4	4,012.6
High Voltage Supply (T3)	1,433.6	1,581.8	1,663.5	1,832.4	1,918.1	1,991.7	2,164.0	12,585.1
Zanzibar (T5)	278.3	298.6	352.9	348.5	344.6	360.8	383.2	2,366.9
Kahama Gold Mine (T8)	156.2	168.7	168.5	181.3	198.8	195.3	185.3	1,254.1
TOTAL	**4,000.4**	**4,429.5**	**4,765.2**	**5,082.1**	**5,284.8**	**5,551.7**	**6,027.7**	**35,141.4**

4.8.4 Renewable energy

Tanzania has various renewable energy sources. These include biomass, solar, hydropower, geothermal, biogas, wind, tidal, and waves. These sources are important for decentralized renewable energy technologies, which nurture the isolated nature of the settlements and are environmental friendly. They are important to users in local households in the rural areas, where most people depend on the use of charcoal, firewood, and cow dung as their major sources of energy. According ADBG, (2015), currently, the country's total generation capacity from renewable energy (excluding large hydro) is about 4.9%; this includes captive generation in sugar, tannin and sisal factories, solar and small hydro plants.

a) *Hydropower*

Hydropower dominated the power industry of Tanzania, before being taken over by the natural gas recently. Currently, hydropower constitutes over 45% of the total power generated in Tanzania. Hydropower in Tanzania has an installed capacity of 561 MW, which

is approximately one-third of total installed power capacity. Apart from the existing 561 MW, Tanzania is expected to generate additional 2,612 MW of hydropower including 2,100 MW that will be generated from the Rufiji hydropower plant.

Table 49:Hydropower plants in Tanzania

S/N	Power station	Installed capacity (MW)	System	Region in Tanzania
A.	**Existing**			
1	Kidatu	204	Great Ruaha River	Morogoro
2	Kihansi	180	Kihansi River	Morogoro
3	Mtera	80	Great Ruaha River	Dodoma
4	New Pangani Falls	68	River Pangani	Tanga
5	Hale	21	River Pangani	Tanga
6	Nyumba ya Mungu	8	River Pangani	Kilimanjaro
	Sub-Total	**561**		
B.	**Expected**			
1	Rufiji	2,100	Rufiji River	Morogoro
2	Kikonge	300	Ruhuhu River	Ruvuma
3	Songwe	180	Songwe River	Songwe
4	Rumakali	222	Rumakali River	Iringa
5	Small hydropower	<10	Various rivers	Various regions
	Sub Total	**2,612**		
	GRAND TOTAL	**3,173**		

b) Wind Energy

Tanzania has areas of high wind potential that cover more than 10% of her land with annual average wind speeds of 5–8 m/s which exist along a coastline of about 800 km with predominant surface winds, moving from south-east to northeast. Small-scale off-grid wind turbines along the coastline and in the islands also possess great potential in Tanzania. The country's wind energy production potential stands at 500 megawatts although there is currently not much to show as its contribution to the national power grid.

Areassuch as Makambako (Njombe) and Kititimo (Singida) have sufficient wind speed for grid-scale electricity generation, with average of wind speeds 8.9 m/s and 9.9 m/s at the height of 30 m, respectively. These areas receives 2,800–3,500 hours of sunshine per year which implies good solar energy potential from rooftop solar or large solar farms. Other areas under assessment in Mkumbara (Tanga region), Karatu (Manyara region), Gomvu (Dar es Salaam region), Timbe (Mtwara region), Makambako (Iringa region), Mgagao (Kilimanjaro region), Kititimo (Singida region), and Usevya (Katavi region).

c) Solar Energy

Tanzania has high levels of solar energy, ranging between 2,800-3,500 hours of sunshine per year, and a global horizontal radiation of 4–7 kWh per m² per day, suggesting that solar can be a major source of energy in Tanzania. Figure 4-8 shows annual solar radiation in

Tanzania. Solar energy is used as a source of power by 24.7% of the households with access to electricity in the country (Bishoge, Zhang, & Mush, 2018), On the other hand, solar energy is used mostly in rural areas with about 64.8% compared to urban areas with only 3.4%. The regions of Lindi, Njombe, Mtwara, Katavi, and Ruvuma lead in the use of solar power electricity in Tanzania. The main uses include heating and drying and photovoltaic for lighting, water pumps, refrigeration purposes, and telecommunication. About 6 MWp (megawatt peak) of solar PV electricity has been installed countrywide for various applications in schools, hospitals, health centres, police posts, small telecommunications enterprises and households, as well as for street lighting. More than half of this capacity is utilised by households in peri-urban and rural areas.
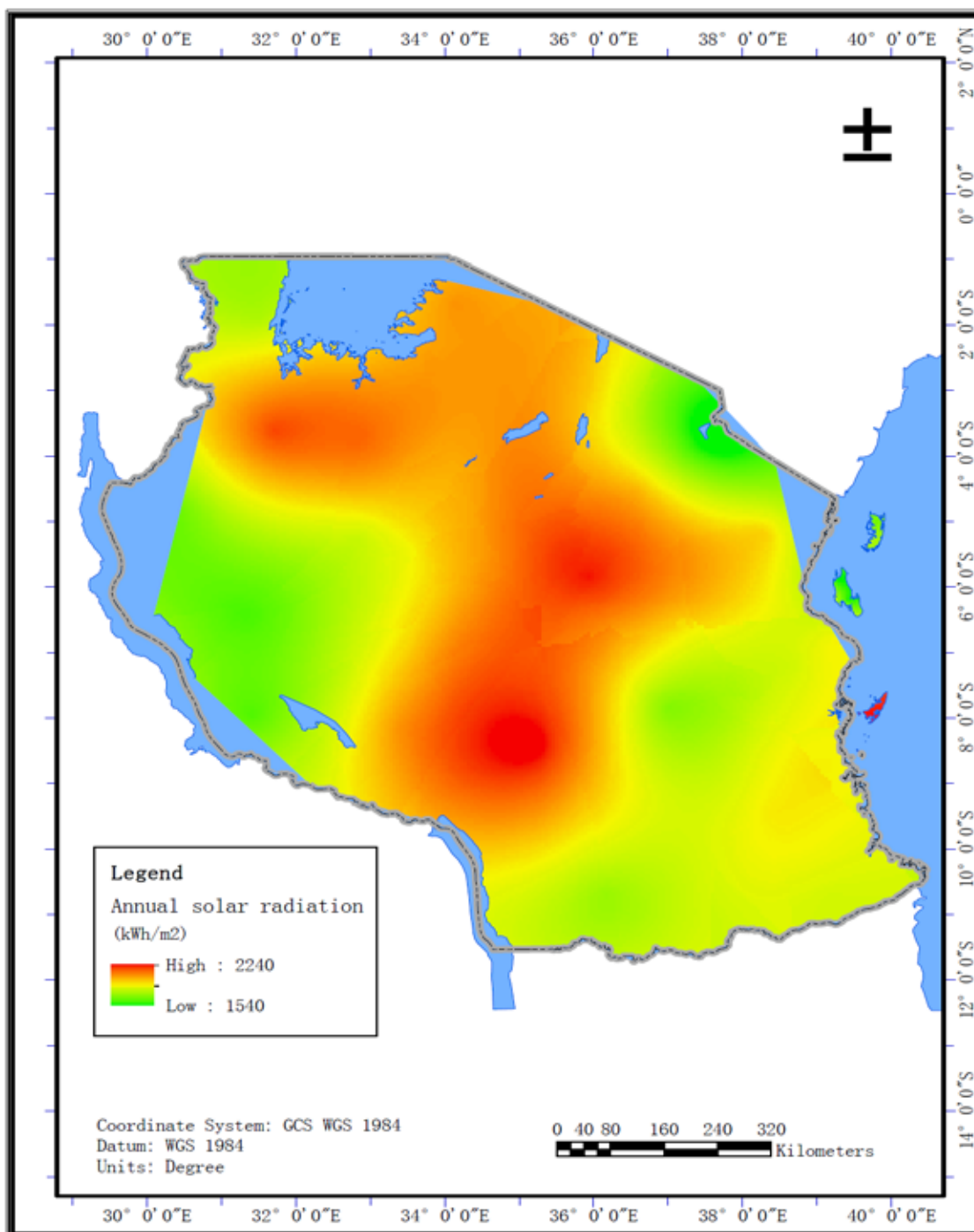
Figure 51: Annual solar radiation in Tanzania (URT, 2019)

d) Biomass energy

Wood energy demand accounts for approximately 90% of Tanzania's overall energy supply and demand. Almost 90% of that demand comes from the household sector, with the remainder coming from household enterprises (often referred to as cottage industries), commercial, institutional and some industrial demand. Charcoal demand has nearly doubled over the past ten years driven by rapid urbanisation and high relative prices or scarcity of energy substitutes, particularly kerosene, electricity, biogas, biomass briquettes and LPG (BEST, 2014). Dar es Salaam city and other urban centers remain the largest charcoal consumers. A lot of biomass is from forests that are harvested traditionally and unsustainably due to factors such as weak law enforcement, low awareness, and high poverty levels.More than 1 million people engage in charcoal production and supply.

Additional to forestry biomass, Tanzania has abundant resources of other biomass that can potentially play a role in substituting for forestry biomass. Most of these resources fall into the categories of residues or wastes. They include agricultural crop residues, such as coffee husks, rice husks, coconut husks, and sisal, cashewnut, cotton, wheat and other crop residues that result from agro-processing; animal wastes are another source of biomass energy. Forestry wastes including sawdust, shavings, thinnings and other residues that come from harvesting, cutting and processing forest resources primarily for timber, pulp and paper, are potentially extensive alternative biomass resources.

Biomass is presently also used for grid generation (around 18 MW) and by the agro-industry to generate its own electricity (about 58 MW estimated). Currently, the installed capacity of sugar industries for power generation through co-generation from the bagasse is about 40 MW as shown in Table 4-10.

Table 50: Sugar industries, their bagasse, and their installed capacity

S/N	Name of the Factory	Available Bagasse (tonnes/day)	Installed Capacity (MW)
1	Kilombero	13,729	10.6
2	Kagera	3000	5
3	TPC	2674	20
4	Mtibwa	2511	4
6	Total	21,914	39.6

e) Geothermal

Tanzania has significant geothermal potential exceeding 650 MW, with most prospects located in the East African Rift System. Geothermal prospects are grouped into main three zones, namely, the northeaster zone with regions of Mara, Kilimanjaro, and Arusha; the south-western zone with regions of Rukwa and Mbeya; and the eastern coastal belt zone in Rufiji Basin. The government under Tanzania Geothermal Development Company has completed four detailed surface studies on developing areas such as Ngozi and Kiejo-Mbaka in Mbeya region, Songwe in Songwe region, and Luhoi in Coast region. According to PSMP, (2016), the challenges in developing geothermal resource are high upfront investment costs; long lead time from conception to production of electricity; capital intensive and high exploration cost and risk, inadequate capital resource to undertake necessary studies; remote location and limited infrastructures. Therefore, geothermal power plant included in the generation

expansion plan is limited to the projects which have high possibility of development potential.

4.9   Challenges related to management of environmental resources

In spite of the various efforts directed towards protection and conservation of environmental recourse in Tanzania, six major environment challengeshave been identified in the National Environment Policy (1997). These challenges include: Land degradation; Lack of accessible good quality water for rural and urban inhabitants; Loss of wildlife habitats and biodiversity; Deterioration of aquatic systems; Deforestation; and Environmental pollution. In addition, demography, excessive withdrawals, land use changes, invasive alien species and climate change that result in loss of perennial flows, eutrophication, sedimentation, and algal blooms are among the major drivers of deterioration of environmental resources in Tanzania.

On the other hand, reasons for environmental deterioration include; inadequate land and water management at various managerial levels; inadequate financial and human resources; inequitable terms of international trade; the particular vulnerable nature of some local environments; rapid growth of rural and urban population and inadequate institutional coordination. Other factors were: inadequate monitoring and information systems; inadequate capacity to implement programmes; inadequate involvement of major stakeholders such as Local communities, NGOs, and the private sector in addressing environmental problems; as well as inadequate integration of conservation measures in the planning of development programmes.

CHAPTER FIVE

POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This Chapter describes national policies, legislation, strategies, plans and programs and how they address or relate to environmental issues in the Tanzania. It further describes institutional framework for environmental management and Multilateral Environmental Agreements (MEAs) as well as other international and Regional Policies and Agreements.

Environmental management in Tanzania is guided by National Environmental Policy (1997), Environmental Management Act (2004), complemented by relevant sectoral policies and legal instruments as well as Multilateral Environmental Agreements.

5.1   Policies

The National Environmental Policy (1997) provides the framework for making fundamental changes that are needed to mainstream environmental considerations into decision making in Tanzania. The policy provides guidelines for determining priority actions, and provides for monitoring and regular review of policies, plans and programs. It further provides for sectoral and cross-sectoral policy analysis in order to bring synergy and harmony among sectors and interest groups. A summary of other relevant policies is presented in **Table 5-1**.

Table 51: Summary of national policies and their relevance to environmental management in Tanzania

Policy	Objectives
i) National Environmental Policy, 1997	The Policy provides the framework for making fundamental changes that are needed to mainstream environmental considerations into decision making in Tanzania.
ii) National Fisheries Policy, 2015	The aim of this Policy is to support the livelihood of fisher-folks and aqua-farmers through increased incomes and self sufficiency in food of fish origin. The Policy also stresses on conservation and management of fisheries resources.
iii) National Agriculture Policy, 2013	The Policy aims to develop an efficient, competitive and profitable agricultural industry that contributes to the improvement of the livelihoods of Tanzanians and attainment of broad based economic growth and poverty alleviation. With regard to environmental management, the Policy aims at promoting agricultural practices that sustain the environment.
iv) National Livestock Policy, 2006	The policy objective on the environment is to ensure the environment is conserved for sustainable livestock production. The policy highlights on sustainable livestock farming and its related activities that require proper utilization and management of the environment.
v) National Irrigation Policy, 2010	The objectives of the Policy on environment include promotion of efficient water use in irrigation systems, and ensure that irrigation development is technically feasible, economically viable, socially desirable and environmentally sustainable.
vi) National Forest Policy, 1998	The goal of the Policy is to enhance the contribution of the forest sector to the sustainable development of Tanzania and the conservation and management of her natural resources for the benefit of present and future generations.

vii)	Wildlife Policy, 2007	The Policy focuses on wildlife protection and conservation in order to ensure sustainability of wildlife ecosystems.
viii)	National Tourism Policy, 1999	The aim of the Policy is to ensure that development of tourism is based on careful assessment of carrying capacities of tourism products and ensure enhancement and improvement of special environment features in order that tourism development does not conflict with indigenous forests, beaches, mountains and other important vegetation.
ix)	National Water Policy, 2002	The main objective of the Policy is to develop a comprehensive framework for sustainable development and management of the nation's water resources. On the environment the policy objective is to have a water management system that protects the environment, ecological system and biodiversity.
x)	National Land Policy, 1995	The Policy aims at developing a coherent and comprehensive framework that defines land tenure and enables proper management and allocation of land in urban and rural areas. Among other things, the Policy advocates the protection of land resources from degradation, for sustainable development.
xi)	National Biotechnology Policy, 2010	The objective of the Policy is to ensure that Tanzania has the capacity and capability to capture the proven benefits arising from health, agriculture, industry and environmental applications of biotechnology while protecting and sustaining the safety of the community and the environment.
xii)	Mineral Policy of Tanzania, 2009	The objective of the Policy on environment is to reduce or eliminate adverse environmental effects of mining, by promoting health and safety conditions in mining areas and addressing social issues affecting local communities.
xiii)	National Health Policy, 2007	The overall objective of the Policy is to improve the health and well being of all Tanzanians. In line with environmental health, Policy seeks to protect community health by enhancing sustainable environmental health.
xiv)	National Energy Policy, 2003	The Policy, among others, focuses on utilization of various energy resources in a sustainable and environmentally friendly manner.
xv)	Sustainable Industrial Development Policy, 1996	The Policy provides for sound environmental management in order to ensure promotion of environmentally friendly and ecologically sustainable industrial development.
xvi)	National Population Policy, 2006	The Policy recognizes the impacts of population growth on natural resources and environment. The policy goal is to prepare and implement coordinated urban, rural and regional development plans for rapid development in the country and to reduce the rate of rural-urban migration.
xvii)	National Human Settlements Development Policy, 2000	The Policy stresses on the need for ensuring that human settlements are kept clean and pollution effects of solid and liquid wastes do not endanger the health of residents.

5.2   Legislation

The Environmental Management Act, 2004 provides framework for environmental related matters. The Act includes provisions for institutional roles and responsibilities with regard to environmental management; environmental impact assessments; strategic environmental assessment; pollution prevention and control; waste management; environmental standards; state of the environment reporting; enforcement of the Act; and a National Environmental Trust Fund. A summary of legislation and their relevance to environmental management is presented in **Table 5-2**.

Table 52: Summary of legislation and their relevance to environmental management

Legislation	Objective
i) Environmental Management Act (Cap. 191)	The Act is a framework environmental law which provides for legal and institutional framework for sustainable management of the environment and natural resources in the country
ii) Forest Act No. 7 of 2002	The Act provides for management of forests and requires carrying out of Environmental Impact Assessment (EIA) for certain development projects.
iii) Wildlife Conservation Act No. 5 of 2009	The Act provides for the conservation of wildlife and ensures protection, management and sustainable utilization of wildlife resources, habitats, ecosystems and the non-living environment supporting such resources, habitats or ecosystems with actual or potential use or value.
iv) Marine Parks and Reserves Act No. 29 of 1994	The Act aims at protecting, conserving, and restoring species and genetic diversity of living and non-living marine resources and ecosystem processes of marine and coastal areas.
v) Fisheries Act No. 22 of 2003	The Act regulates fishing activities in both fresh and marine waters. Among other things, it emphasizes on the conservation of fisheries resources in particular critical habitats or endangered species, and restricts the issuance of fishing licenses for fishing in any conserved areas.
vi) Plant Protection Act No. 13 of 1997	The Act provides for prevention of the introduction and spread of harmful organisms, to ensure sustainable plant and environmental protection, to control the importation and use of plant protection substances, to regulate export and imports of plants and plant products.
vii) Land Act No. 4 of 1999 and Village Land Act No. 5 of 1999	The fundamental principle of the Land Act is to ensure that land is used productively and that, any such use complies with the principles of sustainable development. The Village Land Act as well empowers the Village Government to have legal control on village land and its uses. This also includes prohibiting or minimizing land problems like bush fires as well as land use related conflicts between farmers and livestock keepers/pastoralists.
viii) Water Resource Management Act No. 11 of 2009 and Water Supply and Sanitation Act No. 12 of 2009	The Water Resources Management Act provides the legal framework for the management of water resources within the integrated water resources management (IWRM) framework. The Water Supply and Sanitation Act likewise, provides for a legal framework to ensure water quality by protecting water works and storage facilities against pollution.
ix) Local Government (Urban Authorities) Act No. 8 of 1982	The Act assigns responsibility to Urban Authorities to take measures for conservation of natural resources, safeguard and promote public health.
x) Public Health Act No. 1 of 2009	The Act provides for the promotion, conservation and maintenance of public health with a view of ensuring comprehensive functional and sustainable public health services.

xi)	Mining Act No. 14 of 2010 and its amendments of 2017 and 2019	The Act provides for regulation of prospecting for minerals, mining, processing and dealing in minerals. The Act requires all holders of mining licenses to take appropriate measures for the protection of the environment in accordance with the Environmental Management Act including undertaking EIA in mining activities.

5.3   Multilateral Environmental Agreements (MEAs)

Environment being a global agenda, Tanzania cooperates with other states in managing the global environment. In this regard, Tanzania is a Party to various international treaties aiming at the protection of the environment (Table 5-3).

Table 53: Major Conventions on environment to which Tanzania is a Party

Convention	Objectives
i) Convention on Biological Diversity (CBD) (Ratified- 1996)	To promote the conservation of biological diversity, sustainable use of its components and the fair and equitable sharing arising out of the utilization of genetic resources.
ii) United Nations Framework Convention on Climate Change (UNFCCC) (Ratified - 1996)	To achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, within a timeframe to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.
iii) The United Nations Convention to Combat Desertification (UNCCD) (Ratified - 1996)	To combat desertification and mitigates the effect of drought in countries experiencing serious draughts and/or desertification, through effective action at all levels, supported by International cooperation and partnership arrangements, in the framework of an integrated approach which is consistent with Agenda 21, with a view to contributing to the achievement of sustainable development in the affected areas.
iv) Ramsar Convention on Wetlands (Ratified -1975)	To promote the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world"
v) Convention for Protection of World Cultural and Natural Heritage (Ratified - 1975)	To ensure the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage
vi) Convention on International Trade in Endangered Species of Wild Fauna and Flora(Ratified - 1975)	To ensure that wild fauna and flora in international trade are not exploited unsustainably
vii) Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Ratified - 1992)	The objectives of theConvention include: i) To reduce trans-boundary movement of hazardous wastes and other wastes to a minimum consistent with their environmentally sound management; ii) To treat and dispose hazardous wastes and other wastes as close as possible to their source of generation in environmentally sound manner; and iii) To minimize the generation of hazardous wastes and other wastes in terms of both quantity of potential hazards. The Convention represents the intention of the international community to solve this global environmental problem in a collective manner.

Convention	Objectives
viii) Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade(Ratified - 2004)	The objectives of the Convention are:to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm; and contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.
ix) Stockholm Convention on Persistent Organic Pollutants POPs (Ratified - 2004)	To protect human health and the environment from persistent organic pollutants.
x) The Convention on the Prevention of Marine Pollution from ships (MARPOL) (Ratified - 1973)	To preserve the marine environment in an attempt to completely eliminate pollution by oil and other harmful substances and to minimize accidental spillage of such substances.
xi) Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LC) (adopted on 13 November 1972)	To prohibit the dumping of certain hazardous materials, requires a prior special permit for the dumping of a number of other identified materials and a prior general permit for other wastes or matter.
xii) The United Nations Convention on Law of the Sea (Ratified – 1982)	To define the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources.
xiii) The Montreal Protocol on substances that deplete the Ozone layer (Ratified - 1987)	To establish control and limitthe production and consumption of the chemicals that destroy the ozone layer that protects the Earth.
xiv) Bamako convention on the Ban of the Import into Africa and the control of Transboundary Movements of Hazardous Wastes within Africa (Ratified-1990)	The objectives of the Convention are: i) To protect by strict control the human health of the African population and the environment against adverse effects which may result from hazardous wastes by reducing their generation to a minimum in terms of quantity and/or hazard potential. ii) To adopt precautionary measures, ensure proper disposal of hazardous wastes; and iii) To prevent "dumping" of hazardous wastes in Africa.
xv) Amended Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Western Indian Ocean Region (Ratified – 1996)	To ensure sound environmental management of maritime and coastal areas of the Eastern African Region.
xvi) Convention on Sustainable Management of Lake Tanganyika (Ratified –2004)	To ensure the protection and conservation of the biological diversity and the sustainable use of the natural resources of Lake Tanganyika and its Basin by the Contracting States on the basis of integrated and co-operative management

Convention	Objectives
xvii) The Kyoto Protocol to United Nations Framework on Climate Change (Ratified – 2003)	To strengthen the commitments of developed country Parties with a view to reducing their overall greenhouse gas emissions by 5% below 1990 levels in the first commitment period 2008 to 2012.
xviii)The Cartagena Protocol on Biosafety (Ratified – 2003)	To ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing ontransboundary movements.
xix) African Convention on the Conservation of Nature and Natural Resources (Ratified – 1974)	To ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due to regard to the best interests of the people.
xx) The Lusaka Agreement on Cooperative Enforcement Operations Directed at Illegal Trade in Wild Fauna and Flora (Ratified – 1994)	To reduce and ultimately eliminate illegal trade in wild fauna and flora and to establish a permanent Task Force for this purpose

5.4   Institutional Framework

The Environmental Management Act (Cap 191) sets up the institutional framework for environmental management in the country (Figure 5-1). It confers the task of overall coordination and policy articulation of environmental management in the country and provision of the central support functions to the Ministry Responsible for Environment, which is the Vice President's Office. The direct operational role on management of specific natural resources or environmental services, such as agriculture, fisheries, forestry, wildlife, mining, water, and waste management is conferred to sector Ministries and Local Government Authorities.

The Act establishes the National Environmental Advisory Committee (NEAC) with the role of advising the Minister responsible for environment, among others. It confers the role of enforcement to the National Environment Management Council (NEMC). The Act further establishes Sector Environmental Sections in Sector Ministries and confers the environmental management role on the relevant sectors and with a view to provide a link to the Ministry responsible for environment. The Act gives power to the Regional Secretariats to designate Regional Environmental Management Experts (REMEs) charged with the responsibility to advise and oversee the implementation and enforcement of the Act. So far, since its enactment, Sector Environmental sections have been established in all sector ministries and Sector Environmental Coordinators have either been designated or appointed in such sectors.

Furthermore, the Act empowers LGAs (City, Municipal, District, Township) to designate or appoints Environmental Management Officers to oversee implementation of EMA at respective levels. In addition, the Act establishes Environmental Committees at different LGAs levels to advise and oversee the implementation of EMA within their jurisdiction.
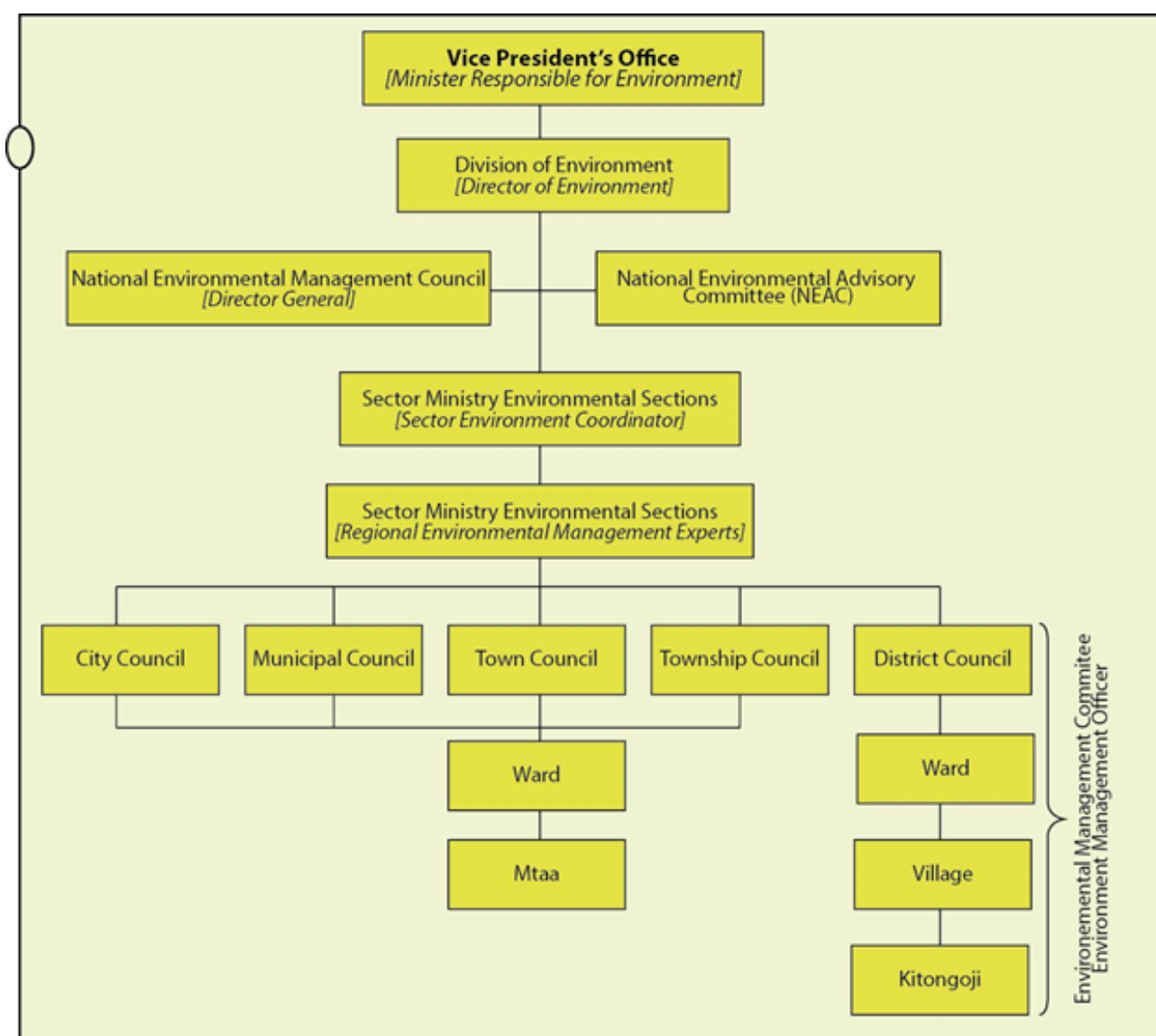
Figure 51: Institutional arrangement for environmental management

5.5   Lessons Learnt on Policy, Legislative and Institutional Framework

Policy implementation as well as legislation enforcement in the existing institution structure, have faced several challenges. There is still existing low capacity (human resources and infrastructure) and inadequate financial resources in implementation, monitoring and evaluation of environmental resources at all levels including NEMC, ministerial, regional and local government levels. Capacity at local government level has been remarkably low where actual interaction between people and the environmental resources prevails. Therefore, there is a need to strengthen capacity at regional and local government, as these are more responsible for the environment at the grass-roots level.

Awareness creation to communities on the policy and legislation is still a challenge and much more effort is needed to that effect. Inadequate awareness on the policy and legal frameworks among the general public contributes to the enforcement challenges at all levels. Limited public awareness on environmental and sectoral policy and legislation as well as environmental issues at large, attributes to less involvement of the community on protecting the environment.

There have been notable achievements including: Improved transparency and participation of local communities in environment planning and management; Designation of Environmental Management Officers at Regional and Districts levels in the country; Improved participation of local communities in the conservation of coastal resources through establishment of 739 of Beach Management Units (BMUs); Improved participation of local communities in the conservation of wildlife resources through establishment 17 Wildlife Management Areas and enhance involvement of communities in EIA and SEA process (URT, 2018).

Apart from the policies and legislations, the Government has implemented other initiatives related to gender and environment. These include: National Strategy for Gender Development (2000); National Strategy on Gender and Climate Change (2012); and The National Guidelines for mainstreaming Gender into Environment (2014).

Despite these achievements, there still some challenges hampering good governance in environmental management. These include: absence of policy guidance of good governance in environmental management; absence of comprehensive guidelines for formulating environmental by-laws; inadequate capacity enforcement of environmental laws; inadequate capacity enforcement of environmental by-laws.

Further, readily government efforts are further constrained by inadequate cross-sectoral policy planning; low involvement and engagement of local communities in designing policy and legal instruments; insufficient environmental information and data generation and accessibility; inadequate enforcement and compliance; inadequate capacity in terms of human resources and financial resource.

5.6   Strategic interventions from lessons learnt

Drawing from the lessons learnt and the long term goal of the Government to further improve the state of the environment in the country, there is a need to implementthe following strategic interventions:

i) strengthen coordination and linkages amongst sectors for environmental management;
ii) enhance resource mobilization to support environmental management;
iii) strengthen research and development to support environmental management;
iv) enhance environmental data generation, management and dissemination;
v) strengthen stakeholder involvement and engagement in environmental management;
vi) strengthen enforcement of relevant legislation and bylaws;
vii) enhance monitoring and evaluation system to support environmental management; and
viii) enhance human resource capacity for environmental management.

CHAPTER SIX

LAND DEGRADATION

Land is under increasing pressure stemming from competition for access, changing consumption patterns and the drive for greater economic growth. These have resulted in land degradation in many parts of the country. Land degradation is caused by many factors acting alone or in combination, concurrently or one at a time, yet progressively. Human activities including shifting cultivation, overgrazing, deforestation, rapid population growth and inadequate land use management are the prime cause of land degradation, which changes the quality of the land.

6.1   Drivers

a) Poverty

Poverty is both the cause and effect of land degradation. While land degradation leads to widespread poverty, poor people tend to over exploit natural resources found in their surroundings, to meet their basic needs. About 28.2% of Tanzanians are below poverty line. Poverty is overwhelming in rural areas where about 33.3% of people are below poverty line. Majority of people particularly the poor in rural areas drive their livelihood from natural resources including forest, fishing and small scale mining (HBS, 2011/2012).

This is leading to a high amount of pressure exerted on natural resource per amount of economic activity. In addition, poverty restricts the opportunities of Tanzanians to invest in agricultural modernization or intensification, which would allow them to earn a livelihood with activities that are less dependent on extraction of resources. Finally, poverty and related short-term coping strategies restrict the possibilities of farmers to take care of the long-term productivity of their resources including soil fertility.

b) Land ownership

In Tanzania land is divided in three groups: general land, reserve land and village land. All the land is state owned and vested on the President. People lease, from the Government, both general and village land for various uses. However, most of the land that falls in village and general land has not been surveyed and in most cases, people are not assigned property rights due to inadequate capacity in terms financial and human resources. As a result, most of the land remains open access for various activities such as pastoralism and shifting cultivation.

c) Economic growth

Tanzanian economic growth has resulted into competing demand for minerals, energy, food, feed, fibre and fuel, intensifying pressures on land. Tanzania is among the sources of these materials to the global economy. It also caters for the country's domestic demand of these materials. This has led to land-use conversion, land degradation and pressure on protected areas.

d) Climate extreme events

The frequency of occurrence of climate extreme events (e.g. droughts, heavy precipitations and associated floods) has been increasing in Tanzania in recent years. The severity of drought is more pronounced in the semiarid regions of Tanzania where estimations show that 61% of land in these areas is likely to be degraded. These areas include some parts of Dodoma, Shinyanga, Manyara, Singida, Simiyu, Geita and Kilimanjaro regions. These areas are characterized by extreme seasonal conditions with relatively low rainfall, a long dry seasons and high seasonal rainfall and temperature fluctuations which cannot reliably produce food and cash crops. Frequent droughts in these areas, leave the land bare, making it susceptible to agents of soil erosion such as wind and water.

e) Culture and beliefs

Unsustainable land management practices built up over generations have often become part of cultural fabric of traditional pastoral and peasant farming communities. Pastoral/nomadic livestock keeping practices is one of the long standing unsustainable land uses practice in Tanzania. This culture is built upon keeping large herds of cattle often for prestige, exceeding the carrying capacity of grazing land. Under this culture, land is viewed as open access and the herdsmen move with their large herds of cattle from one place to another in search for fodder and water. Some of these communities include agro-pastoral Sukuma, Barbaig and Maasai.

6.2   Pressure

Pressure on land is attributed by inadequate land-use plans, inadequate livestock infrastructure, rapid urbanization, and overgrazing.

a) Inadequate land-use plans

Land use planning is an important tool to ensure that land is used on a sustainable basis. It is also applied for livestock management after establishing the carrying capacity of the intended piece of land. In Tanzania, much of land, especially the village land is used without formally approved land use plans, resulting in unsustainable use of land such as overstocking and unplanned settlements. Such practices often lead to land degradation, which if not checked is very expensive to reclaim the degraded land. For example out of 12,450 villages in Tanzania, it is only 1,900 villages that have been surveyed and land use plans prepared by 2018 (National Land Use Commission, 2019).

Statistics until June 2015 shows that the estimation of the general land that has been surveyed was 1.6 Million plots and 23,200 farms while the registered Certificate of Rights of Occupancies were 563,639 as of end of October 2018. This amount is estimated to be 14% of the general land. Therefore, 86% of the general land has not been planned, surveyed and statutorily allocated. Having many areas that are not planned, surveyed and allocated results in several challenges such as growth of unplanned or informal settlements and developing of unplanned towns and further increase of land use conflicts (URT, 2018).
Plot surveying is one of important steps in land delivery process. In Tanzania, although the process of surveying villages has been encouraging, the process of plot surveying has been very slow when compared to demand leading to informal settlements especially in urban areas. This trend shows that about half of the 48 LGAs surveyed in 2017/18, (52%) ranked inadequate land-use management as the highest driver to land degradation in their area. About 28 % of LGAs ranked this problem as high while 17 % ranked medium.

b) Inadequate livestock infrastructure

Livestock infrastructures such as charcol dams and cattle dips are not adequately provided for in livestock keeping areas. As a result, livestock keepers move from one place to another in search for water for their cattle, in most cases from rivers, swamps and wetlands. These movements have resulted into serious problems as it ends up in degrading water catchment areas and land conflicts. For example, in Bahi and Chemba districts working cattle dips are below 20% unlike increasing livestock population.

c) Rapid urbanization

Tanzania is among the rapid urbanizing countries in Africa, with urbanization rate of about 4.7% per annum. This rapid urbanization increases demand for food, building materials and energy, especially charcoal which provides energy for cooking to most of urban population in the country. The increase in food demand pushes demand for arable land in rural areas to produce food to meet high demand for food in urban areas. The demand for arable land in most cases is met by clearing virgin land to open new farms rather than agricultural intensification. Due to poverty and low technology, in most cases opening of new farms is undertaken using slash-and-burn farming technique, which makes the land very susceptible to agents of soil erosion such as water and wind. In recent years more and more farms have been opened up in the marginal areas and even in the protected areas to produce food crops.

d) Overgrazing

It has been revealed that in arid and semiarid agro-ecological zones which are characterized by high number of livestock population are highly degraded including areas in Shinyanga, Simiyu, Dodoma and parts of Tabora, Masai land and Mbulu in Manyara region where livestock units exceeds the carrying capacity. In Babati, there insufficient grazing land for maintaining current livestock density in the District due to increasing number of people and expansion of settlement and agricultural activities at the expense of the grazing lands.

Figure 61: Overgrazing in Bahi District, Dodoma

Overgrazing/overstocking resulting from large herds of cattle being retained by some livestock keepers for prestige, a practice which worked well in the past when land was ample, is impractical today when grazing land is increasingly becoming less and less due to demographic changes. Localized overstocking amplifies the trampling effects of moving herds of cattle, causing severe damage or total loss of grazing pastures; leading to serious degradation. In many regions, livestock population far exceeds the carrying capacity of the land resulting in overgrazing. Other regions facing overstocking include Mwanza, Dodoma, and Manyara.

e) Unsustainable farming practices

In Tanzania, agriculture is mainly undertaken by smallholders whose farming practices are in most cases traditional and unsustainable. These include farming along river valleys during dry season *(vinyungu)*, slash-and-burn farming technique, traditional gravitational irrigation, excessive use of agrochemicals and monoculture, farming on marginal lands such as those on steep slopes. Traditional farming along river valleys is a common problem in many parts of Tanzania. It exposes river valleys to soil erosion as well as siltation downstream. Slash-and-burn farming technique involves cutting and burning of bushes in opening farms leaving the land bare, exposing it to agents of soil erosion. This problem is common in many parts of Tanzania especially where there is extensive land for agricultural expansion.

f) Unsustainable economic activities

Unsustainable economic activities; poor technology in processing goods (e.g. drying of fish

and tobacco); mining and quarrying that lead to abandoned pits, heaps of soil, waste rock and metal scraps; contribute largely to physical degradation of the land and environmental degradation. Presence of abandoned pits and heaps of waste rocks, scrap metals and tailings in abandoned mine sites at the Buhemba Gold Mine, is a vivid example.

| *a)* *Tembo mine gold rush site* | *b)* *Mgusu artisanal gold mining area* |

Figure 62: Unsustainable mining activities in Geita Region

6.3   State

Land degradation can be seen in different aspects as follows:-

a) Soil erosion

Table 6-1 presents areas that severely degraded in the country which require attention in rehabilitating them. Decline and depletion of vegetative cover through deforestation, overgrazing, prolonged drought and unsustainable farming practices, is the most important cause of soil erosion and loss of top soils.

Table 61: Identified Hotspot areas in Tanzania derived for local and global data

Hotspot area	Zone	Indicators	Driver
Dodoma	Semi-arid central	Decline in Productivity High soil erosion (high gullies), Bare lands (signs of desertification)	Agriculture i.e. convention of forest land to cropland
Lindi Semi-arid southern coast		large area very, severely degraded	Livestock keeping, expansion of agriculture, uncontrolled fire, deforestation
Tabora	Semi-arid western	large area severely degraded canopy cover reduced	Agriculture i.e. tobacco farming Grazing i.e. large herds of cattle Shifting cultivation
Singida	Semi-arid central	Very severe, severe degraded, moderate degraded	Agriculture i.e. convention of forest land to cropland

Hotspot area	Zone	Indicators	Driver
Shinyanga	Semi-arid lake zone	Very severe degraded, moderate degraded	Agriculture i.e. cotton, rice farming Grazing i.e. large herds of cattle
Arusha	Northern highland	Bare lands, soil erosion and gullies	Agriculture i.e. maize, farming Grazing i.e. large herds of cattle

(Source: URT, 2018)
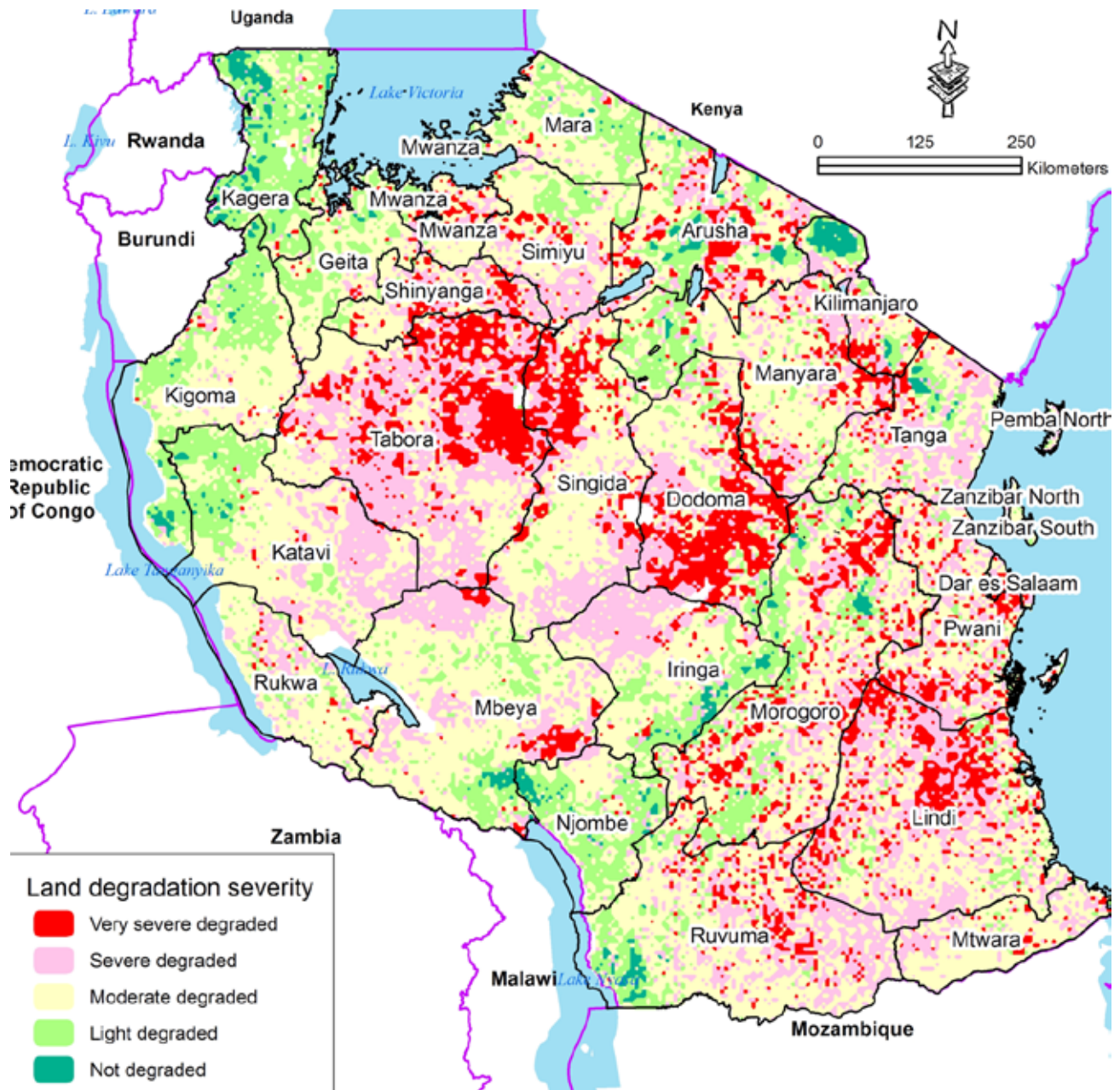
Figure 63: Land degradation severity in Tanzania (URT, 2018)

b) *Loss of soil nutrients/fertility*

Land degradation in most parts of the country has led to loss of soil nutrients (mainly nitrogen, phosphorus and potassium) or organic matter. This problem is serious in highly degraded regions such as Shinyanga, Dodoma, and parts of Kilimanjaro and Singida Regions.

c) Salinization

Salinization, which is the concentration of salts in the top soil, occurs due to poor management of irrigation water or insufficient attention to drainage, consequently leading to development of alkaline soils. This is the case especially in arid areas where high evaporation rates foster the process. The extent of the salt-affected soils in Tanzania is estimated to be 1.7 million ha. This problem has mainly been noted in irrigated farms in Dodoma, Singida, Kilimanjaro and Shinyanga. Salinization has a deleterious effect on soil productivity and crop yields. In extreme cases, damage due to salinization is so great that it is technically unfeasible or totally uneconomic to reverse the process.

d) Soil pollution

Land degradation resulting from inappropriate use of agro-chemicals such as fertilizers, pesticides and fungicides; industrial and consumer chemicals; crude solid waste disposal; improper hazardous waste management, leaves the land polluted with such chemicals. Cashewnut growing regions in the south are projected to experience soil pollution in the future following use of fertilizers and fungicides.

In addition, land degradation resulting from use of mercury in gold recovery, has been causing land and water pollution. Mercury is very harmful to human health due to the fact that it can lead to Minamata disease. Mercury pollution is common in areas that small scale and illegal miners are undertaking gold mining, such as in Geita, Shinyanga and Mwanza Regions. In addition, soil pollution results from leakage of industrial and mining chemicals and mining remains or materials.

6.4 Impacts

a) Decline of soil productivity and food insecurity

Land degradation in Tanzania has, in most cases, led to decline or loss of land productivity due to reduced or depletion of soil nutrients. This has resulted into shifting cultivation and migration of pastoralists.

A decline in agricultural yields has led further into food insecurity. Land degradation, coupled with drought has led to recurring shortage of food in drought-prone areas of the country. The areas affected include Dodoma, Singida, Tabora, Shinyanga, parts of Kilimanjaro and Manyara. This is because when land is highly degraded and is hit by recurring drought, it ends up yielding nothing especially in rain-fed farm-lands.

b) Siltation

Soil erosion from cultivated and pasture land is causing serious increases in sediment and nutrient loads getting into water sources. Siltation causes pollution and drying up of water sources. This is a common problem in most of water sources where there are farming is done upstream. Siltation has detrimental effect to hydropower production dams as they render them useless. This has been the case in Mtera and NyumbayaMungu Dams.

c) Water pollution

Soil erosion from cultivated and pasture lands, causes significant increase in sediment and nutrient loads into water sources. This in turn causes pollution and eutrophication of fresh water ecosystems, wetlands, lakes and rivers, which also has a negative effect on provision of food and livelihood for a significant population in the country.

d) Migrations and land conflicts

Excessive land degradation triggers migrations of people and their livestock in search for productive land, fodder and water. This is especially grazing lands in semi-arid areas such as Shinyanga, Dodoma and Manyara, which have been affected by overgrazing, recurring droughts and subsequent soil erosion resulting from torrential rains and winds. As a result livestock-keepers move to other areas, often to agriculture production areas searching for water and fodder. This results in farmers-livestock keepers conflicts, in various places of the country such as Rufiji (Pwani Region), Mvomero, Kilosa and Kilombero (Morogoro Region) and Mbarali (Mbeya Region).

e) Desertification

Continuing land degradation in semi-arid areas which is further being complicated by overgrazing, has in some places resulted into semi-desert lands. Examples of affected areas include Dodoma, Shinyanga, Singida, parts of Arusha, Kilimanjaro and Manyara Regions.

f) Economic cost of land degradation

The total annual economic value of land lost due to land degradation is estimated at USD 10.2 billion which is equivalent to TZS 23.3 trillion(Status of Land Degradation in Tanzania, 2014). The extent of land degradation and its respective costs are increasing and therefore call for urgent efforts to address the challenge. Further, the economic cost of drought and siltation e.g. on energy, road infrastructures, water for domestic and industrial use, and failure of agricultural projects for livestock and farming, and further impacts of flooding may not be accounted immediately. However estimates can be more than 120 billion TZS annually (Pratt *et al*, 2017).

g) Loss of Biodiversity

Land degradation in most cases has led to loss of biodiversity; this has been the case in most of semiarid areas which are facing overgrazing and recurring drought. Examples of such areas are Shinyanga and Manyara. Loss of natural vegetation has continued to be observed in mining areas which occur during infrastructure development. Loss of biodiversity is a major impact occurring to due land degradation in Shinyanga, Manyara, Katavi and Tabora(URT, 2018).

6.5   Response

Cognizant of the severity of land degradation and its impacts to the environment and socio-economic development, the Government has deployed a number of initiatives aimed at addressing land degradation in the country as follows:
   a) Development and implementation policies, strategies and plans which contribute

towards curbing land degradation. Government in collaboration with relevant stakeholders is reviewing various policies among other issues to provide comprehensive and clear guidance regarding land degradation. Policies under review are: The National Environment Policy (1997); National Forestry Policy (1998) and National Land Policy (1995). Further to this, there are a number of Strategies and Plans which are in place which address matters related to land degradation including: Revised National Environmental Action Plan (NEAP) (2019-2023); Revised Strategy for Urgent Actions on Land Degradation and Water Catchments (2018); and Revised Strategy on Urgent Actions for the Conservation of Marine and Coastal Environment, Lakes, Rivers and Dams (2018).

b) Strengthening land use planning in the country. These include: National Land-Use Framework Plan (2013-2033), the Framework among others provides guidance for the determination of land use of national concerns such as protected areas, wetlands, agricultural, grazing, urban and rural settlements and socio-economic infrastructures.

c) Demarcation and setting aside of land allocations for small-scale mining including Kilindi District (Tanga Region), Kilosa and Mvomero Districts (Morogoro Region), Maganzo, Kishapu and Ibadakuli (Shinyanga Region), Mererani (Manyara Region), Mpwapwa (Dodoma Region), Nyarugusu and Rwamgasa (Mwanza Region) and Manyoni (Singida Region). Demarcation is done mainly for the purpose of enhancing the Government to monitor small-scale mining activities as well as provide extension services.

d) Promotion of cost-effective technologies for agroforestry and soil erosion control on cultivated lands through community based agricultural development projects. Various soil and water conservation technologies are promoted through extension.

e) Mainstreaming environment into National Five-Year Development Plan, 2016/17-2020/21.

f) Enforcement of the Environment Management Act (2004) and its respective Regulations.

g) Land use planning and delivery - village land use plans; formalization/regularization of unplanned settlements; and survey of plots. Plot surveying is one of important steps in land delivery process to customers

Several achievements have been recorded as a result of implementation of these interventions. Some of these include: 1,900 villages have been surveyed with land use plans in 2018 compared to 800 villages surveyed in 2010; Enhanced efficiency in environmental management by setting up institutional Framework for environmental management in the country which has cascaded responsibilities from the central government to local government; Recognition and issuance of more than 300,000 Certificates of Customary Right of Occupancy by 2016, this arrangement contributes to proper land management through ownership and contributes towards combating land degradation.

Table 62: Number of village land certificates and customary land titles issued, 2005 – 2018

SN	Region	Village Land Certificate	District Land Registry	Village Land Registry	Customary Land Titles
1	Arusha	455	5	8	45,251
2	Dodoma	417		3	2,679
3	Iringa	403		70	37,029
4	Njombe	403	1	15	1,819
5	Geita	403		1	503
6	Kagera	469		3	1,826
7	Kigoma	220	1	1	13
8	Kilimanjaro	480	1	11	2,900
7	Lindi	372	1	4	17,445
8	Manyara	366	1	73	38,299
9	Mara	490	3	5	24,260
10	Mbeya	868	2	86	25,036
11	Morogoro	630	2	3	122,552
12	Mtwara	766	2	1	33,735
13	Mwanza	880	1	3	1,036
14	Coast	291		11	11,710
15	Rukwa	417		11	1,343
16	Ruvuma	501	4	14	25,631
17	Shinyanga	510			1,445
18	Simiyu	454	2	41	48161
19	Singida	389	1	9	29,119
20	Tabora	405	1	1	7,091
21	Tanga	500	3	11	24910
	TOTAL	**12,393**	**31**	**385**	**563,639**

(Source: Ministry of Lands and Human Settlement Development, 2018)

It is expected that, the increased number of village land certificates and customary land titles issued 2005-2018 would reduce challenges that existed in the past. Such challenges included land use conflicts and village boundary conflicts. Hence, positive results are also envisaged on part of containing anthropogenic pressure on environmental resources in the country.

CHAPTER SEVEN

DEFORESTATION AND FOREST DEGRADATION

Deforestation is any illegal process (such as shifting agriculture) that transforms forested areas to non-forested land. Forest degradation is any process that reduces the density of flora or fauna in a forest, especially by removal of trees, resulting in decreased interactions between these components, and more generally to its functioning.

Despite the many benefits and services accrued from forests, the forest sector in Tanzania is facing many challenges, including high deforestation rate and forest degradation mainly caused by human activities.

7.1 Drivers

a) Poverty

Most of Tanzanians' livelihood depend on the natural resources including forest resources for their survival. Daily activities such as agriculture, grazing, firewood collection and charcoal production, are conducted in the forests and go hand-in-hand with deforestation and forest degradation with the rate estimated at 373,000 ha per year.

Poverty is overwhelming in rural areas where about 33.3% of people are below poverty line. Majority of people particularly the poor in rural areas drive their livelihood from natural resources including forest resources (HBS, 2011/2012). This is leading to a high amount of pressure exerted on forest resource per amount of economic activity. In addition, poverty restricts the opportunities of Tanzanians to invest in agricultural modernization or intensification, which would make them to earn a livelihood in less dependence on extraction of forest resources.

b) Population Growth

The recent population growth projection (2018) has indicated to stand at 52.6 million people compared to 44.9 million people in 2012. This increase in population has serious ramification and exerts more pressure on utilization of natural resources, particularly forest resources. The pressures on the environment intensify as the population grows. The growing trends of population and consequent demand for food, energy, and housing have considerably altered land-use practices and severely degraded Tanzania's forests. In some cities and large urban areas, settlement expansion are unplanned and encroaching into nearby forest reserves.

c) Economic growth

Tanzania annual GDP growth of 7.1% in 2017 (URT, 2019) and the global economic growth coupled with globalization, has resulted into expansion of trade among nations and competing demand for food, feed, fibre and fuel, intensifying pressures on forest resources. Tanzania is among of the source of these materials to the global economy. Economic activities such as construction, agriculture, timber harvesting and industrialization have been key drivers to deforestation and forest degradation.

7.2   Pressure

a) Energy demand

An estimated 90 % of Tanzania's energy needs are met through the use of wood fuels. Firewood remains the most common source of fuel for cooking in rural areas whereas charcoal is mostly used in urban areas (TFS, 2013). The estimate indicate about 500,000 tons of charcoal per year are consumed in Dar es Salaam, this is due to the fact that charcoal is a single largest source of household energy in urban areas (URT, 2014). With this continued heavy dependence on charcoal and firewood as sources of energy for domestic use, coupled with absence of policy guidance on sustainable charcoal production, the forest resources remain at threat.

b) Unsustainable farming practices

Farmers consider forest soils are fertile, therefore along the forest boundaries it is common for farmers to encroach on forest land, especially where forest boundaries clearly marked and patrolled. Farming system applying a slash and burn approach which is commonly used produces ash that is rich with potassium is considered as a key to crop performance. The burning destroys young regeneration and it often destroys much more forest area than is needed by the farmer. This is the prime cause of deforestation.

In Tanzania, farmland is expanding at the rate of 2.4 % per year whereby total area under shifting cultivation is 66,000 km^2.The estimate shows that the total loss of wood to this practice is about 14.9 million cubic meters annually.

c) Wildfires

The extent of fire damage to forests, biodiversity and other natural resources on the Mainland is very high. Most of the fires are intentional, especially those set for clearing of farmlands. This has been observed in many part of the country especially during the dry season (July to November). However, most of the fires occur in the miombo woodlands and the coastal forests as a result of uncontrolled human activities.

Figure 71: Forest area affected by fires 2013 - 2017

Figure 7-1 indicates trend in forest area affected by fires from 2013 to 2017. An average of 8.7 million ha are burnt annually (ranging from between 7.9 and 10.3 million ha) across the country (TFS, 2018). Forest fire incidences occur in many parts of the country predominantly in Kigoma, Mbeya, Tabora and Rukwa Regions which is dominated by the miombo woodland.

Figure 72: Preparation of agricultural fields with fires in Uyui district

d) Forest land tenure

Deforestation occurs mostly in non-reserved forests while forest degradation takes place both in reserved and non-reserved forestlands. Currently there are about 2.3 million ha (10.2% of the forest reserves on village lands) which are under effective management. The remaining 19.67 million ha (89.5%) of forests in village lands is unreserved (open access forest areas) and is subjected to unsustainable practices such as agricultural expansion, wild fires, livestock grazing and illegal harvesting. This is a reflection of weak capacity of village governments to effectively manage the forests. In the majority of cases, formalization of forest land tenures, especially for villages and private owners is in slow pace.

e) Overgrazing and nomadic pastoral practices

Grazing in forests and woodlands is still considered a 'free-for-all' undertaking. Free-range grazing has been a source of antagonism between the forest resource managers and ecologists on one hand, and livestock keepers on the other. Overstocking causes serious environmental impacts including damaging forest and wetland resources. Examples are in Kilombero and parts of Biharamulo, Ngara and Misenyi.

Figure 73: Livestock caught grazing in Serengeti National Park

f) Climate change

Severe and recurrent drought as a result of climate change can result in destruction of forests and forest resources. In recent years, Tanzania has experienced increasing incidences of recurrent and prolonged droughts with severe implications to the livelihood. These incidences has aggravated the challenge of deforestation and forest degradation.

g) Inadequate enforcement and compliance to relevant laws and regulations

Despite the existence of policies and laws governing forest resources, the challenge has been inadequate enforcement and compliance to these instruments. This is mainly due to inadequate capacity, in terms of personnel and financial resources, leading to further destruction of forests.

7.3   State

a) Loss of forest cover

The Tanzanian mainland is estimated to have a total of 48.1 million hectares (ha) of forest, which is 51 per cent of the total area, with woodlands occupying about 90 per cent of the total forest area and the remainder being shared by mangrove forests, montane forests, small patches of coastal forests, and plantations of softwood and hardwood. Annual deforestation on the Tanzanian Mainland is estimated at 469,420 ha (MNRT, 2018). This challenge has been increasing across the country wide.

Legend
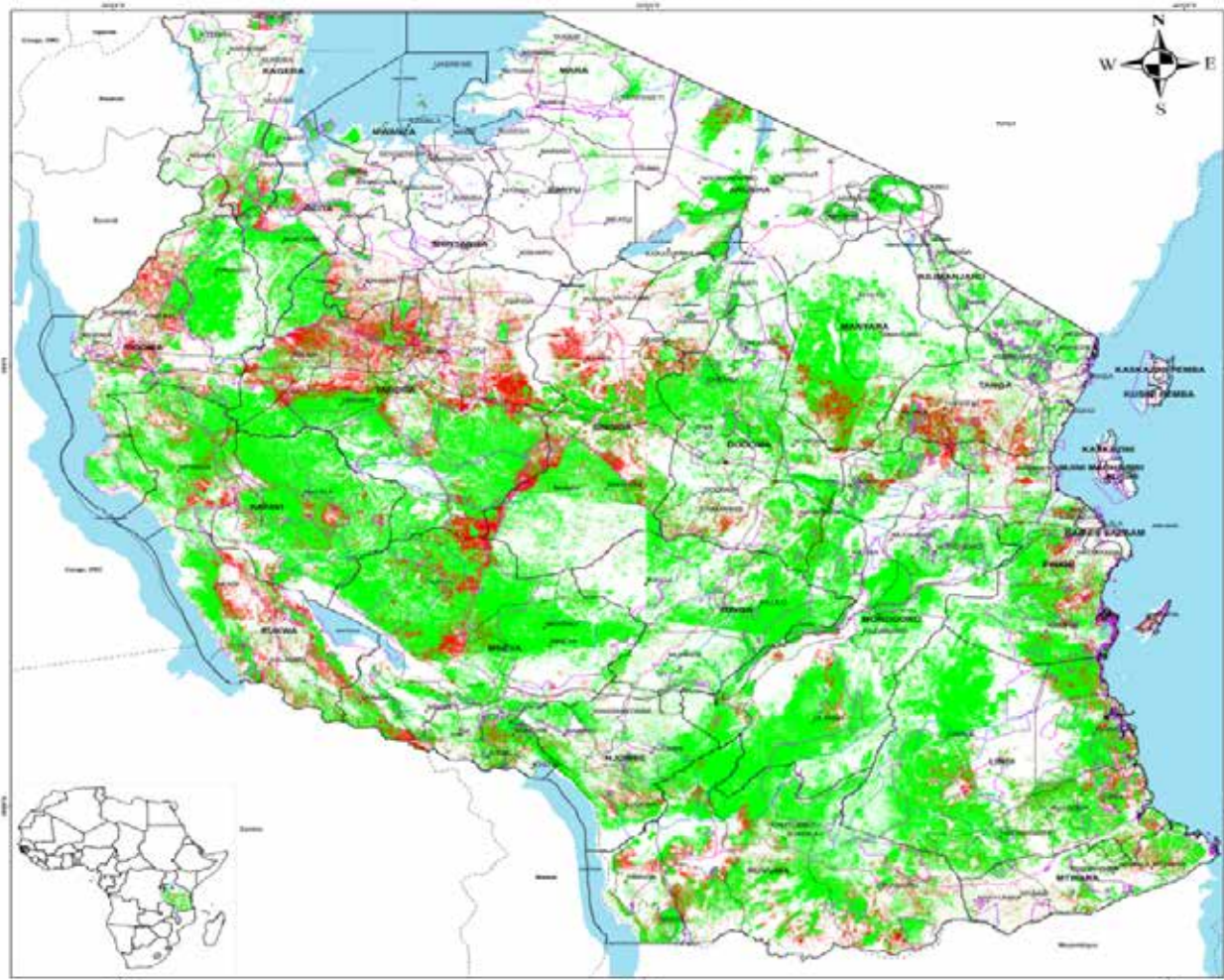
·	District name		Regional boundary
·	Capital city		District boundary
	River		Road
	International boundary	(green)	Forest
	Reserved area	(red)	Deforestation
	Water body		

	Total deforestation (ha)	Annual deforestation (ha/yr)
Main land	1,159,000	469,000
Zanzibar	25,190	3,189

Reserved areas	Total Deforestation (ha)	Annual Deforestation (ha/yr)
Mainland	1,068,116	97,101
Zanzibar	1,877	171

Figure 74: Deforestation map of Tanzania, 2002-2013 (URT, 2015)

b) State of trees

NAFORMA estimated the number of trees in Mainland Tanzania to be 77.2 billion. Useful tree species of large dimensions are becoming rare due to human impacts. The average number of trees per capita is 1,723, primarily of small dimensions and slow growth. NAFORMA figures show a lower average growing stock in natural forests and mangroves (-32% and -59% respectively) compared to earlier estimates.

c) Demand and supply

The total annual supply (growth) of wood at National level is estimated at 83.7 million m³. However, only about half of this, i.e. about 42.8 million m³ is available for harvesting at a sustainable level. The annual growth of the natural vegetation types is low compared to plantations. The annual demand (consumption) of wood is estimated at 62.3 million m³ mainly for household energy and loss due to land area conversions. The consumption exceeds the sustainable supply, causing an annual wood deficit of 19.5 million m³. The estimate of the average demand for wood is therefore 1.39 m³/year/capita while the annual allowable cut (the sustainable supply) is estimated at 0.95 m³/ year/capita.

d) Loss of forest goods and services

The present value of net losses from deforestation to the Tanzanian economy in the period 2013–2033 amounts to TZS 5,588 billion (USD 3.5 billion). This scenario analysis used data from Catchment Forest Reserves to account the economic effect of deforestation not only on timber resources, but also on other provisioning services, including non-timber forest products, regulating services such as water provisioning for domestic use and livestock, and supporting services such as biodiversity. This shows that the present value of net losses are an order of magnitude higher when taking into account the effect of deforestation on the full range of forest ecosystem services.

7.4   Impact

a) Loss of biodiversity

Widespread deforestation could lead to loss of biodiversity. Logging of the most valuable timber species such as *Miliciaexcelsa* (Mvule), *Pterocarpusangolensis* (Mninga) and *Dalbergiamelanoxylon* (Mpingo) has led to threaten the species to extinction.

More than half of inland water ecosystems (rivers, lakes and dams) have been degraded and are continuing to be threatened in terms of changed water regimes, pollution and conflicts over resource use. Similarly, signs of environmental degradation and decline in coastal and marine biodiversity.

b) Cost of deforestation

The analysis by (NAFORMA, 2014) assumed that deforestation levels, which on average were 372,816 ha per year between 1995 and 2010, would remain constant for the next 20 years: 2013–2033. A discount rate of 5 per cent was used, which is the rate that the Bank of Tanzania uses in analysing long-term investments.

There are two types of deforestation costs. First, once a hectare of forest has been cut down that same hectare does not contribute any more to the value added of the forestry sector the following year. Second, there are multiplier effects as investments in the forestry sector contribute to the value added of other sectors in the country. In other words, deforestation will reduce this positive indirect effect on other sectors. Combining these two costs results in total costs of TZS 83,771 per hectare per year (2013). Based on deforestation rates of 372,816 ha per year, the discounted costs for the period 2013 to 2033 amount to a total cost of TZS 607 billion (USD 263 million) (URT, 2015).

c) Energy loss

Deforestation (particularly in watersheds and water sources), has further knock-on effects due to reduced water flows and subsequent interrupted power generation in hydroelectric schemes such as Mtera and Kihansi.

Continued biodiversity loss, unsustainable utilization and associated degradation of a wide range of ecosystem services amounts to at least five percent (5%) of the national GDP and affects most severely the poor communities who depend most directly on their immediate environment for survival (URT, 2014).

7.5 Response

a) Preparation and implementation of policies, legislation, plans, strategies and programmes

The Government has formulated some new and reviewed some of the existing legislations to address issues of deforestation and forest degradation.The developed regulation is wildlife corridors regulations 2017 which aimed at protecting the pathways of animals from one ecosystem to another. The legislation under review include Plant Protection Act (PPA) 2019 and Agriculture Land Management Act 2019 is being formulated.

Several Strategies and action plans have been reviewed include National Environmental Action Plan (NEAP), the revised National Strategy on urgent Actions for Conservation of Land and water Catchments and the National Strategy for Conservation of Marine coastal environment, Lakes, rivers and dams.

Furthermore, several programmes and projects have been formulated and implemented to enhance forest conservation in different ecosystems in the country; these include Resilient Natural Resources for Tourism and Growth (REGROW), Lake Nyasa Catchments Sustainable Land Management, Addressing Climate Change Adaptation in Productive Coastal Zone of Tanzania, Adaptation Measures to Reduce Vulnerability of Livelihoods and Economy of Coastal Communities of Tanzania, Reversing Land Degradation Trends and Increasing Food Security in Degraded Ecosystems of Semiarid Areas of Tanzania, Ecosystem Based Adaptation for Rural Resilience in Tanzania (EBARR).

b) Promotion of traditional management practices

Traditional forest management such as *ngitiri* in Shinyanga; *alalili* in Maasailand; and *milaga* in Dodoma, are now recognized and it plays an important role in the management of forests and woodlands across many parts of Tanzania.

c) Participatory Forest Management (PFM)

The Government has been promoting participation of local communities in forest management through Joint Forest Management (JFM) and Community Based Forest Management (CBFM). It is estimated that about 5.4 million ha of forests are under JFM arrangements which represents 31% of the forest area under central and local governments.

d) Tree planting campaign

The Government continue to enhance Tree Planting Campaign under the MNRT - Forest and Beekeeping Division through TFS. According to the Strategy for Urgent Actions on Land Degradation and Water Catchments (2006) which is under review requires each District is supposed to plant not less than 1.5 million trees. However, some districts have set their own targets depending on their Action Plan.

e) Promoting LPG as an alternative energy for cooking

Increase household use of gas for domestic purposes and hence reduce consumption of biomass and protect environment whereby volume of LPG imported has increased from 24,470 metric tonnes in 2011 to 90, 296 metric tonnes from in 2016(URT, 2018). Furthermore, during the period of 2017/2018, LPG Marketing Companies (LMCs) imported 120, 961 MT of LPG. This is an increase of 13% compared to LPG 107, 083 MT imported in the last financial year 2016/17. (URT - EWURA 2018).This indicates increased use of LPG as an alternative energy source.

f) Establishment of forest plantations

TFS has continued to secure new areas for establishment of forest plantations including changing status of degraded forest reserves for the same and acquisition of new areas. Six new plantations namely, Morogoro (Morogoro), North Ruvu (Pwani), Korogwe (Tanga), Chato (Geita), Mpepo (Ruvuma), and Iyondo Mswima (Mbeya) were established. A total of 121,922 ha was secured for plantation establishment of the new Chato-Biharamulo plantation (Table 7-1).

Table 71: New forest plantations established by TFS between 2014 and 2017

Plantation name	Year established	Total area (ha)	Area planted (ha) to date	Remarks
Morogoro	2014/15	12,950	37	Forest reserve area converted to plantation
North Ruvu	2014/15	20,000	523	Forest reserve area converted to plantation
Chato - Biharamulo	2017/18	50,000	440	Part of FR converted to plantation.
Mpepo	2017/18	2,017.21	395	Newly acquired area.
IyondoMswima	2017/18	12,000	200	Forest reserve area converted to plantation.
Korogwe	2014/15	10,805	220	Degraded Forest reserve area converted to plantation
Pagale	2017/18	12,950	-	Degraded Forest reserve area converted to plantation. It is under management of Mtibwa forest plantation
Buhigwe	2016/17	1,200	60	Newly acquired area and planting

(Source: URT, 2018)

CHAPTER EIGHT

BIODIVERSITY LOSS

8.1   Introduction

Tanzania is one of the twelve mega-diverse countries of the world, and the nation's biological diversity has important economic, technological and social implications. The country hosts six out of the 25 globally known biodiversity hotspots. The country has extensive diversity of species with at least 14,500 known and confirmed species and is among 15 countries globally with the highest number of endemic as well as threatened species. The country is a home to about 20% of Africa's large mammals.

The dependency on biodiversity for socio-economic development in Tanzania is underscored by the rendered ecological services, source of food and medicines, source of building materials and energy as well as perpetuation of nature as decomposers of organic wastes and enrichment of soils and aquatic environment. Thus the conservation of biodiversity in Tanzania is vital to humanity's economic and social development of the country.

Biodiversity are vital assets for the wellbeing of people and economic growth of a country. Also, the integrity of biodiversity determines the wellbeing and extent of wildlife stability in a particular locale. Alteration of the integrity of biodiversity at any level impairs the wellbeing of both human and wildlife. Globally, Biodiversity loss is identified to be a major threat that is affecting and will continue to affect wildlife wellbeing and consequently impact on human survival and economic nourishment on the globe if no mitigation measures taken.

Despite being biodiversity rich, the country continues experiencing a rapid loss in biodiversity mainly emanating from anthropogenic rather than natural influences. Impact on biodiversity loss consequently affects the ecosystem processes which ultimately impair on ecosystem goods and services that are eminent for environmental sustainability, social and economic development.

8.2   Drivers

a) Rapid population growth

The increasing population growth at 52.6 million (2017), coupled with unsustainable socio-economic activities, poses a major threat to the country's biodiversity. Since majority of the population resides in rural areas and depends on subsistence agriculture, whose harvests are highly unreliable. The rural community is forced to depend on natural resources such as forests in order to meet their basic needs such as firewood, food, water and income. This leads to unsustainable exploitation of forest resources and clearance of forests, wetlands and grasslands and over-exploitation of wildlife.

b) Increasing demand and trade for plant and animal species

Demand for some plant and animal products, mainly recognized to be of high value is progressively growing. Ivory, horns, game meat and skins are some of the animal products driving to loss of animal biodiversity. There are also markets for some bird and reptile

species in various countries. As demand for these species increases, smuggling increases simultaneously, leading to over-utilization and eventually disappearance. For example, hardwood demand for timber and other uses increases pressure and illegal harvesting of hardwoodtree species like *Pterocarpusangolensis* (Mninga), *Dalbergiamelanoxylon* (Mpingo);*Chlorophoraexcelsa* (Mvule) and *Afzeliaquanzensis* (Mkongo). These species are threatened and are nearly to extinction.

c) Invasive Alien Species (IAS)

The most recent data shows that, there are more than 198 IAS in the country, making Tanzania the most vulnerable country in East and Central Africa.Invasive species are considered the second major factor leading to the loss of biodiversity after habitat loss. Human mobility, road construction and soil transfer, climate change, agriculture intensification and disturbances of habitats are the major driving forces leading to spread of IAS in the country. Invasive Species replace the native species and colonizes the area which in turn transforms the landscape and destruct the ecosystem process and functions leading to loss of biodiversity.

| a) *Parthenium hysterophorus* infestation in a bean crop field in Kijenge, Arusha Municipality | b) *Chromolaena odorata* infestation on cassava crop in Nyasense village, Serengeti District |
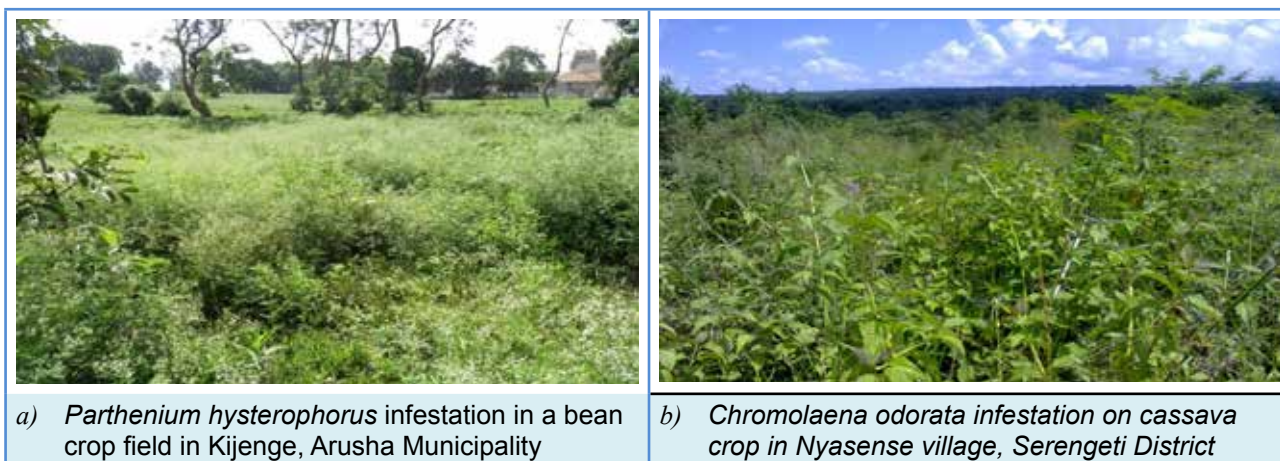
Figure 81: Invasion of alien plants in some crop fields in the country (URT, 2015)

Currently, the rate of invasion and spread of invasive species is very high in protected areas including national parks, game reserves, game controlled areas, forest reserves and Ngorongoro Conservation Area. For example, in Ngorongoro Conservation Area, the *GutenbergiaCordifolia*(Figure 8-2) has proliferated in the rangeland particular in the crater where it has replaced most native grasses preferred by wild animals. Likewise, invasion of water hyacinth and other weeds in Lakes Victoria, Jipe and Rukwa has posed threat to biodiversity.

Figure 82: *Gutenbergia Cordifolia(left)* is threatening Ngorongoro Conservation Area *(right)*

d) Climate change

Severe droughts as a consequence of climate change exert pressure on biodiversity and ecosystems at large. The country has been experiencing frequent and severe droughts leading to poor harvests. These impacts coupled with rapid population growth, low adaptive capacity of the rural communities to the impacts of climate change has resulted into unsustainable resource use that in turn negatively affect biodiversity. Furthermore, drying of water bodies (e.g. rivers, charcol dams, dams, lakes and wetland) due to severe and prolonged drought contributes to the loss of biodiversity in such areas.

8.3   Pressure

a) Agricultural expansion

More than 70% of the population in Tanzania resides in the rural areas where they are engaged in subsistence agriculture which is characterized with low productivity. There is huge demand for land for crop production to feed the fast growing population both in the rural and urban areas. Expansion of agricultural land coupled with unsustainable agricultural practices pose a great threat to the biodiversity. Furthermore, the demand for new areas for agricultural expansion has forced some farmers to encroach protected areas creating serious pressure to wildlife resources.

b) Unsustainable use of agricultural inputs

Use of excessive agricultural inputs and uncontrolled disposal of domestic and industrial effluents are some of the main sources of pollution and eutrophication, which exert tremendous pressure to aquatic biodiversity. For example, eutrophication of water bodies leads to increased species mortality, changes in species assemblages and loss of aquatic flora and fauna diversity. Furthermore, unsustainable use of fertilizer and pesticides used in agriculture and against disease vectors can accumulate in rivers and other freshwater bodies, with significant negative consequences to the aquatic species survival and so leading to loss of biodiversity.

c) Nutrient loading in aquatic environment

The increasing nutrient loads in ocean, lakes, rivers, wetlands are becoming a driver of biodiversity loss in the aquatic ecosystem. Blooms of green algae on water surfaces are good indicators of excessive nutrient loads. The major cause of nutrient deposition includes; land use change, hydrological disturbance and pollution. Excessive deposit of such nutrients in aquatic area destructed the coral reef and other breeding sites for fish and other aquatic organism. Also, regular application of industrial fertilizers over time coupled with unsustainable farming practices simultaneously increases the deposition of Nitrogen nutrient in the soil which in turn limit major nutrients uptake and accelerates the leaching loss of base cations that may also be limiting or favouring some plant species over others.

8.4   State

a) Loss of ecosystem diversity

The long-term viability of wildlife populations depends mainly on the habitat among others factors. Changes in habitat have substantial impact on wildlife population and biodiversity at all levels. Although, the response of species to habitat loss and other environmental changes is typically not instantaneous, especially when considering changes at large spatial scales, it is certain that any loss of habitat has been, and stills the major factor threatening the biodiversity across the world. The loss leads to gradual decline of number of species and go extinct. The loss of habitat often involves decrease in area or fragmentation and deterioration of quality of habitat caused by either intentional change in land use, such as the conversion of forested land to other land use patterns or due to unintentional damage.

Tanzania has lost about one-third of important ecosystems over the past few decades undermining livelihoods of many people who depend directly on them. Forests occupy 55% of the total land area (about 48.1 million ha). Tanzania has lost about 38% of its forest cover at an annual rate of about 469,420 ha and if this rate escalates coupled with demographic and economic pressures, the country may deplete its forest cover in the next 50-80 years. More than half of inland water ecosystems (rivers, lakes and dams) have been degraded and are continuing to be threatened in terms of changed water regimes, pollution and conflicts over resource use. Similarly, signs of environmental degradation and decline in coastal and marine biodiversity are becoming more obvious with the country losing about 44,000 ha of mangroves over the last 30 years (1980-2010).
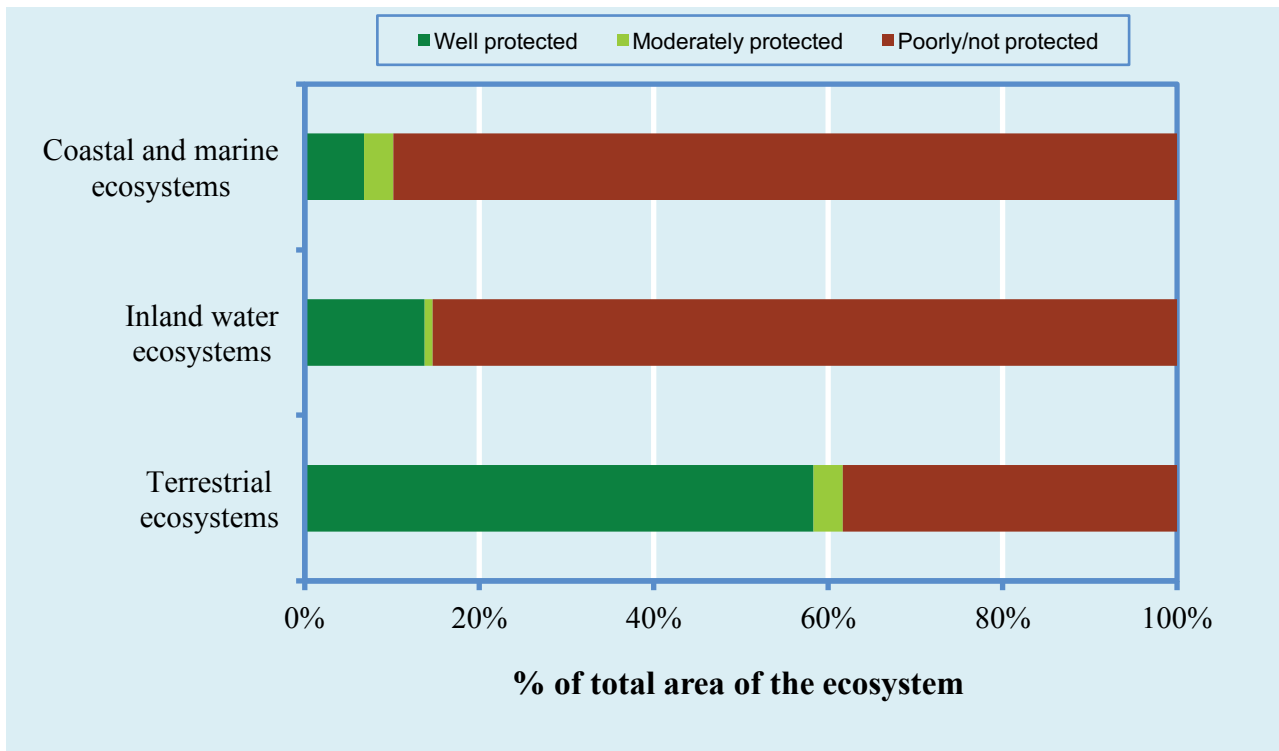
Figure 83: Protection level of different ecosystems in Tanzania

The designated forest and wildlife protected areas surpass the international target (2020 Aichi Biodiversity Targets). However, marine protected area is lagging behind. The aim of Government plans is to gradually expand these areas to attain national target that is set at 10% by the year 2020. About 40% of the total land area has been designated as forest and wildlife protected areas exceeding the international target of 17%. Tanzania has a total territorial sea of 32,000km^2 of which the gazetted Marine Protected Areas (MPAs) is 2,173 km^2 that is about 6.5% of the territorial sea (URT, 2014).

b) *Declining species diversity*

There is inadequate information and data to generate reliable trends on the status of species diversity in the country. However, there are multiple indicators suggesting overall declining trends for a significant number of species. The flora and fauna of Tanzania is extremely diverse with at least 14,500 known and confirmed species, out of which, more than half of them (54%) constitute plant species. The country has between 400-3,000 endemic species. Of the endemic species, the proportion of threatened species is highest for mammals and cycads while the highest number of threatened endemic species is found in amphibians (URT, 2014).The number of threatened species in the country has almost tripled over the last decade which can be linked to habitat loss, fragmentation and degradation as well as climate change impacts. There are 914 threatened species recorded in Tanzania (accounting for about 4% of threatened species globally) and the country is among 15 countries globally with the highest number of threatened species. The proportion of threatened species is highest for plants and amphibians while the highest number of threatened species is found in plants which is more than 375 species (URT, 2014).
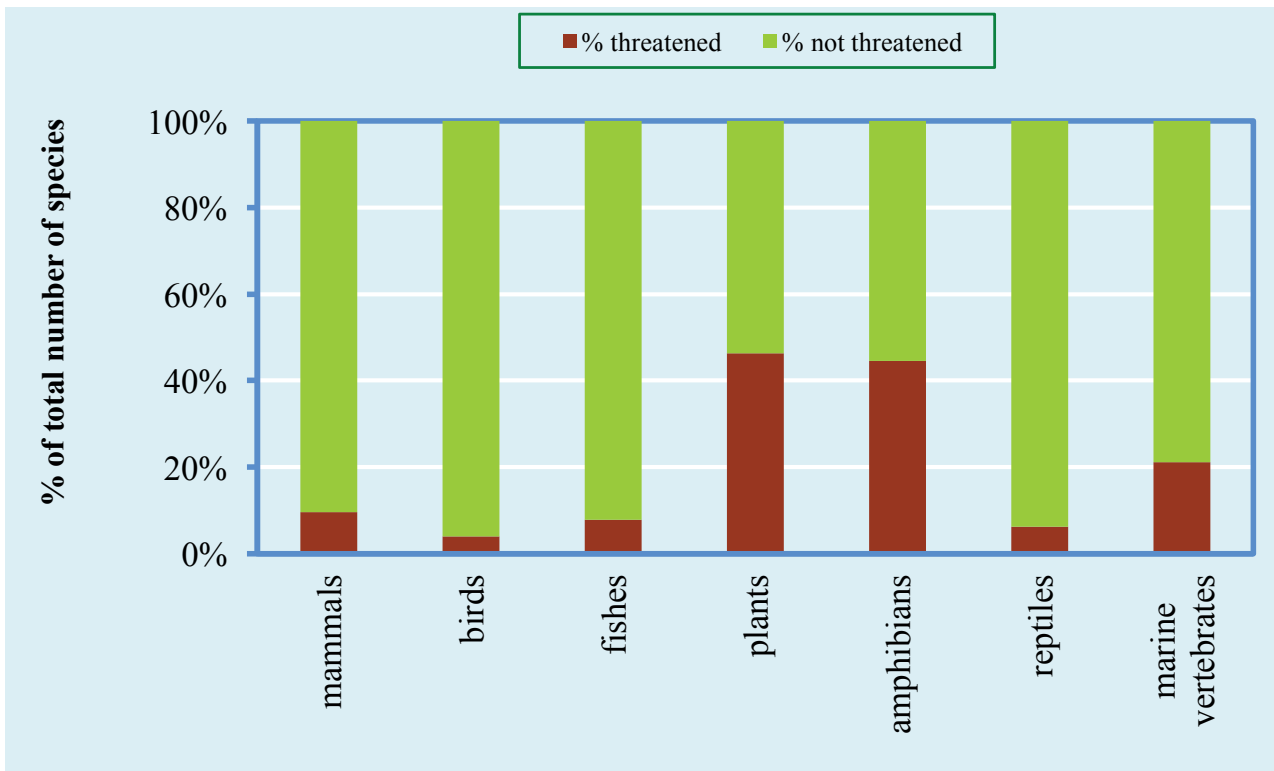
Figure 84: Approximate proportions of endemic species for some of the major taxonomic groups

Notwithstanding the country's richness in wildlife biodiversity, the sector is under tremendous pressure. The key species that are under this pressure include the larger carnivores such as lions, leopards, cheetahs, wild dogs and the herbivores group includes population of elephants, giraffe, zebras, buffalos, antelopes, wildebeests, and black rhinoceros could be increase or decrease depending on a number of factors such as loss of habitats, prolonged drought and poaching. Out of these species, rhinoceros and elephants are the most highly endangered due to poaching.

The elephant Total Count (TAWIRI, 2015) from six key ecosystems give a total population size of 42,469 elephants. Adding up all other protected areas, the elephant population size estimate in Tanzania is 43,521. The current estimated elephant population in Tanzania has declined significantly from 109,051in 2009 to 43,521 in 2014; a 60% decline. The major declines occurred in Malagarasi-Muyovozi 81%, Ruaha-Rungwa 76%, and Selous-Mikumi 66%. Despite this, elephants increased by 98% in Serengeti and 64% in Tarangire-Manyara in reference to 2009 countrywide elephant census.
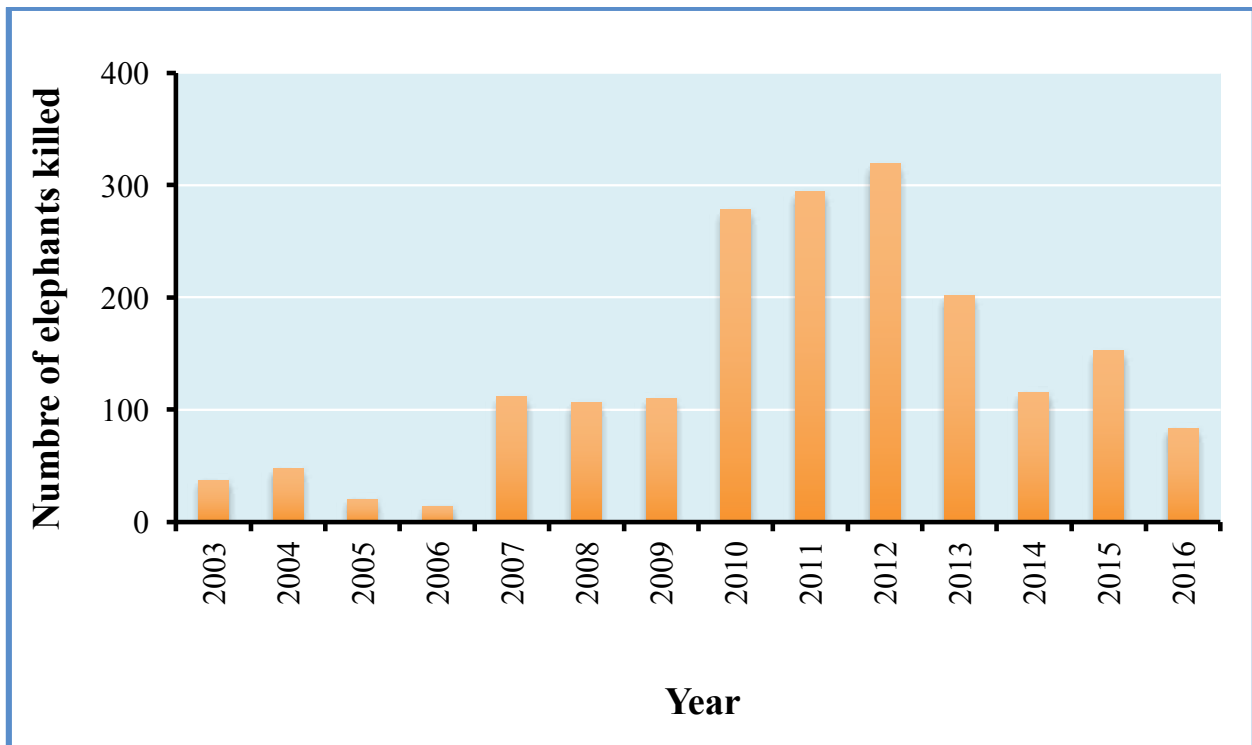
Figure 85: Number of illegally killed elephants in all protected areas in various years (TAWIRI, 2018)

The number of elephants illegally killed has relatively been decreasing comparing with years 2010 – 2013 (Figure 8-5). Probably the government ant-poaching efforts and closure of the ivory market in China could account for the difference.Apart from improvement in numbers of illegally killed elephants, poaching of other animal species has been reported. For example, in Serengeti alone a range of 97,796 to 140, 615 wildebeest reported to be poached annually (Dennis and Parker, 2015).

c) Declining genetic diversity

Genetic diversity seems to be declining in natural ecosystems as well as in agricultural and livestock production systems. The extents of such decline and its overall impact have not been documented. Comparatively, significant progress has been made for ex-situ conservation of plant and crop genetic resources than for livestock. A total number of 1,729 crop germplasm are conserved nationally while a total of 4,430 germplasm collected in the country are conserved in international gene banks. More than 95% of the conserved germplasm nationally are landraces or traditional cultivars while about 3% are materials collected from the wild. In contrary, conservation of animal genetic resources in Tanzania is done at a very limited scale both in-situ and ex-situ resulting into extinction of some breeds.

8.5   Impact

a) Loss of ecosystem goods and services

Biodiversity as part of the ecosystem underpins all human life and activities. The goods

and services biodiversity provides are vital at sustaining human well-being, and to future economic and social development. The benefits provided by biodiversity among others include food, water, timber, air purification, soil formation and pollination. Loss of biodiversity due to human activities results in altered capacity of healthy ecosystems to deliver this wide range of goods and services to the community and economy. For example the increasing trend of biodiversity loss put in danger an account of the 909 globally threatened taxa (793 species, 74 subspecies, 42 varieties) of animals and plants in the Eastern Arc Mountains.

b) Economics of biodiversity loss

Biodiversity is critical to the national economy contributing more than three quarters of the national GDP and sustaining livelihoods of majority of Tanzanians. Agriculture, livestock, forestry, and fisheries together contribute over 65% of GDP and account for over 80% of total employment and over 60% of the total export earnings. Furthermore, forests provides for over 90% of energy consumption in the country while hydropower contributes about 37% of power supply in the country. The average Total Economic Value (TEV) of catchment forest reserves was established to be more than 17,250 USD/ha. On the other hand, tourism industry is now worth over USD1 billion annually (URT, 2014).

The economic losses emanating from water pollution are also significant since degraded aquatic system limits usage of water and sometimes require water treatment, which is a costly undertaking. It is estimated that impacts resulting from poor sanitation and hygiene cost the country about USD 206 million per year or equivalent to 1% of annual GDP (URT, 2015). Equally important are losses of revenue emanating from lost tourism and recreation opportunities as a result of polluted beaches, and due to illegal activities such as poaching, illegal logging and illegal fishing, and associated conservation costs to combat these activities. Economic losses may have more severe effects at household level especially in poor communities, which depend solely on biodiversity for their livelihood.

c) Increased costs of conservation

The increase in poaching incidences has continued forcing the government to incur enormous amounts of funds in recent years to address this problem. These funds could have been allocated for other developmental activities. In its efforts to combat the escalating poaching problem, in 2013 the Government launched a special anti-poaching operation known as "OparesheniTokomezaUjangili" to crack down on poachers, dealers and traders in ivory and other elephant products.

d) Socio-economic loss

Continued biodiversity loss, unsustainable utilization and associated degradation of a wide range of ecosystem services amounts to at least five percent (5%) of the national GDP and affects most severely the poor communities who depend most directly on their immediate environment for survival.

e) Increased human wildlife interactions

There have been incursions of livestock in protected areas ranging from game controlled areas, game reserves up to the National Parks. This creates a pressure to wildlife and

jeopardizes health of livestock and humans as more that 60% of diseases affecting human being emanates from wildlife. Livestock encroachment is caused mainly by increased number of livestock, human population increase, absence of land use plan, unclear boundaries of protected areas and unscrupulous wildlife officers who colludes with livestock keepers. Increased humanlivestock and wildlife interaction has resulted to increased transmission of zoonotic diseases. Over recent years, there have been increased reported cases of anthrax in hospitals that are located in areas with high human-livestock and wildlife interactions. Despite the under reporting of the disease, Ngorongoro District had a tremendous increase in number of cases where in year 2016, 68 cases were recorded in hospitals in the District.

f) Increased Invasive and Alien Species (IAS)

There is a long list of IAS in the country ranging from plant pathogens (e.g. *Colletotrichumcoffeanum*, Invertebrate (Insect) pests (e.g. *Prostesphanustruncatus* (larger grain borer), Vertebrate pests (e.g. *Corvussplendens* (Indian house crow) and *Rattusrattus* (Black roof rat), Aquatic Weeds (e.g. *Eichhorniacrassipes* (Water hyacinth) and *Pistiastratiotes* (Water lettuce), terrestrial weeds (e.g. *Lantana Camara* (Lantana), Animals/ fish species (e.g. *Latesniloticus* (Nile perch), to Tree/shrub species (e.g. *Daturastramonium* (Common thorn apple).Parthenium weed, *PpartheniumHysterophorus*a fast maturing plant, which can survive under low moisture conditions, and produces many seeds (up to 25,000) that can remain dormant for 3-5 years is one of the many Invasive Alien Plants (IAP's) that has been accidentally introduced into Tanzania (Figure 8-7). The weed is reported to cause up to a 40% reduction in crop yields. Where it invades, it displaces pasture species, reducing available grazing.

Figure 86: *PartheniumHysterophorus* occupying maize field in Kyerwa district

8.6   Response

a) International and regional co-operation

Tanzania is a Party to the Convention on Biological Biodiversity (CBD) to join global efforts to conserve biological diversity, ensuring sustainable use of biological resources and promoting equitable sharing of benefits arising out of the use of genetic resources. Tanzania is also a party to other biodiversity-related conventions such as Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), RAMSAR Convention, and the Convention on the Conservation of Migratory Species of Wild Animals (CMS). Such initiatives also take place at regional and sub-regional levels where Tanzania is also a party. Regional treaties and agreements which Tanzania has ratified include the Lusaka Agreement; Convention on Sustainable Management of Lake Tanganyika; and Amended Nairobi Convention for the Protection, Management and Development of the Western Indian Ocean. All these complements government efforts to address the challenge of loss of biodiversity

b) Sectoral policies, legislation, strategies and plans

Major policies, strategies, legislations and plans that cover the integration of other sectors activities on environment and biodiversity in the country include: the Five-Year Development Plan 2016/17 – 2020/21, the National Energy Policy (2015), National Environment Policy (1997) which is currently under review; National Forest Policy (1998) which is currently being reviewed and Forest Act (2002); the Water Policy (2002); the Wildlife Policy (2007); the Land Policy (1995) which is also under review; National Fisheries Policy (2015); Environment Management Act (2004); Fisheries Act (2003); Village Land Act (1999); Land Act (1999); National Agriculture Policy (2013); Livestock Policy (2006); Wildlife Conservation Act (2009); the National Biodiversity Strategy and Action Plan (2015),the National Anti-Poaching Strategy (2015), Biosphere Reserve Strategy (2019), Species Management Action Plan (2018), Fisheries Sector Development Strategy (2018), Agricultural Sector Development Strategy (2016); the revised Strategy for Urgent Actions on Land Degradation and Water Catchments (2018); Plant Protection Act (1997) currently under review; the revised Strategy for Urgent Actions on Conservation of Marine and Coastal Environment, Lakes, Rivers and Dams (2018); National Strategy for Reduced Emissions from Deforestation and Forest Degradation (REDD+ - 2011); The National Water Sector Development Strategy; National Climate Change Strategy (2012); and the revised National Environmental Action Plan (2018). The Government has also prepared the National Forest Resources Monitoring and Assessment (NAFORMA) report (2013), which aims at assisting the country to map its forest resources. The information assists the country to assess its forest resources including the size of the carbon stock stored within its forests. This will also feed into better policy making to ensure Tanzania's most valuable forests are both conserved and utilized in a sustainable manner. This would also help to mitigate the negative impacts of climate change.

c) Engagement of non-state actors in biodiversity conservation and management

The Government recognizes the contribution of non-state actors (Non-governmental Organizations, Community Based Organizations and the Private sector) in the conservation of natural resources in the country. Environmental conservation activities by these stakeholders are countrywide, with varied levels of resources, scale and coverage. Tanzania

has continued to encourage stakeholders to engage in environmental management activities in the country. Local communities have also been participating in efforts related to conservation of biodiversity through arrangements such as Wildlife Management Areas (WMAs) and Beach management Units (BMUs). Some of the non-state actors include WWF, Frankfurt Zoological Society, Africa Wildlife Foundation, BTC, GIZ, JICA and IUCN.

d) Conservation and designation of new protected areas

About a third of the country's total area is protected as National Parks, Game Reserves, Marine Parks and Forest Reserves. For sustainable management of the protected areas, the country has established respective authorities that are charged with ensuring that the natural habitat, flora and fauna are protected including newly Tanzania Wildlife Management Authority (TAWA). At the time of this reporting, the government has elevated the status of three game reserves (Burigi, Biharamulo, and Kimisi) to National Parks. Further to this, two corridors of Litumbandyosi and Gesimasowa have been elevated to game reserves. In addition to these, the government also have nominated the Gombe-Masito-Ugala to man and biosphere reserves.

Currently the Community-Based Forest Management (CBFM) covers about 2.3 million ha mainly on forests in village lands. In case of wildlife protected areas, community around the national parks and game reserves are encouraged to form Wildlife Management Areas (WMAs) so as to benefit from the wildlife resources while protecting the wildlife. To-date, there are 22 gazetted Wildlife management Areas in the country. There about 739 established BMUs operating in Lake Victoria, Lake Nyasa, Lake Tanganyika and Lake Rukwa. Further to these, 18 Marine protected areas have been established which comprise 15 Marine Reserves and 3 Marine Parks.

CHAPTER NINE

ENVIRONMENTAL POLLUTION

Environmental pollution which involves contamination of the ecosystem and the surrounding atmosphere by different forms of pollutants is currently a growing problem in Tanzania. It has a significant harmful effect on the quality of water, air and land and on the quality of life in general. Environmental pollution commonly results from uncontrolled/haphazard disposal of various types of wastes including municipal, industrial, mine and mineral processing and agricultural.

9.1 Water Pollution

Water pollution is largely attributed to inadequate management of domestic sewage, especially on-site sanitation; industrial effluent; leachate from solid waste dump sites; leakage from fuel filling stations; automobile and repair garages; industrial workshops; and run off associated with urban agriculture. In mining areas, water pollution sources involves mine rock dumps, acid mine drainage and chemical contamination particularly mercury and cyanide from artisanal and small scale gold mining. Both licensed large, medium and small-scale miners and illegal miners often results in chemical spills and leaching of mining effluent that contributes to contamination of surface and groundwater sources. In case of farming, application of agrochemicals which eventually wash downstream and thus contaminating water sources.

9.1.1 Drivers

Key driving forces towards words water pollution are population growth, economic growth, climate change and poverty.

a) Population and economic growth

Water pollution is intensified by the rapid population growth and urbanization. The urban population of Tanzania is rapidly expanding, with quadrupled figures since 1990. By October, 2018, 32.6% of the population in Tanzania was urban.

The growing population and over extraction of natural resources and services has outpaced and compromised the capacity of responsible authorities to provide adequate related environmental related infrastructure including sanitation, solid and liquid waste management facilities.

For example, by 2016 only 20% of total urban population in Tanzania had access to central sewerage system (URT, 2018). The rest of the population use waste treatment facilities, which are defective thus jeopardizing public health and integrity of the environment.

b) Climate change

Climate change is associated with irregular floods. Worth noting that in eastern Africa, Tanzania is the most flood-affected country in the region. More intense rainfall and flooding could result in increased nutrients, suspended solids and sediment yields, thus compromising the

quality of surface water. Climate change may also cause seawater rise and thus influencing salinization leading to groundwater pollution in coastal areas.

c) Poverty

Poverty is related to among others economic growth and level of provision of various social services as well as management of various wastes emanating from them. Poverty is also associated with proliferation of unplanned areas characterized by lack of basic services particularly waste management infrastructure.

9.1.2   Pressure

a) Unsustainable agricultural practices

Water pollution is also attributed to unsustainable agricultural activities notably improper use of agrochemicals (pesticides and inorganic fertilizers) and poor farming methods, which are responsible for soil erosion and consequently sedimentation of river bodies.

b) Unsustainable industrial activities

Tanzania's real gross domestic product (GDP) of about 7.1% in 2017 was supported by expansion in both the industrial and agriculture sectors. About 80% of industries in Tanzania, which includes agro-industries, chemical factories, breweries, soap and steel-manufacturing establishments, are located in Dar es Salaam City. Many of these industries were established without adequate environmental attention; as a result they have been operating with inadequate waste treatment facilities.

The industrial effluents and by-products are discharged in the water bodies. Some industries have been responsible for water pollution by the chemical discharges from the industries. The pollutants are for the most part toxic to humans and animals and in some instances and also interfere with the environment by polluting soils. Dar es Salaam provides a large proportion of the city's industrial employment but consequently a larger portion of the urban environmental pollution. Most industries have no proper liquid-waste treatment and disposal systems, and consequently pollute soils, groundwater and the surface water.

c) Unsustainable mining activities

While there is records of good mining practices, in some projects mining activities have led to water pollution due to Acid Rock Drainage (ARD) and chemicals especially mercury (for small scale mining) and cyanide (for medium and large scale mining). Pollution of water due to mining activities is more pronounced in the Lake Victoria Basin (LVB), which is well endowed with rich mineral deposits of gold and diamonds. Both large and small-scale mining activities are carried out. A large number of small-scale miners for example in Katente mining site are involved in digging gold which is related to a number of disaster risks. Figure 9-1 indicates various small scale gold mining activities in Katente mining site.

Katente ward map showing gold mining pits in Katente mining site	a) Women miners engaged in digging, hand sorting and blending at Katente mining

Figure 91: Small scale mining activities at Katente mining site
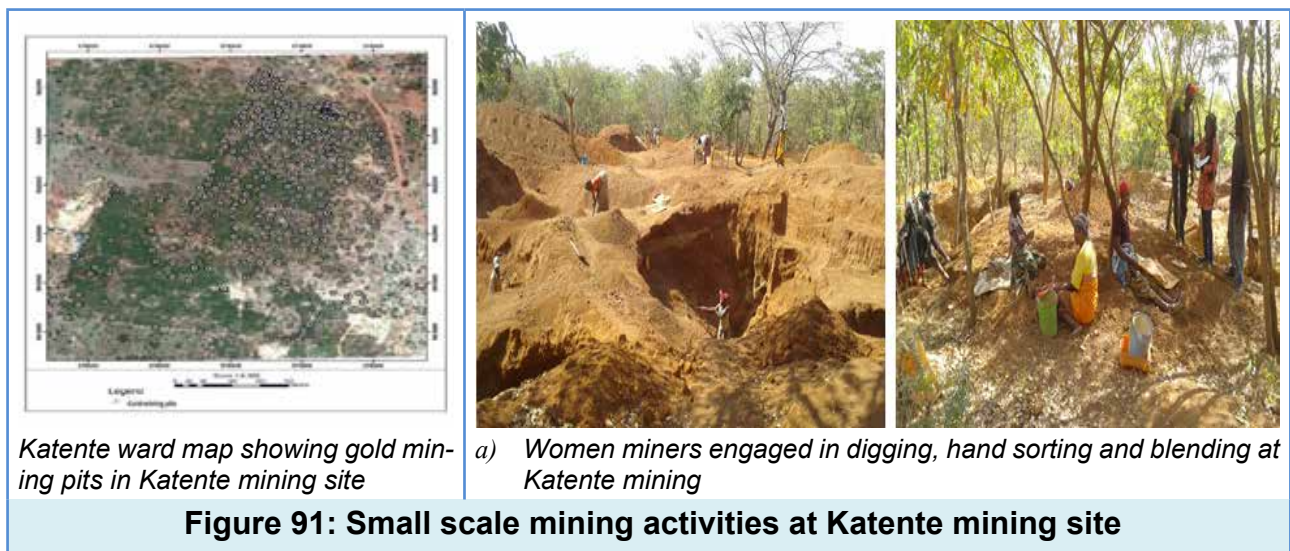
9.1.3 State

a) Water quality

Water pollution is a growing environmental problem in Tanzania. Some of the major lakes are reported to be polluted with accelerated eutrophication from elevated phosphorus, nitrogen and chlorophyll-a concentrations, of the growing human activities in the catchment area and around the lake. As such, water pollution emanates from a number of point-source pollution loads (e.g. domestic, and industrial) and on-nonpoint pollution (e.g. land runoff and leaching of nutrients).

b) Waste management

Pollution of water sources for most urban centres in Tanzania originates from poor disposal of solid wastes and liquid wastes–essentially discharge of raw or inadequately treated wastewater effluents to water sources. This is due to lack of adequate wastes and sanitation facilities and poor hygienic practices as discussed in chapter three. Currently, only 20% of the urban population have access to sewerage services. Sanitation provision rates in Tanzania has improved greatly since 2005, whereby improved and unshared facilities covered 43% of the urban population in 2016 up from 14.2% in 2005.

c) Rivers and streams

In large urban centres in Tanzania such as Dar es Salaam, water bodies are used for final wastewater effluent disposal. For example Mlalakuwa a seasonal River in Kinondoni Municipality in Dar es Salaam that discharges to the Indian Ocean is commonly used as an open drain for untreated wastewater and for solid wastes disposal. This in turn affect the natural health and status of the river. Plate 9.2 indicates discharge of wastewater from the industry to the Mlalakuwa River, while Table 9-1 presents pollution loads as determined in Mlalakuwa River. As can be noted level of different parameters involving: microbiological, physical-chemical, nutrient, organic and heavy metal parameters exceeds the permissible standard also indicated in Table 9-1.

Figure 92: Discharge of wastewater from an industry to the Mlalakuwa River

A study on pollution assessment along Msimbazi River, Tanzania indicated various types of industries and activities that discharge effluent into Msimbazi River in Dar es Salaam(Chanzi, 2017). These include garages, car washing facilities, leachate from Old Kigogo dumpsite, abbatoir, and food processing industries. Figure 9-3 indicates leachate as discharged from Vingunguti abattoir into Msimbazi River (Chanzi, 2017). The sources of wastewater influents into Msimbazi River include various human activities agriculture and industries located within Msimbazi valley.

Table 91: Water quality in Mlalakuwa River

Parameter	Permissible limit	Measured level	
		Minimum	Maximum
T.C (count/100ml)	10,000 (count/100ml)	0 (count/100ml	2,424,000 (count/100ml
Nitrate (mg/l)	20 mg/l	4.4mg/l	1925mg/l
Sulphate (mg/l)	500 mg/l	2.3 mg/l	3216.7mg/l
DO mg/l	6.0 mg/l	0.13 mg/l	11.8mg/l
BOD mg/l	30.0 mg/l	2.5mg/l	130mg/l
COD mg/l	60.0 mg/l	3.1mg/l	162mg/l
Cr mg/l	2.0mg/l	0	0.093
Pb mg/l	0.1mg/l	0	1.77
Cu mg/l	0.1mg/l	0	4.46
Ar mg/l	0.005mg/l	0	0.08
Zn mg/l	0.05mg/l	0	0.44
Mn mg/l	5.0 mg/l	0	4.5

(Source: URT, 2016)

Figure 93: Leachate discharge at Vingunguti abattoir into Msimbazi River

On the other hand improper solid waste management contributes to air pollution, surface and groundwater contamination and public health challenges. In many urban centres in Tanzania the amount of solid waste generation from household and various other economic activities is increasing and in some cases only small proportion of the total waste is collected and disposed of. As discussed in chapter three for example in Dar es Salaam city waste generation has indicated an increasing trend, but substantial amount still remain uncollected resulting into various types of pollutions. Figure 9-4 indicate various forms of pollution in Jangwani area in Dar es Salaam city. As can be note some stream running through the area is highly polluted with human waste and industrial and other human activities.

a) Haphazardly disposed plastic waste

b) Water supply

| c) sub-standard pit latrine | d) A section of the Msimbazi River |

Figure 94: Pollution arising from different sources, Dar es Salaam City

d) Groundwater

Solid and liquid wastes from various large and small-scale manufacturing industries and workshops are the main sources of ground water pollution. As a result of absence or inadequacy capability of the generating entities and municipalities, dumping of all forms of liquid and solid waste is done inappropriately leading to pollution of various ecosystems including groundwater.

Unreliability of surface water in urban area has resulted in increasing ground water dependency for drinking, irrigation and industrial purposes. Dependency of ground water in some areas such as coastal areas has resulted in seawater intrusion and pollution of fresh groundwater near the Indian Ocean. In Dar es Salaam City, nitrate pollution of groundwater is the result of contamination by wastewater from pit latrines and leakage from septic tanks. High nitrate concentrations with a maximum of 421 mg/L than the permissible upper limit of 75 mg/L have been reported in various ground water sources in the city (Mtoni *et al*, 2014) (Figure 95).
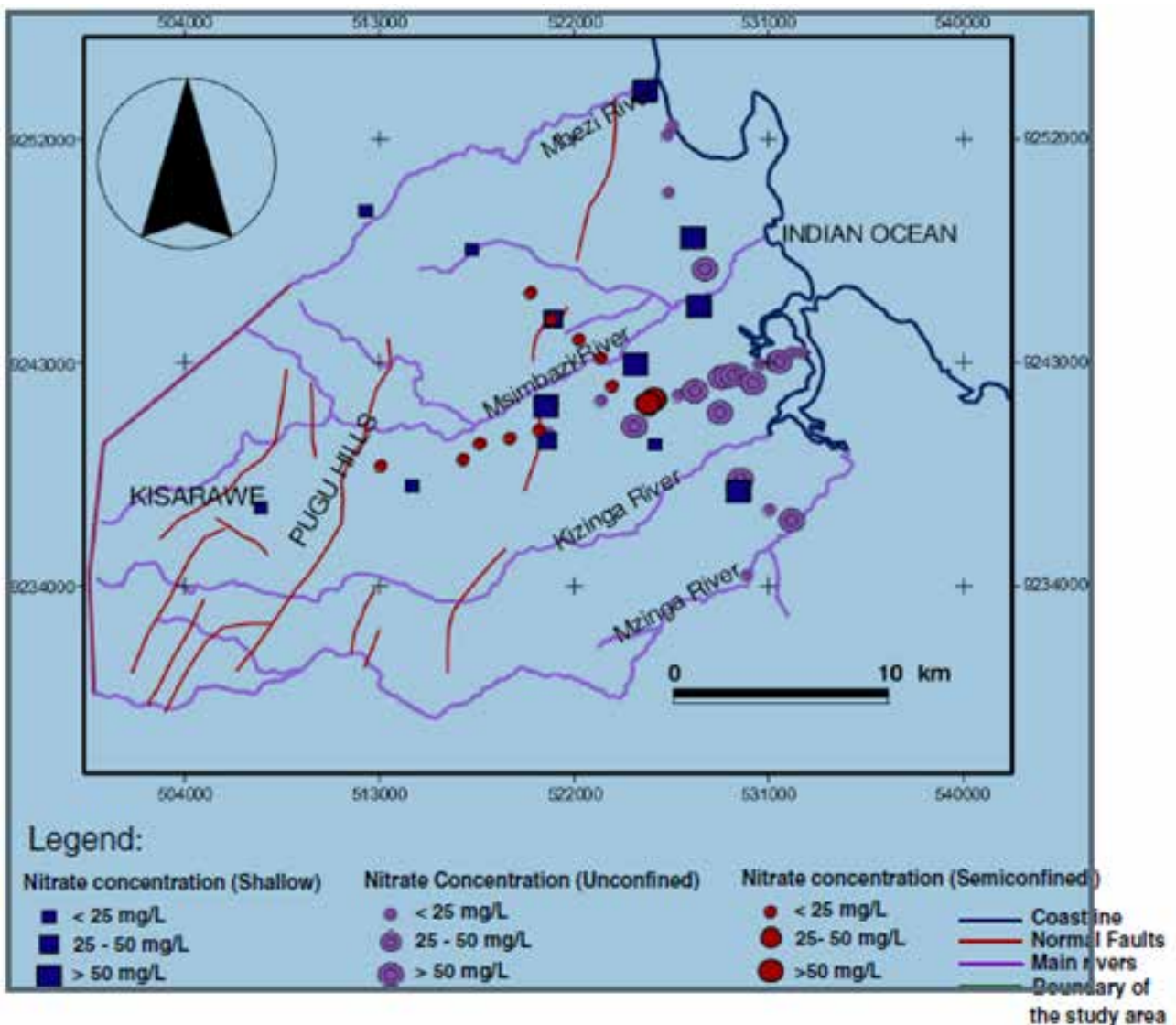
Figure 95: NO$_3$- concentrations in Dar es Salaam quaternary sand aquifers

(Mtoni *et al*, 2014)

9.1.4 Impacts

a) *Increased water-borne diseases*

Waterborne disease are among infectious diseases spread primarily through contaminated/ polluted water. Figure 9-6, for example, shows the number of affected people by various waster borne diseases in Lake Victoria basin between 2009 and 2015. The diseases are: cholera, dysentery, typhoid, schistosomiasis, intestinal worms and diarrhoea as reported by (EAC - LVEMP, 2018). According to National Health Policy (2007), Water, Sanitation, Hygiene and Food Safety problems remain of big concern in the country since more than 60% of OPD diagnosis has been associated with poor sanitation and hygiene practices. This results into increased cost of treatment of ailments associated with ground water pollution (such as diarrhoea, dysentery and cholera) which in turn also results into loss of productive time due to illness.
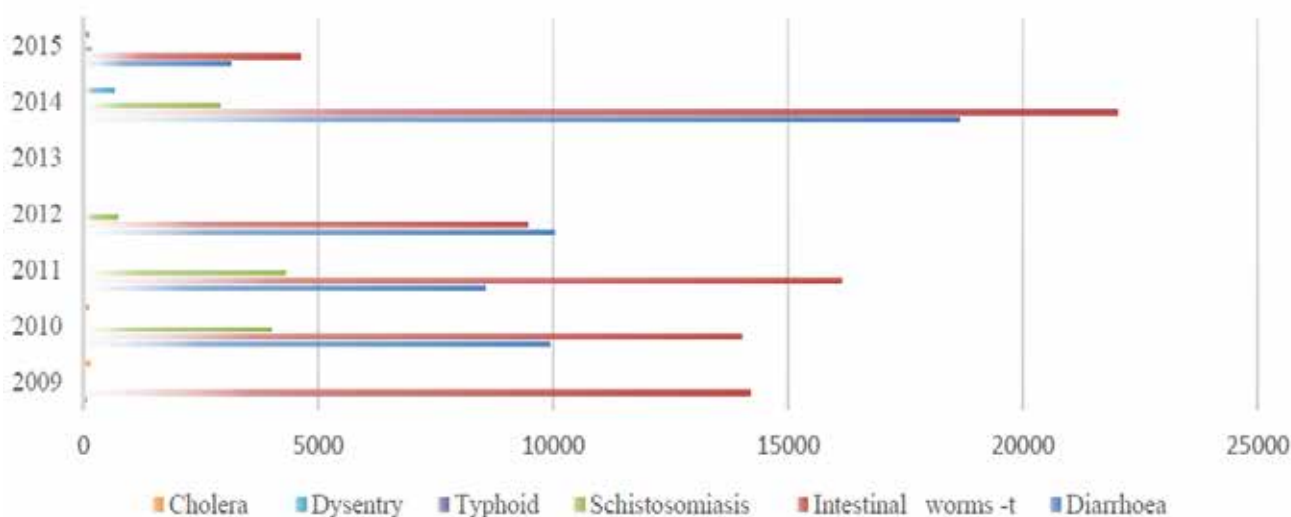
Figure 96: Water borne diseases in Musoma town, 2009-2015 (EAC - LVEMP, 2018)

b) Increased water treatment cost

Water pollution has been partly responsible for increasing operational costs due to increased use of chemicals for water treatment for removal of pollutants such as turbidity and pathogenic microorganisms.

c) Decrease of water sources

Ground water pollution can also render large quantities of water unsuitable for human and other uses. Ground water is normally threatened by pollution from various sources including domestic wastes, industrial wastes, agricultural wastes, and run off from urban areas. All of these contaminants finds their way into local water bodies and subsequently to ground water, thus leading to both surface and ground water quality problems and in turn limit them as water supply sources for the communities.

9.1.5 Response

a) Policies and legislation

The Government has adopted several policies and legislation, which aim at curbing pollution of water bodies. These include the National Environmental Policy (1997) that advocates the prevention and control of pollution of fresh, marine and coastal waters, including that from land-based sources. This policy statement is supported by the Environmental Management Act (EMA-2004). The Water Resources Management Act (2009), which provides for institutional and legal framework for sustainable management and development of water resources; outlines the principles for water resources management; provides for the prevention and control of water pollution and participation of stakeholders and the general public in implementation of the National Water Policy. International and regional initiatives to curb water pollution include the Nile Basin Initiative, the Lake Tanganyika Integrated Regional Development Programme and Lake Victoria Environmental Management Programme. Again currently the National Plant Protection Act (1997,) which makes provisions for to prevent the introduction and spread of harmful organisms, to ensure sustainable plant and environment

protection as well as regulating the export and imports of plants and plant products is under review.

b) Engagement of non-state stakeholders in environmental pollution control

Private sector and NGOs have been involved in natural resources issues including water pollution control. Some of the NGOs active in water pollution control include AGENDA, ENATA, EEPCO, PECCO and CONCERN. Water users associations have also been established by communities in various water basins.

c) Cleaner production initiatives

Cleaner industrial production initiatives have contributed significantly to reduction of pollution. In recognition of the role of cleaner production approach in solving industrial pollution problems the Government established the Cleaner Production Centre of Tanzania (CPCT) to promote the rational use of energy and raw materials and minimize waste generation from industries. This is because the best point of application of the preventive principle to reduce waste and emissions is the initial planning phase of a new industry

9.2 Air Pollution

The major sources of air pollution in Tanzania and especially in major cities like Dar es Salaam are motor vehicles (believed to be the primary source affecting ambient air quality), industrial pollution and residential burning of waste and fossil fuels. The number of vehicles continues to grow from year to year and emissions of gases from vehicles (including PM_{10}) contributes to a large extent to air pollution causing respiratory problems, especially in the young and the elderly. Inadequate urban planning is a significant driving force behind rising emission levels, because residential and commercial centres are often far apart, forcing mass movement of workers on a daily basis. Air pollution poses a serious problem in urban areas with rapid urbanization and industrialization.

9.2.1 Drivers

a) Economic growth

The urban air pollution problem is growing as economic development drive increases combustion of fossil fuels for transportation and industrial processes. In major urban centers air quality is a worsening problem due in part to rapidly growing industrial establishments, vehicle fleets, limited road infrastructure, road congestion, and high per-vehicle emissions. Most of the imported vehicles in the country are old with poor fuel efficiency thus contributing to air pollution in urban centers.

b) Urbanization

High population growth and the continuing rapid rate of urban growth in Tanzania have put significant pressures on existing urban infrastructure including road network and resulted in significant unplanned development leading to traffic congestion and consequently air pollution problems.

9.2.2 Pressure

a) *Inadequate enforcement of relevant legislation and regulations*

There has been inadequate enforcement of relevant legislation and regulations due to inadequate capacity to enforce in terms of human and financial resources.

b) *Inadequate urban planning*

Despite the rapid urbanization, there has not been a corresponding effort by the Government in guiding urban planning in response to rapid urbanization rate. Rapid spatial growth and population growth in Dar es Salaam, coupled with a rise in car ownership, is putting strain on Dar es Salaam's insufficient road network. Figure 9-7 shows a case of inadequate planning and its implications in terms of difficult vehicle movement in urban centres.
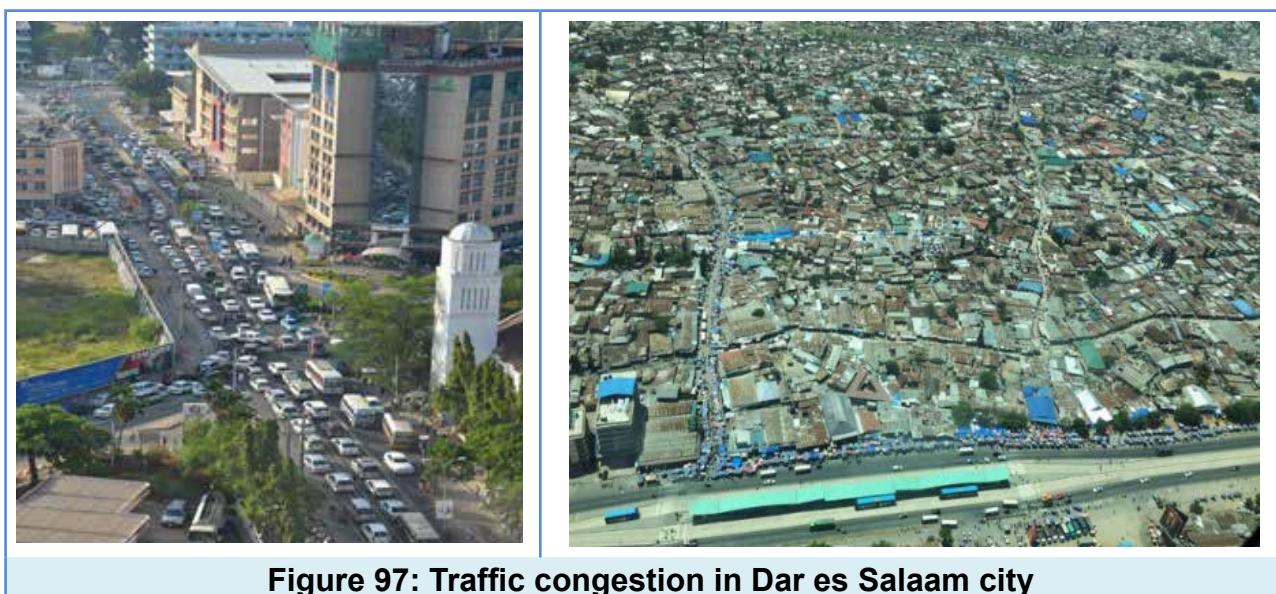
Figure 97: Traffic congestion in Dar es Salaam city

Inadequate urban planning and random development of small-scale industrial and workshop activities in residential areas cause environmental nuisances such including air pollution which also may result into heat emissions. These nuisances are both harmful to the environment and local populations negatively affecting the quality of life in those areas.

9.2.3 State

Air pollution problem is evident in terms of urban road congestion in urban centers in Tanzania where the number of vehicles required to meet demand exceed the capacity as the growth rate of population of vehicles in urban areas does not keep pace with the expansion of road network. For example Figure 9-8 shows that the number of vehicles that passes through Selander Bridge in Dar es salaam city, only on Friday varies from around 16,000 to 18,000 depending on the type of vehicle. Congestion on the bridge and perhaps the entire urban centers is less on Saturdays most probably because many urban residents don't go to work over the weekends.

In some cases breathing these highly toxic chemicals can even lead to the fatal to humans, can harm fish and other aquatic life and damaging natural environment such as buildings, monuments and statues.
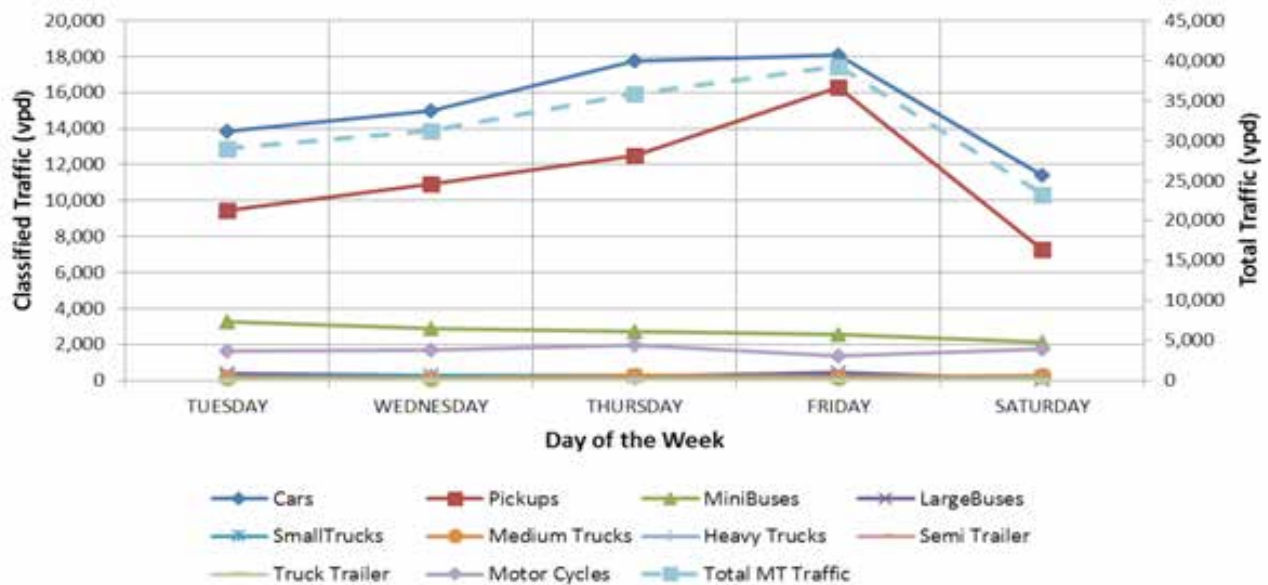
Figure 98: Daily Traffic Variation along Selander Bridge to City Centre(Korean Exim Bank, 2014)

Table 92: Spatial variability of air pollutants

Pollutant	Location	Mean	Standard deviation	Minimum	Maximum
PM$_{10}$ (µg/m^3) **Urban**		**86.0**	**14.3**	**50.1**	**119.3**
	Harbour	87.2	30.0	31.6	143.4
	Landfill	248.0	97.7	62.9	453.2
	Suburban	108.9	37.9	35.1	175.4
	Traffic	152.9	24.6	104.9	193.3
PM$_{2.5}$ (µg/m^3)	**Urban**	**30.1**	**6.1**	**15.2**	**45.0**
	Harbour	26.8	9.4	14.1	41.6
	Landfill	44.9	11.7	28.1	69.0
	Suburban	38.7	12.8	27.3	78.6
	Traffic	48.8	9.3	33.3	70.8
PM$_{2.5}$ absorbance coefficient	**Urban**	**6.2**	**1.0**	**3.8**	**8.4**
	Harbour	4.7	1.5	2.8	8.1
	Landfill	6.5	1.4	3.3	9.3
	Suburban	6.9	1.5	5.0	10.9
	Traffic	14.3	1.7	12.0	18.4
NOx (µg/m^3)	**Urban**	**26.2**	**7.0**	**13.7**	**37.3**
	Harbour	8.0	6.3	5.4	21.9
	Landfill	22.0	10.7	7.0	68.0
	Suburban	24.3	8.2	5.3	46.1
	Traffic	109.4	12.4	88.1	133.2
NO$_2$ (µg/m^3)	**Urban**	**23.1**	**3.6**	**14.4**	**29.0**
	Harbour	11.2	2.4	7.4	18.1
	Landfill	16.2	3.4	8.3	21.9
	Suburban	20.0	3.5	10.4	28.0
	Traffic	40.5	4.6	34.1	52.7

Figure 9-11 indicates results of study on spatial variability of ambient air pollution concentration in Dar es Salaam city (Njee, Meliefste, Malebo, & Hoek, 2016) which differed per pollutant, e.g. the PM_{10} concentrations were higher at the suburban and landfill site compared to the urban background whereas the NO_2 concentration was lower. The traffic site had higher concentrations compared to urban background site of each of the pollutants measured.
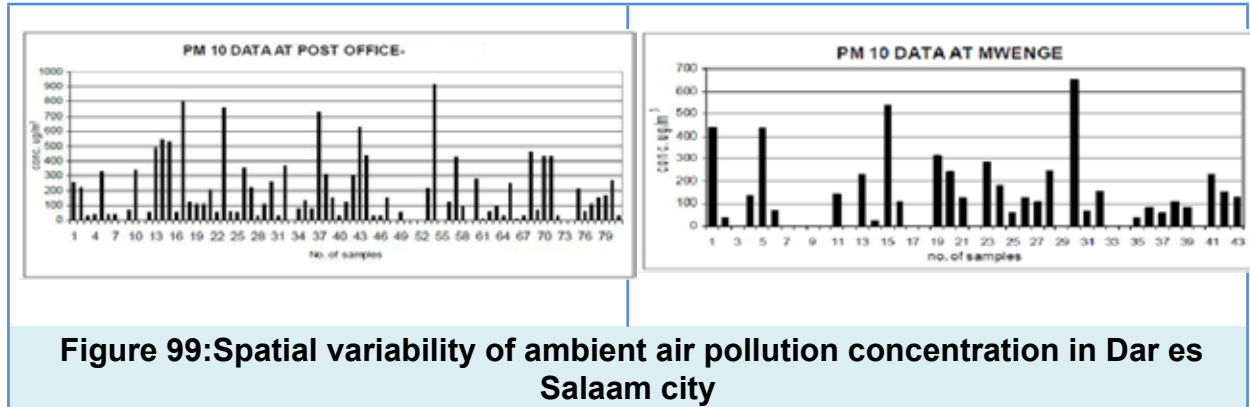
Figure 99:Spatial variability of ambient air pollution concentration in Dar es Salaam city

9.2.4 Impacts

Human health and the environment

Air pollution poses risk to human health. The common health problems caused by air pollution include respiratory diseases and lung cancers. Air pollution also causes nuisance to people.

9.2.5 Response

a) *Air Quality Standards*

The government responded by formulating Environmental Management (Air Quality Standards) Regulations (2007). These Regulations, made by the Minister responsible for the environment under sections 143, 144 and 230 of the Environmental Management Act, concern the prevention and control of air pollution and require the National Environmental Standards Committee to, among other things: prescribe criteria and procedure for measurement for air quality; (b) establish ambient air quality standards; (c) establish emission standard for various sources of air pollution. They also define enforcement power.

b) *Mass and bulk transit initiatives*

The government initiated and implemented a project on the establishment of a bus rapid transit system (BRT phase 1) which is currently operation in Dar es Salaam city. This project has not only upgrade and modernized public transport, but has also contributed in reducing emissions associated with transport sector. The government is now in the process of implementing BRT Phase 2 (19.3 km) and Phase 3 (23.6 km) in Ilala and Temeke Municipalities, Dar es Salaam city. In addition, Standard Gauge Railway (SGR) is being constructed from Dar es Salaam to Mwanza that would facilitate transportation of passengers and cargo.

9.3 Noise Pollution

Noise has been common in urban areas, however, of recent, it has been increasing and widespread. These areas have appreciable concentrations of industries and ongoing physical development which involve construction and increasing traffic as well as other socio-economic activities. Prolonged exposure to noise pollution could lead to an array of health problems.

9.3.1 Drivers

a) Urbanization

Unplanned and uncontrolled rapid urban development and industrial expansion are the main causes of noise pollution in urban areas. With the ever-increasing number of vehicles on roads, sound from vehicles and exhaust systems, is one of the sources of noise pollution. Construction boom has given rise to noise and vibration pollution.

b) Industrial expansion

In Tanzania, noise generated from industries since some are located within or near residential area. Unique feature of noise pollution in urban area is related to the informal sector that encompasses small-scale industries (SSIs), which are located deep within residential areas. It is nowadays common in many urban areas to find car repair, carpentry and metal workshops, which are not acoustically insulated located side-by-side with residential buildings.

9.3.2 Pressure

a) Inadequate enforcement of legislation

Noise pollution is largely attributable to inadequate enforcement of regulations which govern the operation of entertainment premises. It is not uncommon to find entertainment facilities, motor vehicle garages even industrial buildings, located side by-side with residential buildings, which result in noise pollution in the residential areas. Issuance of licenses for operating entertainment facilities, car repair workshops medium and small scale industries deep within residential areas, which are not acoustically insulated contrary to the urban planning regulations, fuels the entertainment noise pollution problem.

b) Limited public awareness

In addition, there is limited awareness of the existence of noise related laws, hence they rarely report noise problem to the responsible authorities and as such the problem remains unchecked.

9.3.3 State

a) Traffic noise pollution

Traffic noise is one of the environmental source of pollution in most urban areas in Tanzania

due to increase in road traffic volume in all major urban centers. For *example*, the vehicular population in Dar es Salaam has been growing at 10% annually since 1995 (URT, 2011). Moreover, the proportionate increase in importation of used vehicles into Tanzania is a strong enough basis for concern on traffic caused noise pollution.

b) *Noise Pollution due to social events*

Major sources of noise pollution due to social events include domestic appliances, social halls, religious preaching events, bars and grocery stores and social events (wedding, cultural dances, sport games). A significant number of noise sources are located among and within residential premises thus causing noise disturbance to their neighbourhoods. Most of the social clubs are not acoustically insulated thus causing noise pollution.

Findings of a study on the effects of Noise Pollution on Students' Learning in Selected Urban Public Secondary Schools in Dar es Salaam City (Nziano, J, 2018), indicated that students were in agreement that the leading causes of noise in schools included welding machines (85%), motor vehicles (77.5%), and other activities (72.5%) related to social functions (e.g. funeral, public bars, weeding and traditional activities).
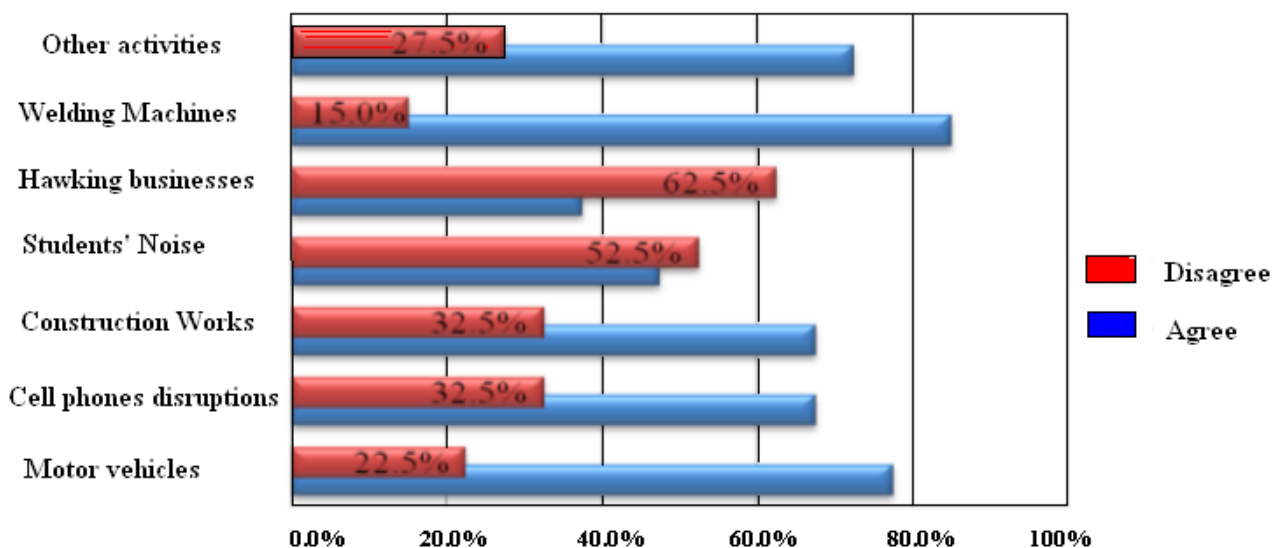
Figure 910: Students' responses on sources of noise

The study also indicated similar number of students' responses who indicated that construction activities and use of mobile phones (75%) causes a significant noise in urban schools. A few of them agreed that students' talking in classrooms (47.5%) and petty trades/businesses (37.5%) caused noise in schools. In addition, there were disagreement among respondents regarding petty businesses (62.5%) and students' voices (52.5%) to be the sources of noise because such activities were considered to be the least cause of noise in schools.

In a study to evaluate noise pollution from the use of household electricity generators in a high-density residential area in Dar es Salaam city (Menkiti & Agunwamba, 2015), the average noise level of 97.60 dB was obtained. This exceeded the WHO value of 50 dB allowed for residential areas.

In another study (Nyarubeli, Tungu, Bratveit, Sunde, Kayumba, & Moen, 2018), have reported findings of a study on occupational noise exposure among iron and steel factory workers in Tanzania which indicated that the personal work exposure in four factories ranged from 85.4 to 96.2dB with an average value of 92.0dB, without using hearing protective gear, which imply high risk of developing hearing problems.

9.3.4   Impacts

a) Social conflicts

Several complaints due to nuisance resulting from noise pollution by neighbouring communities and individuals have been recorded particularly in urban areas. Some of the sources of noise pollution include social events and entertainment services. Such areas include Dar es Salaam, Mbeya, Mwanza and Arusha.

b) Health impacts

Noise health effects are the physical and psychological health consequences of regular exposure, to consistent elevated sound levels. Elevated workplace or environmental noise can cause hearing impairment, hypertension, ischemic heart disease, annoyance, and sleep disturbance. Exposure to prolonged or excessive noise has been shown to cause a range of health problems ranging from stress, poor concentration, productivity losses in the workplace, and communication difficulties and fatigue from lack of sleep, to more serious issues such as cardiovascular disease, cognitive impairment, tinnitus and hearing loss.

9.3.5   Response

Regulatory framework

To address the noise pollution problem, the Government has formulated *Noise and Vibrations) (Standards and Control) Regulations, 2013*. These Regulations National Environment (Noise and Vibrations) (Standards and Control) Regulations, 2013, are meant to control noise pollution in urban centers across Tanzania. The Regulations make any loud, unnecessary noises which annoy, disturb, injure or endanger the comfort, health or safety of anyone or the environment to be punishable by two years in prison, a D5,300 USD (TZS 10 million) fine or both.

9.4   Electrical and Electronic Equipment Waste (E-waste)

E-waste contains toxic and other hazardous substances that pose a threat to the environment and human health. Tanzania is facing a rapid increase in use of electrical and electronic equipment with subsequent accumulation of e-waste generated over time. The increase of e-waste has been contributed by the influx of electric and electronic equipment such as computers, mobile phones, television sets, data operating products and other electrical and electronic products.

9.4.1 Drivers

a) Rapid changes in technology

Tanzania has acknowledged ICT potential for economic growth, income generation and hence reduction of poverty and as such since mid-1990's when the country was at the peak of open market economy and other bilateral agreements, rapidly advancing technology e.g. analogue to digital broadcasting migration process in Tanzania (TCRA, 2013) has brought constant upgrades to more sophisticated models of EEE with increasing short lifecycles, contributing to increasing volumes of e-waste.

b) Changing lifestyles and consumption patterns

The changing lifestyle of people coupled with urbanization (rapid growing urban middle class), projected to reach 40% by 2030 and 50% by 2050, has led to increasing rates of consumption of EEE. For instance, in the last two decades, the penetration rate of personal computers has increased by a factor of 10, while the number of mobile phone subscribers by a factor of 100 (CPCT, 2011). Currently, there are 41,833,834 voice telecom subscribers up to June 2018 (TCRA, 2018) compared with 34,251,801 at end of the year 2014 and 27,627,156 during 2012. The number of active subscribers/active decoders for pay TVs services in Tanzania has also increased from 422,384 in 2012 to 2,236,577 at the end of 2017 year (TCRA, 2017). Another fact about e-waste in the country would be drawn from 1995 figures when there were only 88,000 subscribers of fixed lines and 2,198 mobile phone subscribers (TCRA, 2017).

9.4.2 Pressure

a) Increasing demand

The increasing demand for modern and convenient services combined with population growth with 2018 projection standing at 54,199,163), economic projections of continued GDP growth at 7.1 in 2018 (URT, 2018), growing middle class population and improving standard of living, suggest that the volume of e-waste in the country will continue to increase substantially over time.

b) Inadequate capacity for E-waste management

Unfortunately, the growing volume of e-waste does not match with the available capacity of the country to manage them in an environmentally sound manner e.g. through regulatory and legislative approaches.

9.4.3 State

Estimates indicate that e-waste generation annually is in excess of 300,000 tonnes annually. In 2018, a total of 11 private companies were licensed to collect e-waste mainly for export totalling to 234,000 tonnes. E-waste accounts for 0.5% of the total municipal solid waste generated in the country. In 2016, about 603,000 fake mobile phones were switched off and ended as e-waste. This situation caught public and private sectors unprepared on how

to safely dispose the switched off phones. Rapid increase of e-waste and its ineffective management have contributed to aggravate environmental pollution.

9.4.4 Impacts

a) Potential health and environmental impacts

Most EEE contain hazardous materials, most of which are likely to cause cancer, oxidative stress, DNA damage, respiratory illness and reproductive problems. Mixing of E-waste with general municipal waste due to lack of formal management scheme poses further potential health and environmental impacts. Table 9-3 presents a summary of potential environmental and public health impacts/problems related to E-Waste.

Table 93: Summary of potential health and environmental hazards of electronic components

E-Waste Component	Processing Potential Health hazard	Potential Environmental Hazard
Cathode Ray Tubes (CRT), LCDs Silicosis, Cuts from the glass, Inhalation of phosphor 8 or contact		Water sources (ground water) contamination by phosphor
Printed Circuit Boards	Tin or Lead inhalation, Possibility of inhalation of mercury, beryllium and/or brominated dioxin	Air contamination by emitted gases
Chips and other gold plated components	Acid contact with skin and/or eyes resulting into permanent injury Inhalation of acid fumes resulting into respiratory problems	Acidification of water sources affecting the flora and fauna of the areas
Plastic components	Exposure to hydrocarbons, brominated dioxins, PAH, Exposure to dioxins and furans	Contamination of air by the emitted gases when burnt
Steel, Copper and precious metals	Exposure to heavy metals	Contamination of air, water sources and the soil
Mother Board, dismantled printed circuit boards	Intoxication of dumping sites surrounding residents, workers in the dumping sites from Tin, Lead, Beryllium etc.	Contamination of surroundings and water sources-ground water

b) Loss of resources

Generally, E-waste contains iron and steel; plastics; non-ferrous metals and other constituents. When these materials are not recovered, raw materials have to be extracted and processed to produce new products, resulting further in significant loss of resources and damage to the environment. Non-recovery of E-waste also results into loss of employment and income generation especially to unemployed youths in urban areas.

9.4.5 Response

a) Policies and legislation

A number of policies and regulations have been formulated with a bearing in e-waste management. Relevant national policies include, among others, National Environmental Policy (1997);National Health Policy (2007);Sustainable Industrial and Development Policy (1996);and ICT Policy (2016). On the other hand, relevant legislation include Environmental Management Act (2004); Public Health Act (2009); Fair Competition Act (2003); Merchandise Marks Act (1963); Hazardous Waste Management Regulations (2009); and Electronic and Postal Communication Act (EPOCA)(2010).

b) Licensing system for collection, recycling and export of e-waste

In accordance with the requirements of the Environmental Management Act (2004) and the Hazardous Waste Regulations (2009), a licensing system has been put in place for companies and individuals involved in collection, transport, recycling an export of hazardous waste including e-waste. It is hosted under the Vice President's Office - Division of Environment. In the year 2018, a total of 11 companies were issued licenses on e-waste management handling a total of 234,000 tonnes of e-waste (Figure 9-11).

Figure 911: Dismantled e-waste ready for export by one of the licensed companies in Dar es Salaam City

CHAPTER TEN

DETERIORATION OF AQUATIC SYSTEMS

10.1 Introduction

Tanzania is endowed with abundant and significant water bodies and wide range of ecological and aquatic resources. This is a result of diverse aquatic ecosystems which provide economically important ecosystem services. The abundant ecological resources are also a result of the country's location along the coast of the Indian Ocean providing the country with abundant coastal and marine resources as well. Furthermore, Tanzania lies in the African Great Lakes region and boasts of two great lakes namely; Lakes Victoria and Tanganyika. In addition, the country hosts a variety of inland natural water bodies including lakes and rivers, wetlands, and artificial water bodies (dams and reservoirs).

Despite their significance to human life and socio-economic development, human activities have resulted to deterioration of these ecological systems; thereby decreasing their capacity to deliver the expected benefits. According to (Kaaya et al., 2015), the rich supply of the ecological systems is under threat as a result of demographic changes, excessive withdrawals, land use changes, exotic species invasions and climate change that in turn result in loss of perennial flows, eutrophication, sedimentation, and algal blooms.

10.2 Drivers

a) Population growth

The current Tanzania's population of 54.2 million is expected to expand at the rate of between 2.8-3.1% and ultimately grow to 89,204,781 people by the year 2035. Increase in population will result into increased demand for natural resources and ecosystem services including water supply, waste disposal facilities , land for agricultural activities and human settlement thereby exerting a high pressure on the natural aquatic ecological system. Projections show critical water scarcity in the country by the year 2050.

b) Economic growth

Tanzania's GDP growth rate averaged 7.1%. The country's natural resources are expected to contribute immensely to planned economic development and hence remain the backbone of the planned economic growth in industrialisation and ambitions towards the Middle-Income Status. Needless to say that the economic growth will lead to increased demand for natural resources, consequently resulting into overexploitation as well as unsustainable utilization of natural resources. As a result, the country will experience significant changes in land use whereby most forests and wetlands including mangrove forests are converted to agricultural lands in order to meet the demand for food to feed the rapidly growing population, as well as raw material demand for the growing industries.

c) Poverty

Worth noting also that about 28% of the population in Tanzania live below basic needs poverty line. As a result they largely depend on direct exploitation of natural resources for

their livelihood. This exploitation is mostly done through unsustainable practices such as the use of destructive fishing gears leading to destruction of aquatic systems. High poverty levels and rapid population growth have exacerbated environmental problems arising from poverty related uses and over exploitation of ecosystems.

d) Climate change

Climate change has significant impacts on aquatic ecosystems. It modifies biological, chemical and physical conditions of the aquatic ecosystems, consequently affecting their capacity to support human needs. Extreme climate events such as tropical storms thunderstorms, and droughts have increased and are projected to further increase in intensity and frequency across the country. These events are expected to have significant consequences for aquatic ecosystems with the p otential for large changes in ecosystem processes, responses, and functions.

10.3   Pressure

10.3.1 Freshwater systems

a) Deforestation

Generally, the main pressure facing freshwater of Tanzania include deforestation. Deforestation is driven by expansion of agricultural activities, including shifting cultivation, wildfires, lack of clearly defined boundaries, illegal logging, and livestock grazing. Other contributing factors are unsustainable charcoal production for domestic and industrial use, lack of systematic management, and introduction of alien and invasive species. Currently, estimated deforestation rate in Tanzania is 469,420ha per annum.

b) Destructive fishing practices

The use of destructive fishing practices (mainly beach seines or 'kokoro') constitute a major and widespread problem in Tanzania. Beach seine does not only lead to fishing of very small mostly juvenile fishes, but also results into destruction of breeding habitats of fish. Beach seine incidences were highest between 2012 and 2013, and declined significantly thereafter as shown in Figure 10-1 as result of government's effort to curb the problem through various surveillance operations. The problem is more pronounced in Lake Victoria and Mtera Dam for same time period (Figure 10-2). The average beach seine incidences for freshwater bodies are highest in Lake Victoria (80%), followed by Mtera dam (9%), while no incidences were recorded in Lake Tanganyika (Figure 10-3), most likely due to its deepest nature that prohibits the use of beach seine into the lake.
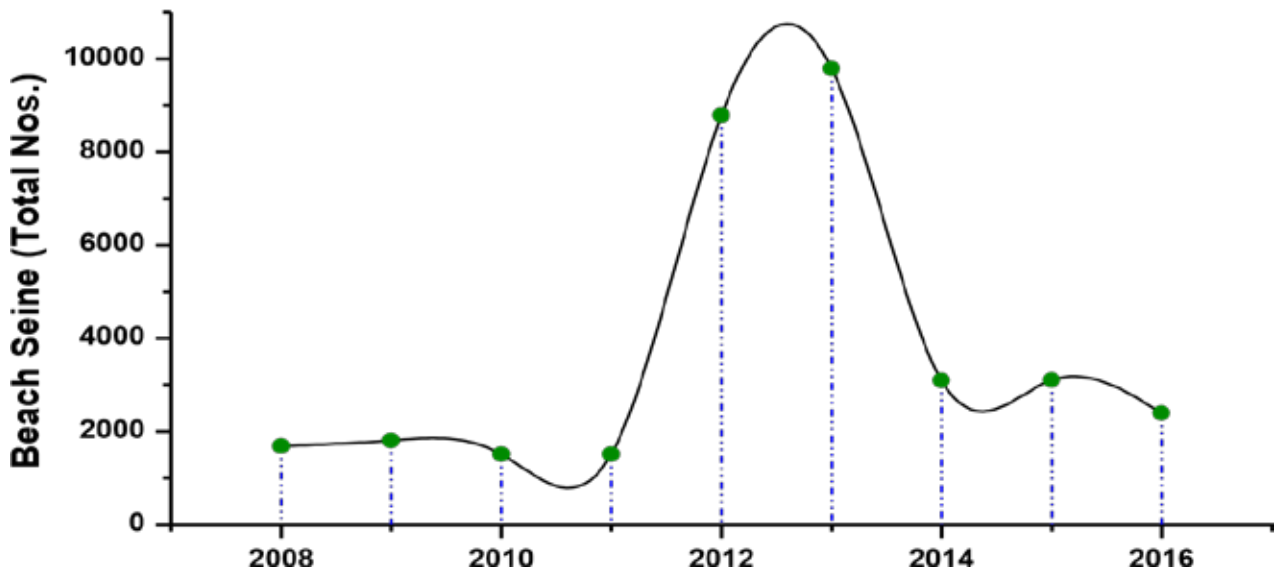
Figure 101: Incidences of beach seine in freshwater ecosystems
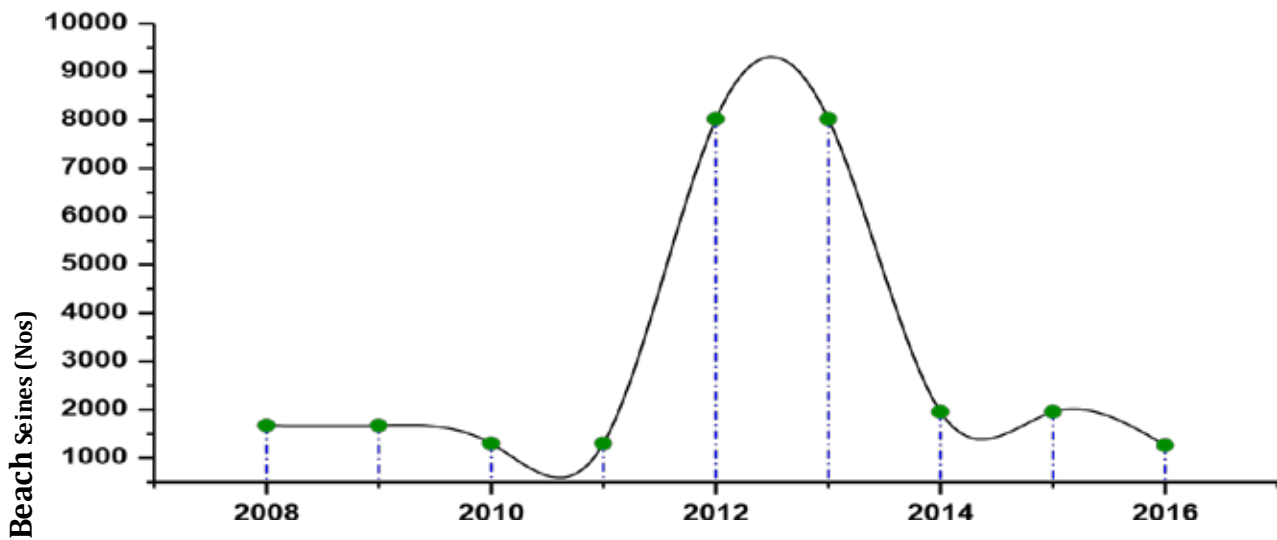
Figure 102: Incidences of beach seine in Lake Victoria

Legend:
- T.
- L.Nyasa
- L.Rukwa
- Mtera
- N. ya Mungu
- Minor Water
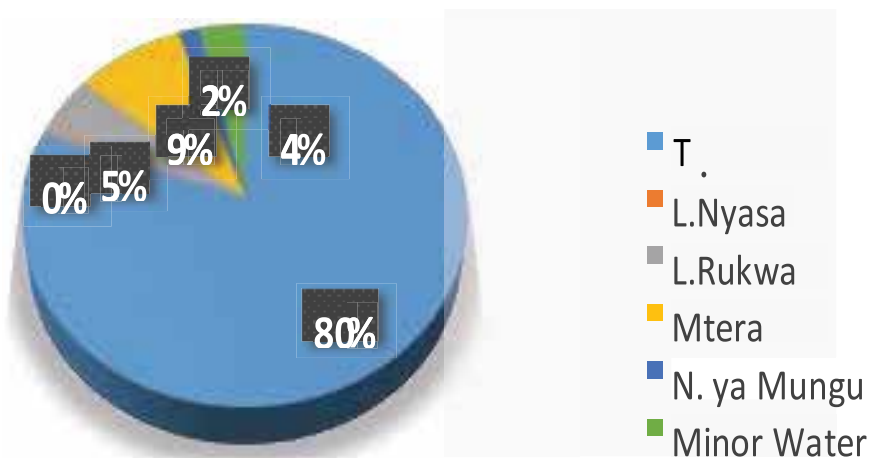
Figure 103: Incidences of beach seine in different freshwater bodies

c) Unsustainable agricultural practices

Communities around freshwater bodies are mainly agricultural dependent and are involved mostly in subsistence agriculture. In most catchments, terracing and other soil conservation techniques are not practiced, therefore lead to soil erosion. Water demand for irrigation, has significantly caused reduction in river discharges. The situation is considered to be critical in some of the rivers such as Ruaha, Pangani, Wami and Ruvu, and lakes (e.g. Lake Victoria), with multiple socio-economic conflicts and potential ecological and environmental impacts.

d) Inadequate waste management

Inadequate waste management contributes to freshwater pollution from various sources including agricultural runoff, domestic and industrial effluents. Data obtained for Lake Victoria (Table 10-1) show pollution loading as discharged from various industries. In total the BOD_5, COD, Total Nitrogen (TN) and Total phosphorus (TP) discharged from these industries/ Sector is approximated to 2587, 3012, 65 and 41 tones/year, respectively, which certainly significantly contributes to poor quality of freshwater.

Table 101: Pollution loading in Lake Victoria from different Industries

Industries/Sector	Pollution loading (Tons/Year)			
	BOD_5	COD	TN	TP
Fish	1,345.82	1,760.10	11.65	23.29
Brewery	687.65	859.10	6.59	5.40
Dairy	20.06	24.87	0.19	0.09
Laboratory	3.64	4.60	0.06	0.01
Edible Oil	144	0	9.9	5.28
Meat	80.34	89.31	0.55	0.58
Textile	108.68	9.25	29.68	0.70
Sewerage	77.18	77.18	3.47	4.87
Soft Drinks	119.90	119.90	2.82	0.65
Coffee	1.3		0.03	0.12
Total	**2,587.27**	**3,012.01**	**64.92**	**40.88**

(Source: EAC-LVEMP, 2018)

Improper use of pesticides in agriculture is a serious emerging problem for species survival and water quality in freshwater bodies. Pollutants from mining and industrial activities (such as lead, cadmium, iron and copper), and organic wastes from leaking sewage systems, can accumulate in rivers and other freshwater bodies and affect water quality and species survival. On the other hand, improper use of fertilizers is considered to significantly affect aquatic systems. It has been observed that while plants use 50% of nitrogenous fertilizers applied to soil about 2 to 10% interfere with surface and groundwater sources thus leading to further deterioration of the ecological systems.

Disposal of raw wastes as well as untreated effluents from industries including residues from agrochemicals which are used to enhance agricultural yields are also a major source of pollution in water bodies and other ecological systems. Rivers in urban centres, for example

Msimbazi in Dar es Salaam, have been used as dumping sites for waste from various sources.

e) Inadequate education and awareness

Inadequate education and awareness may lead to deterioration of aquatic resources through inappropriate use of these resources, thus accelerating both the downwards spiral of poverty and environmental degradation. Insufficient access to education and to information make it difficult for local people to manage available natural resources in a sustainable and sound manner, thus creating loss of livelihood opportunities and of biological diversity. Universal access to basic education and vocational training, community information on sound agricultural methods, waste management, natural resources management, coastal protection, water resources management, and fisheries management are all essential in reducing environment degradation.

10.3.2 Coastal and marine systems

Coastal and marine systems of Tanzania are under a variety of pressure. These include but not limited to unsustainable fishing practices, climate change, deforestation, lime-making, pollution, soil erosion, and gas and oil exploration.

a) Destructive fishing practices

Both beach seine and blasts are common in coastal and marine habitats. Overall the problem of beach seine is more pronounced in freshwater bodies than in coastal and marine habitats. The trend of beach seine incidences remained more or less constant in the period 2008–2015 with 768 beach seine incidences a year and dropped significantly in 2016 with less than 348 beach seine incidences for that particular year (Figure 10-4). The incidences of beach seine are highest in Mtwara (64%), followed by Coast Region (22%) and lowest in Lindi (3%) as indicated in Figure 10-5).
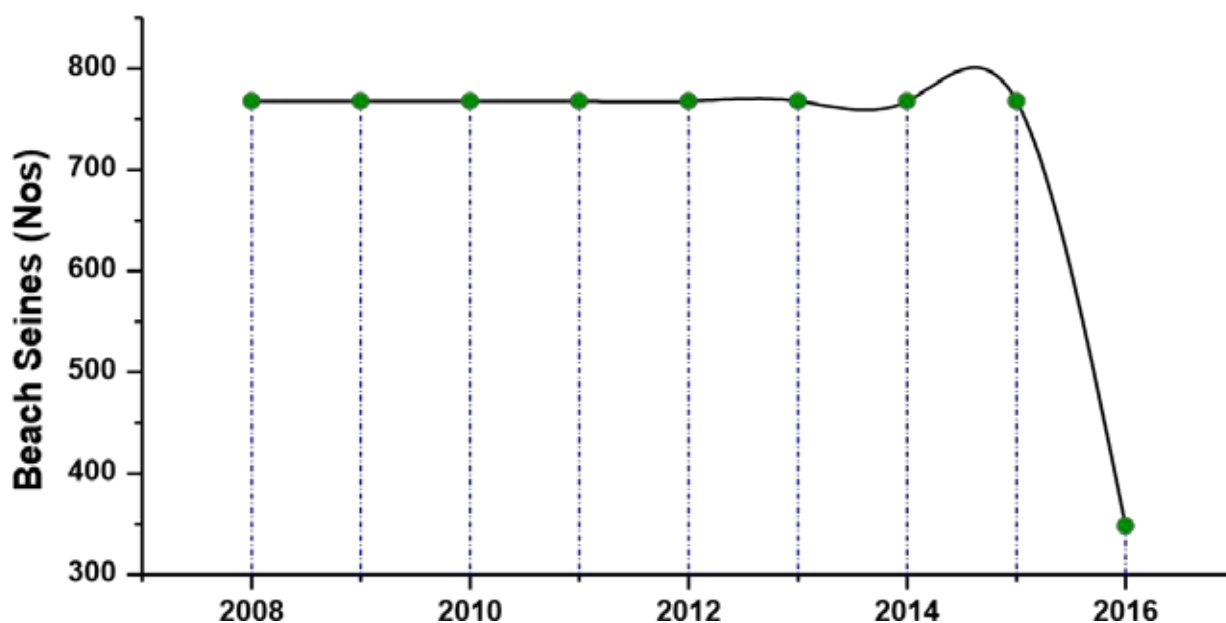
Figure 104: Beach seine incidences in coastal habitats of Tanzania by year
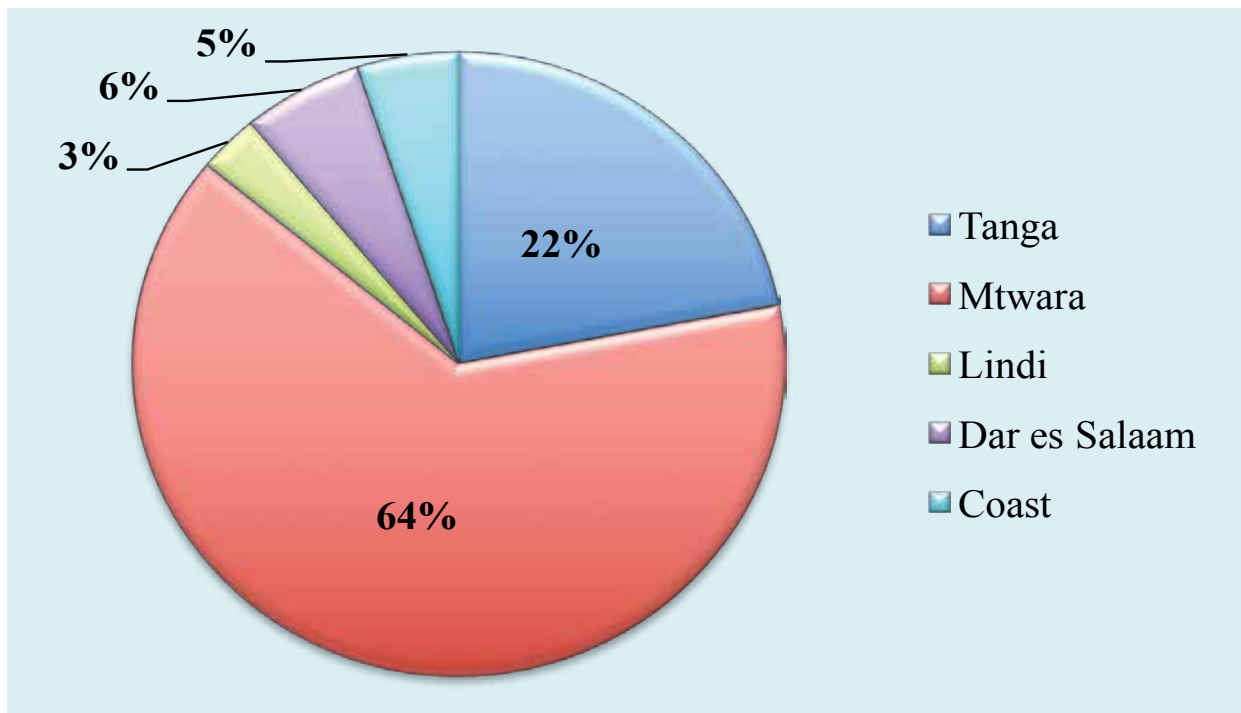
Figure 105: Incidences of beach seines by Region

Blasts, on the other hand, constitute the major problem in coastal and marine habitats. Blast fishing causes considerable adverse effects to fisheries as it destroys not only fish habitats especially coral reefs, it also kills fishes and all other reef-dwelling organisms. Although blast fishing is characterized by lack of historical data, a generalized trend of blast incidences shows that the problem of blast fishing was on the rise in the 1980s, and declined significantly between 1990 and 1995, and then rose again and was at sustained high levels during 2006-2016 (Figure 10-6). Recent efforts at quantifying the problem as shown by average monthly incidences of blast fishing in all the coastal regions of Mainland Tanzania for the period May, 2016 - October, 2017 indicates a general declining trend with a substantial decline of about 88% (Figure 10-7). Blast incidences decline is attributed to government efforts to curb the problem.
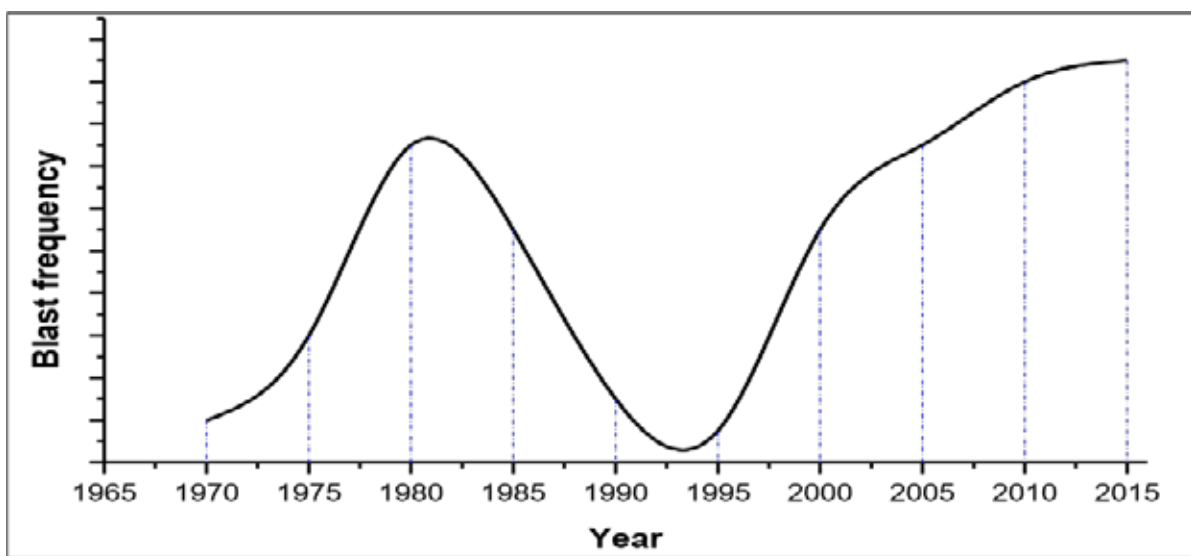
Figure 106: Generalized trend of blasts incidences for the period 1965 and 2015

Y = 3549.96525 + 43.27143 X − 31.10221 X^2 + 1.07109 X^3
R^2 = 0.91 , P < 0.0001

Missing Data
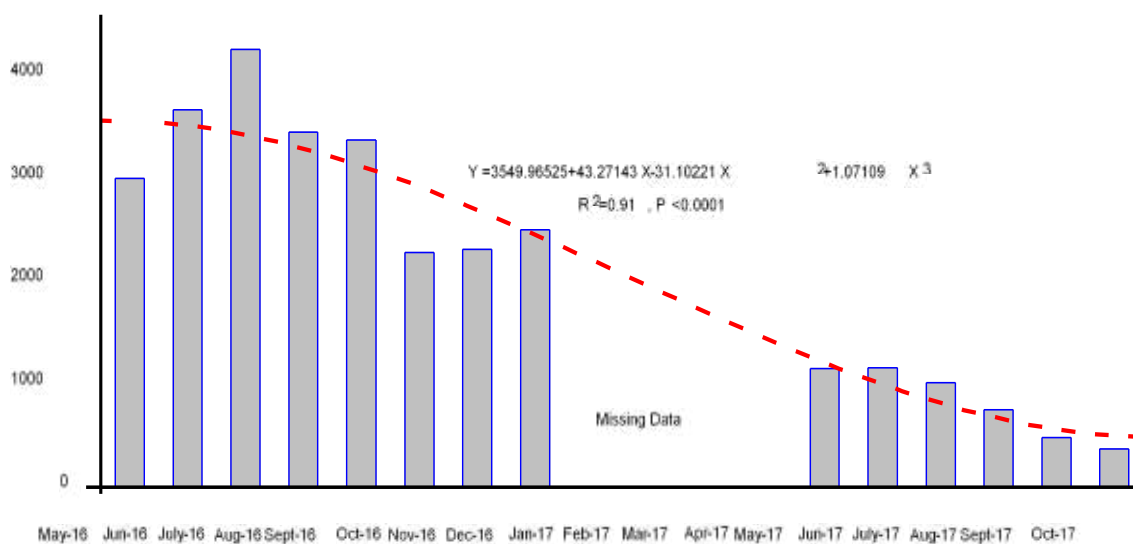
Figure 107: Trends of estimated total blasts per month from May 2016 to October 17

b) Deforestation and human settlements

Deforestation is a result of requirement for biomass and construction materials from the mangrove trees. It is also caused by requirement for land for cultivation as the population expands in coastal settlements. Figure 10-8 shows harvested mangroves (for construction purposes) as well as paddy cultivation in coastal areas in Rufiji Delta.Main causes of coastal degradation include population growth which causes excessive exploitation and uncontrolled use of coastal and marine resources e.g. mangrove cutting; increasing pressure from tourism; major developments associated with industrial growth; and coral mining for supplying building material for construction activities and lack of non-resources dependant jobs in rural coastal area.

Figure 108: Harvested mangrove poles and a paddy in Rufiji Delta

As for human settlement, (Mabula, Mangora, and Muhando, 2017), mangroves in Kunduchi, in Dar es salaam city, have generally been encroached, cleared and converted to salt

pans and property development (hotels and human settlements) (Figure 10-9). Salt works coverage was recorded to be 50.9 ha and up to 4.3 km of the salt works perimeter directly bordered by the mangrove forest. On the other hand, the length of settlements bordering mangroves was recorded to cover 3.2 km.
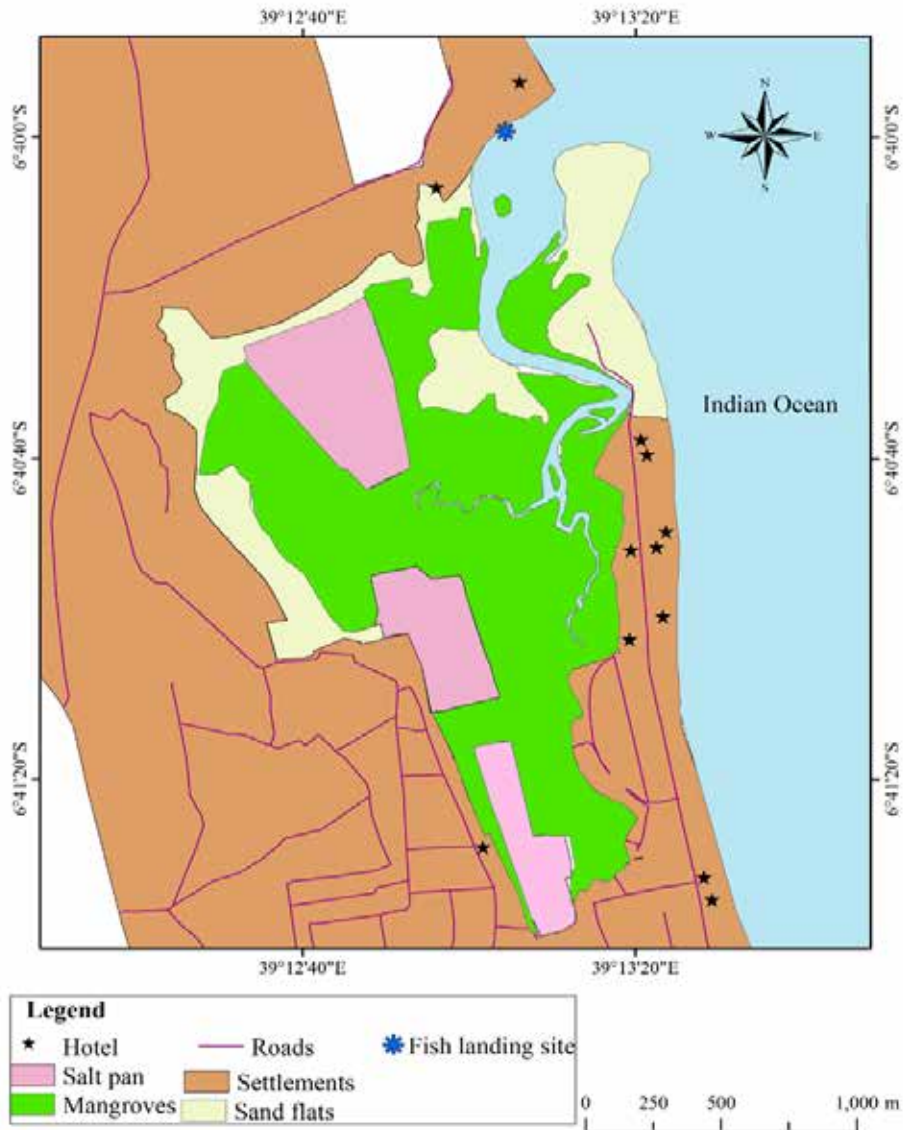
Figure 109: A map of Kunduchi site showing the extent of human encroachment in mangroves through settlement development and salt works construction (2017)

c) Pollution

Pollution is another environmental challenge facing many beaches in Tanzania. Raw and untreated industrial, domestic agricultural wastewater eventually ends up in estuaries and consequently pollutes the marine and coastal ecosystems. The beaches are prone to environmental pollutions due to various human activities taking place along the beaches such as recreational activities which results into trash and plastic. Littering of the beaches have negative effects on people's health, livelihood, the beauty of the beaches, and tourism along the coastal towns. Most aquatic habitats suffer from excessive levels of nutrients mainly phosphates and nitrates that originate from domestic, industrial as well as agricultural

activities. Herbicides and pesticides used in agriculture find their way into aquatic systems, and most of these are toxic to wildlife. Heavy metals such as lead, cadmium, iron and copper from industries and mining activities, and organic wastes from sewage, can accumulate in aquatic systems and affect water quality and species survival, and could have a long-term detrimental health effects if taken up higher in the food chain.

In terms of wastewater collection and disposal in the city, for example, the existing sewerage systems is served by 15 pumping stations, 9 systems discharging into 9 existing waste stabilization ponds, and the remaining which is serving the City Center, Kariakoo, Upanga and Muhimbili, discharges untreated waste directly into the Indian Ocean through the existing 1000 mm diameter sea outfall pipe extending 1 km into the ocean (Figure 10-10).

a) *Pipe discharging raw wastewater to the ocean*	b) *Broken down manhole resulting into raw wastewater discharge close to the coastline*

Figure 1010: Dar es Salaam wastewater sea outfall

With the global increase in population and associated wastewater, much of it untreated, and the rapid growth in nitrogen fertilizer use, the overall burden of nutrients reaching the oceans has tripled since pre-industrial times, and could double or triple again in the 'business-as-usual' scenario.

d) Erosion and shoreline exposure

Currently shoreline erosion is one of the major coastal problems facing Tanzania. Several factors, including sea level rise, geology, and rapid coastal population growth accompanied by rapid increase of human activities that interfere with natural processes, have been linked to the problem. Based on a study conducted in Bagamoyo district, ocean shoreline erosion was attributed to sea-level rise and severe floods on the coast itself and along rivers (Figure 10-11). Other climate change related factors include the fact that the timing and intensity of rainfall are no longer reliable, changes in water temperature and that the direction and strength of seasonal prevailing sea winds are no longer predictable.

Figure 1011: Coastal erosion in a village in Bagamoyo, Coast Region, Tanzania

Besides, destruction of coral reefs due to blast fishing, mangrove clearance and sand and coral mining along coastal river valleys as well as increased wave action expose shorelines to direct wave surges, hence escalates coastal erosion. Blasts cause irreversible damage to coral reefs, destroying the habitats of many reef species, shattering the natural barriers that protect Tanzania's coastline from erosion and storm surges, and threatening the country's reputation as an important marine tourism destination.

10.3.3 Wetlands

a) Population growth

Pressure on wetlands has recently been increasing due to growing population and consequently growing demand for utilizable land and water. Example, in Lake Victoria, there is a total area of 42,000 ha covered by wetland of which 308,000 ha equivalent to 73% is dominated by seasonal Swamps/Flood plain. Due to land changes uses associated to population increases, approximately 75% of the wetland area have been affected up to 2016. Significantly 13% out of them are severely degraded.

b) Encroachment of the wetlands

Wetlands are currently under pressure from encroachment especially from various human activities including agriculture and livestock keeping. Plate 10.2 shows degradation due to improper agricultural practices and livestock grazing close to the wetland as reported in a

study on the analysis of drivers and economic consequences of wetland degradation along Ruvu riverine in the coastal ecosystem (Liberath, G. 2017).

Figure 1012: Wetland degradation due to improper agricultural practices and live-stock grazing

c) Pollution

Wetlands are threatened by pollution from various sources especially from the disposal of the untreated or partially treated domestic and industrial effluents as well as from the unsustainable use of fertilizers.

10.4   State and trends

10.4.1 Freshwater systems

a) Water quality change

Most surface water bodies are characterized by deterioration of water quality mainly due to pollution emanating from various diffuse as well as point sources such as untreated or partially treated sewage, excessive and irrational use of agrochemicals in catchment areas, chemical discharges from industries, mining activities, and atmospheric deposition. Due to inadequate monitoring of water bodies, data on water pollution is patchy, scarce and in most cases not easily accessible. There is some data in Lake Victoria for pollution loading (Table 10-1). Although plastic pollution is not at present a major problem in Lake Victoria, it is important that this situation is addressed early enough before the situation gets out of hand.

b) Freshwater Fisheries

There is an increase in fisheries production from freshwater systems since the period reported in the last report. Freshwater fish production for the reporting period (2012–2016) is generally on the increase as the production increased from 290,473 tons in 2011 to 308,771 tons in 2016 (Figure 10-11).
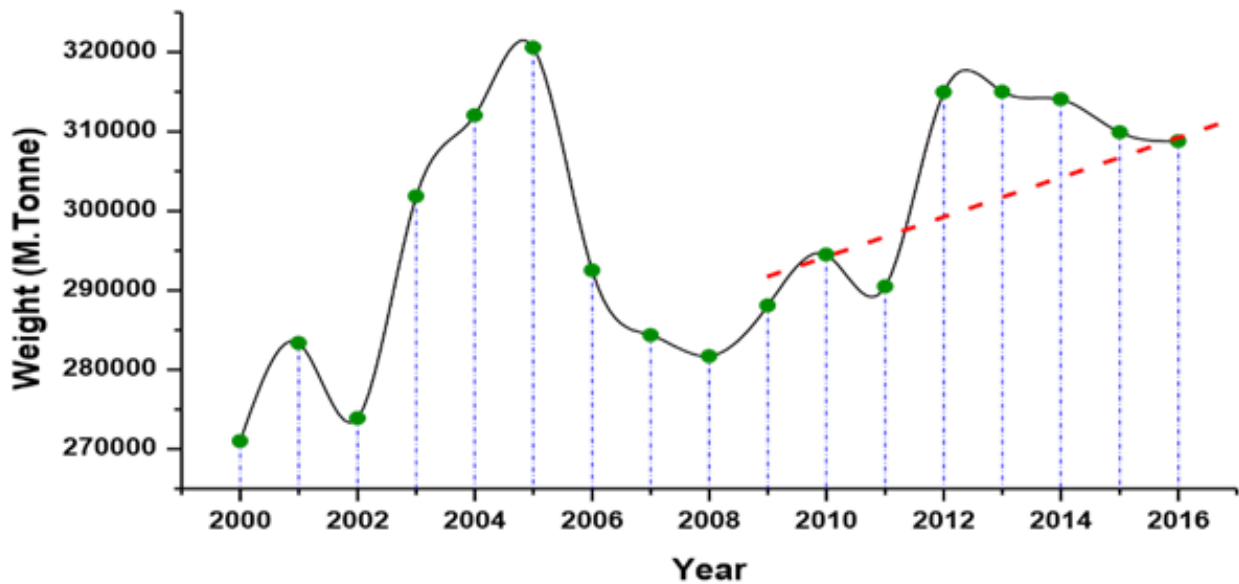
Figure 1013: Freshwater fish production for the reporting period

Comparing the production of the major lakes (Lake Victoria, Lake Tanganyika, Lake Nyasa and Lake Rukwa) it is obvious that production from Lake Victoria contributes substantially to the total production from freshwater bodies (Figure 10-12). Out of 308,771 tones recorded in 2016 from freshwater bodies, 238,096 tones (77%) came from Lake Victoria.
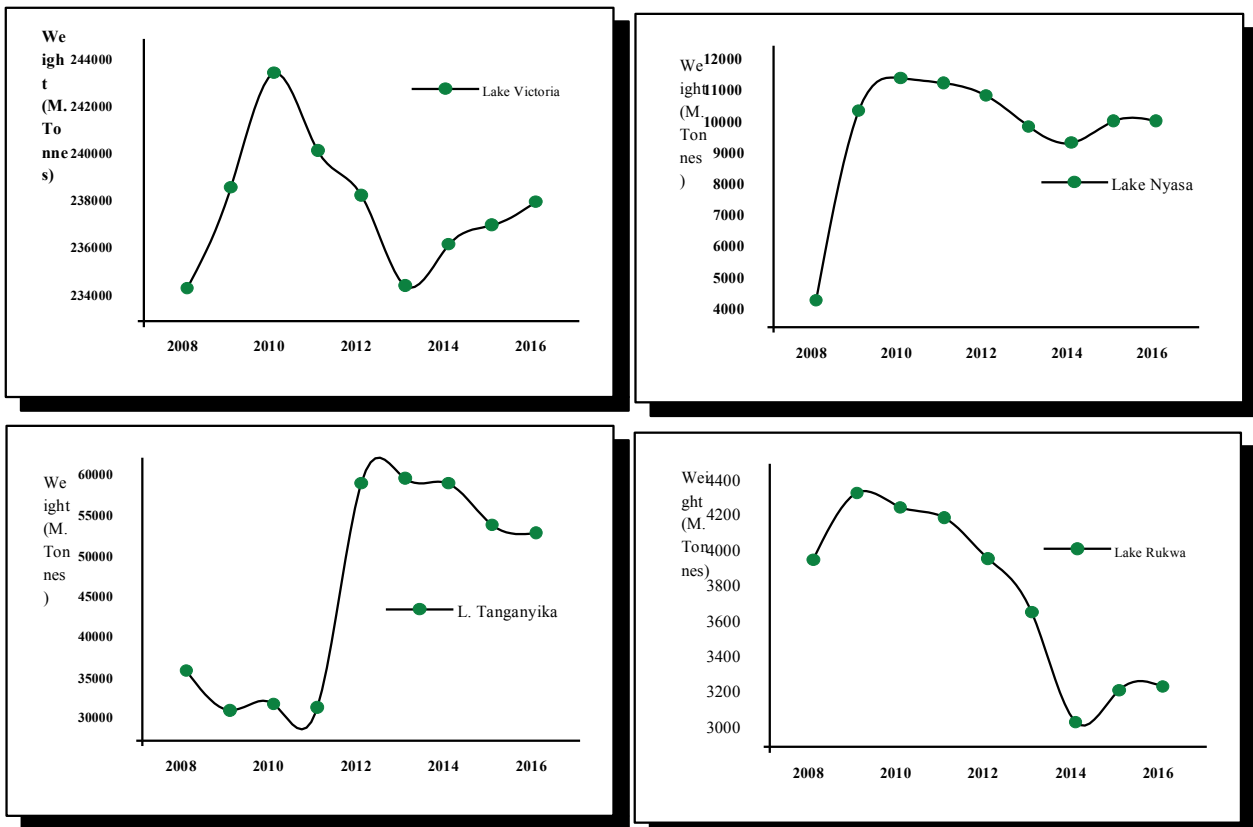
Figure 1014:Freshwater fish production for the reporting period

10.4.2 Coastal and marine systems

a) Mangroves

There are no current data on mangrove coverage countrywide, however, between 1989 and 2003 Mainland Tanzania lost about 6% of its mangrove at a rate of about 479 ha per year. Decreases were noted in Rufiji, Kilwa and Mkuranga Districts. Efforts to manage mangroves through law enforcement, awareness raising and mangrove planting are underway. Yet mangrove cutting for poles as well as clearance for rice farming still continues especially in remote areas (Figure 10-8).

b) Coral reefs

Coral reefs found in remote areas are mostly impacted by destructive fishing mostly blast fishing which was rampant in Tanzania. The use of small-mesh seine nets adds to the problem. In contrast coral reefs in marine protected areas are generally in good health.

c) Marine Fisheries

The marine fisheries of Mainland Tanzania for the period 2011–2016 is generally on the increase (Figure 10-13). Production increased from 50,592 tons in 2011 to 53,823 tons in 2016.
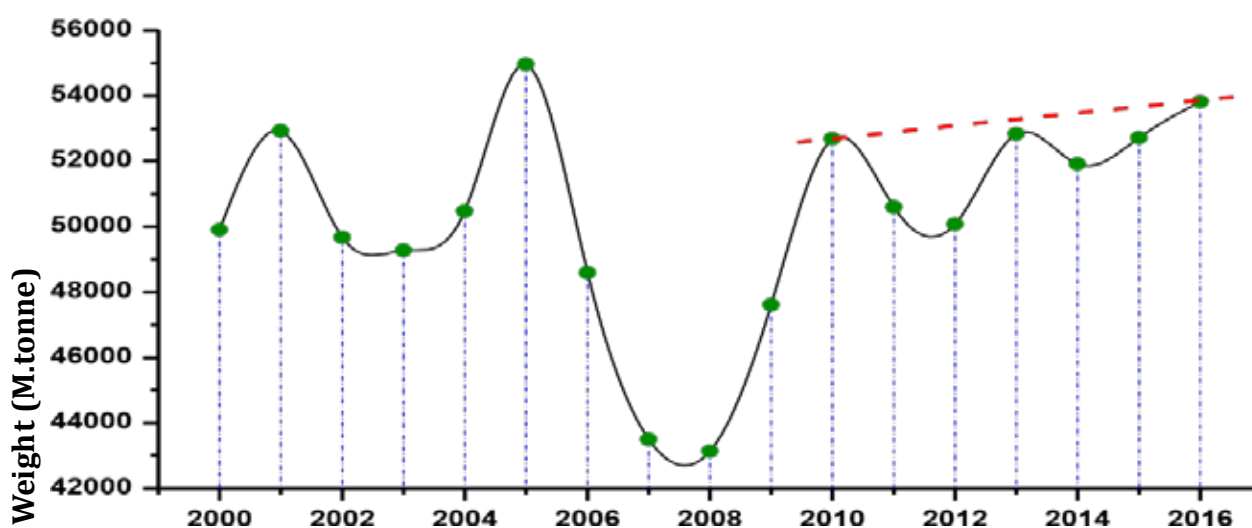
Figure 1015: Marine fish production (2000-2016)

d) Mariculture production

Mariculture production in Tanzania is dominated by seaweed farming, which to a large extent operates at subsistence level. In 2013 a total wet weight of 386 tonnes of seaweed were exported from Tanzania. Seaweed production gradually increased from 2006 to 2011 where the production peaked up to 700 tonnes. However, from 2012 to 2014, the production decrease rapidly. From 2015 to 2016 the production increased up to 1200 tonnes (Figure 10-16). Weather changes and unreliable market are among factors for the observed trend.
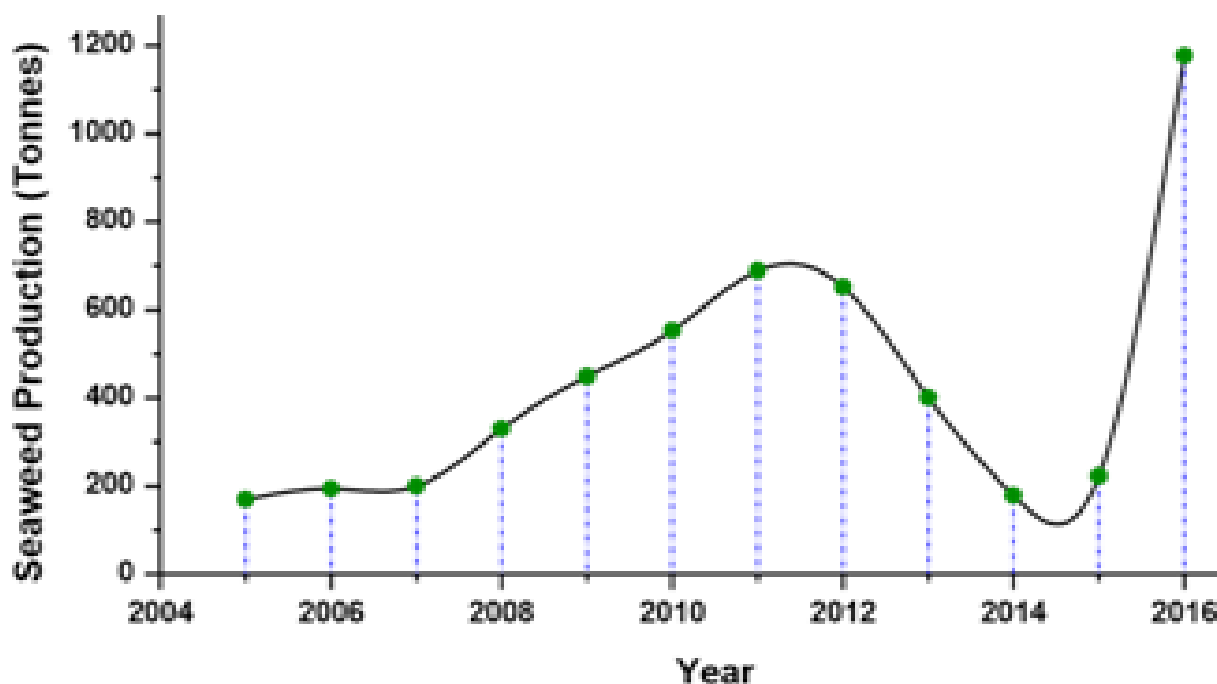
Figure 1016: Trend of seaweed production between 2005 and 2016

10.5   Impacts

Impacts due to deterioration of aquatic systems in freshwater, coastal and marine, or wetlands, include decrease in productivity, reduction in fish yields and biodiversity, water shortage and increase in potential health risks such as vector-borne diseases. Studies quantifying the overall value of such losses countrywide are limited. However, these losses can be inferred from the figures, which highlight the services provided by wetlands. Available data indicate that at some localities e.g. Nyumba ya Mungu, 92% to 95% of the households derive their income and food from the wetland resources (Halima and Munishi 2009). Considering the rate of degradation of aquatic systems in Tanzania, it is convincing that both economic and ecological values of most of these systems will be or have already been reduced, with subsequent effect on livelihoods of local communities and their environment. Loss or degradation of the aquatic systems may imply high costs to the people in obtaining the goods and/or services that might be lost.

10.6   Response

The government has constructed extensive 780 m, 500 m and 860 m sea walls at Barack Obama, Mwalimu Nyerere Memorial College in Kigamboni and Pangani respectively. These extensive sea walls along coast stop the shores from disintegrating and are scattered with scenic viewpoints for residents to enjoy.

Also various strategies in response to the issues related to deterioration of aquatic system in Tanzania have also been initiated both at National and local levels by various stakeholders. Some of these initiatives are the following:

i)   Several sectoral Policies and legislations that have relevance for the management of marine and coastal environment which cover sectors such as: environment, fisheries, forestry, land use planning, marine transport, tourism, energy, minerals, culture, and industries and trade. Some of these include National Fisheries Policy

(2015), Agricultural Policy (2013), Fisheries Act. (2011), Marine Parks and Reserves Act (1994) and the Merchant Shipping Act (2003). A wide range of approaches have been adopted within the legal and regulatory framework aiming at protection of the coastal and marine environment

ii)   Several Strategies aimed at conservation of aquatic habitat have been reviewed. The strategies includes the revised National Strategy on urgent Actions for Conservation of Land and water Catchments and the revised National Strategy for Conservation of Marine coastal environment, Lakes, rivers and dams, and Fisheries Sector Development Strategy

iii)   Establishment of cross-sectoral initiatives to manage/combat dynamite fishing. Through this initiatives awareness plan for dynamite fishing have been developed.

iv)   Establishment of mechanisms to enhanced cooperation with neighbouring countries and put in place various measures for management of the trans-boundary aquatic resources.

v)   A total of 4 Ramsar sites including the Malagarasi - Muyovozi wetlands, Rufiji-Mafia-Kilwa Marine Ramsar Site, Lake Natron Basin and Kilombero valley floodplain exist in the country. The National Sustainable Wetlands Programme and National Wetlands Strategy were implemented in 2014, in order to achieve sustainable utilization that also entail inventory, research, monitoring of wetland resources, as well as addressing issues and concerns necessary for implementation of the policies relevant to the management of wetlands.

vi)   Implementation of a project on Addressing Core Capacity on Adaptation to Climate change in Productive Coastal zones of Pangani, Bagamoyo, Rufiji and Zanzibar. The project aimed at enhancing the capacity of coastal communities to adapt to the impacts of climate change whereby 1,000 ha of degraded mangroves were rehabilitated in Rufiji; and 860m of Pangani sea wall was reconstructed.

vii)   Implementation of Concrete Adaptation Measures to Reduce Vulnerability and Livelihood of Coastal Communities in Dar es Salaam whereby constructed extensive 780m and 500 m seawalls at Barack Obama and Mwalimu Nyerere Memorial Collage in Kigamboni, respectively. In addition, 3,000 m^2 of coral reefs in Sinda Kigamboni were restored.

CHAPTER ELEVEN

WATER QUALITY DEGRADATION AND ACCESSIBILITY

11.1   Introduction

Water is essential for various domestic uses and a necessary input for production in various sectors of economy including industry, mining, hydropower generation, tourism, agriculture, fisheries and livestock keeping. The main sources of water supply in the country are surface water (rivers, lakes, dams and wetlands) and groundwater. The need for water supply is fundamental to all population, and increased coverage will significantly contribute to improving the quality of life of the people.

Among the major sources of water in Tanzania include rivers and lakes. Lakes and swamps cover 5.4 million hectares and comprise 5.8% of the country. The major ones include: Lake Victoria, Lake Tanganyika and Lake Nyasa, which also form the border with the neighbouring countries. Other lakes are Lake Rukwa, Lake Eyasi, Lake Manyara and Lake Natron. The available annual renewable water resources in Tanzania is about 89 km^3 as of 2015/2016 hydrological year with possibility of decreasing with time, hence reducing the annual average available renewable water resources per capita. This decline could be attributed to different reasons including climate change effects, inadequacy in planning and water security infrastructures, population increase, increase of social economic activities, catchment degradation as well as water user conflicts.

Many water resources in Tanzania are however, currently threatened by pollution associated with inadequate sanitation facilities, untreated industrial effluents and various other human activities. The magnitude of the problems is also exacerbated by the impacts of climate change. Again degradation of quality of water due to various human activities, poses a great risk to both the health of the population and on economic sectors. The National Environmental Policy (1997) has identified accessibility to good quality water both in urban and rural areas as one of the major problem requiring urgent attention. Furthermore, the National Water Policy (2002) acknowledges that despite significant investment in water supply services since early 1970s, water supply coverage to the population in the country is still inadequate.

11.2   Drivers

a) Economic growth

*Increase in agri*cultural and industrial activities and mining operations coupled with lack or inefficient treatment of effluents and discharging of raw or semi-treated effluents into receiving waters, contributes to pollution of water. In this regard, there has been increasing trends in pollution levels and water quality deterioration. In addition, uncontrolled use of agrochemicals coupled with poor agricultural practices have led to an increase in sediments, nutrients and pollutants that directly impact water quality.

b) Population growth

In 2008, Tanzania had 96.27 km3 of renewable water resources per year, which corresponded

to 2,266 m³ per person per year. MoW, (2013), indicated that Tanzania population is expected to grow to around 59.8 million by the year 2025 and consequently the annual average available water per capita, will be reduced to about 1,500 m³ per person per year. The decrease in renewable water resource per year is attributed to the rapid population growth and projected economic growth which will increase water demand and henceforth place an additional burden and thus the need for water supply infrastructure expansion in the country to match the current and projected population.

c) Climate change

Climate change has been altering hydrologic cycles, with impacts predicted to be manifested as changing precipitation patterns and more intense droughts, particularly in semi-arid areas. Severe and recurrent droughts in the past few years triggered a decrease in water flows in rivers, hence declines of water levels in satellite lakes and dams, and shrinkage of receiving lakes such as Lake Rukwa and Lake Victoria. In some areas, perennial rivers have changed to seasonal rivers, consequently leading to shrinkage or disappearance of some wetlands. In addition, sea water intrusion into freshwater wells has been experienced especially in coastal areas due to sea level rise.

11.3   Pressure

a) Improper waste management

Increasing urbanization, mining activities, agriculture and industrialization, have negative implications for water quality. Pollution from industrial and municipal effluents, poor disposal of solid waste and agricultural run-off in some water bodies and rivers, have reached alarming levels. About 90% of the population in the country use on-site sanitation systems, majority of which are of poor standard and thus contributing to surface and groundwater pollution. The increasing volume of untreated or partially treated industrial wastewater discharge is also among major causes of water pollution.

b) Limited capacity to invest in water supply and sanitation

Investment in water supply, either for infrastructure expansion or rehabilitation has not matched the pressure on demand because of the growing population. However, for the past two decades, the Ministry of Water has been implementing sector reforms that aim at improving the integrated water resources management and improving water supply and sanitation services in both rural and urban areas through implementation of the Water Sector Development Programme (WSDP).

c) Increasing water demand

Although freshwater is in abundance in the country, with growing urbanization, industrialization and rising food demand, unprecedented growth in water demand is foreseeable. Tanzania's urban population is projected to grow from less than 15 million people in 2012 to more than 60 million people by mid-century. This rapid urban population growth offers the potential for structural transformation, as well as scale and agglomeration economies that can accelerate human and economic development, which in turn will contribute to increased demand for water supply. (FAO, 2016), has indicated that the main water demand will be in irrigation (85%) followed by municipal uses which will be at the rate of 10% of the total water withdrawal.

d) Unsustainable human activities in water catchment basins

Human activities have influenced every major hydrologic process of the water cycle including: altered rainfall regimes (e.g., modified by urban areas), accelerated runoff and overland flow from impervious surfaces and tile drains, reduced infiltration from soil compaction and impervious surfaces, and induced changes in evapotranspiration from irrigated agriculture and trees in urban areas. (Liyanage & Yamada, 2017), have also reported that human activities pose significant threat to conservation and management of water resources efforts and that generally water quality is worst in highly populated areas, average in medium populated areas and less serious in less populated areas. Although groundwater is an important freshwater resource in Tanzania, rapid urbanization, informal/unplanned settlements and agricultural intensification in major basins are constantly threatening its sustainability.

e) Encroachment of water sources

Tanzania is faced with widespread degradation of land and water catchments due to agricultural activities in water catchments, on hills and in other fragile sections of ecosystems.

Similarly, pastoralists move with large herds of livestock in search for pasture and water and in the process, contributing to severe environmental degradation on land and in water catchments. People have been invading water catchment areas and carry out activities like building settlements, cutivations, and logging for various activities, including charcoal and brick curing, Damage to water sources has led to water scarsity and causing conflicts between water users.

11.4   State

a) Water quality

Thirty water samples collected from boreholes and shallow wells in Hombolo catchment in Dodoma region have been found to have high nitrate concentrations of 51.35 and 37.91 mg/L, respectively. Nitrate concentration varied by land use types with agricultural areas being the largest contributor (exceeding 80 mg/L) while wells in residential areas had relatively low concentrations (about 2.97 mg/L) as shown in Table 11-1.

Table 111: Nitrate results by wells, and land use in a catchment in Hombolo District

Group	Mean NO_3 concentration (mg/L)
Well type	
Shallow well	51.35±15.33a
Deep well	37.91±13.85b
Land use	
Agriculture	80.28±17.87a
Urban-Commercial	50.63±18.78a
Urban-Residential	2.97±0.86b

(Source: Salustiane et al, 2017)

Figure 111 shows the land use characteristics of Ruvu river basin categorized in five classes as reported by (Aphao and Sharma, 2018). Ruvu River Pollution Index (RPI), shows land use characteristics and urban areas exhibits very high influence on water pollution followed by agricultural areas.
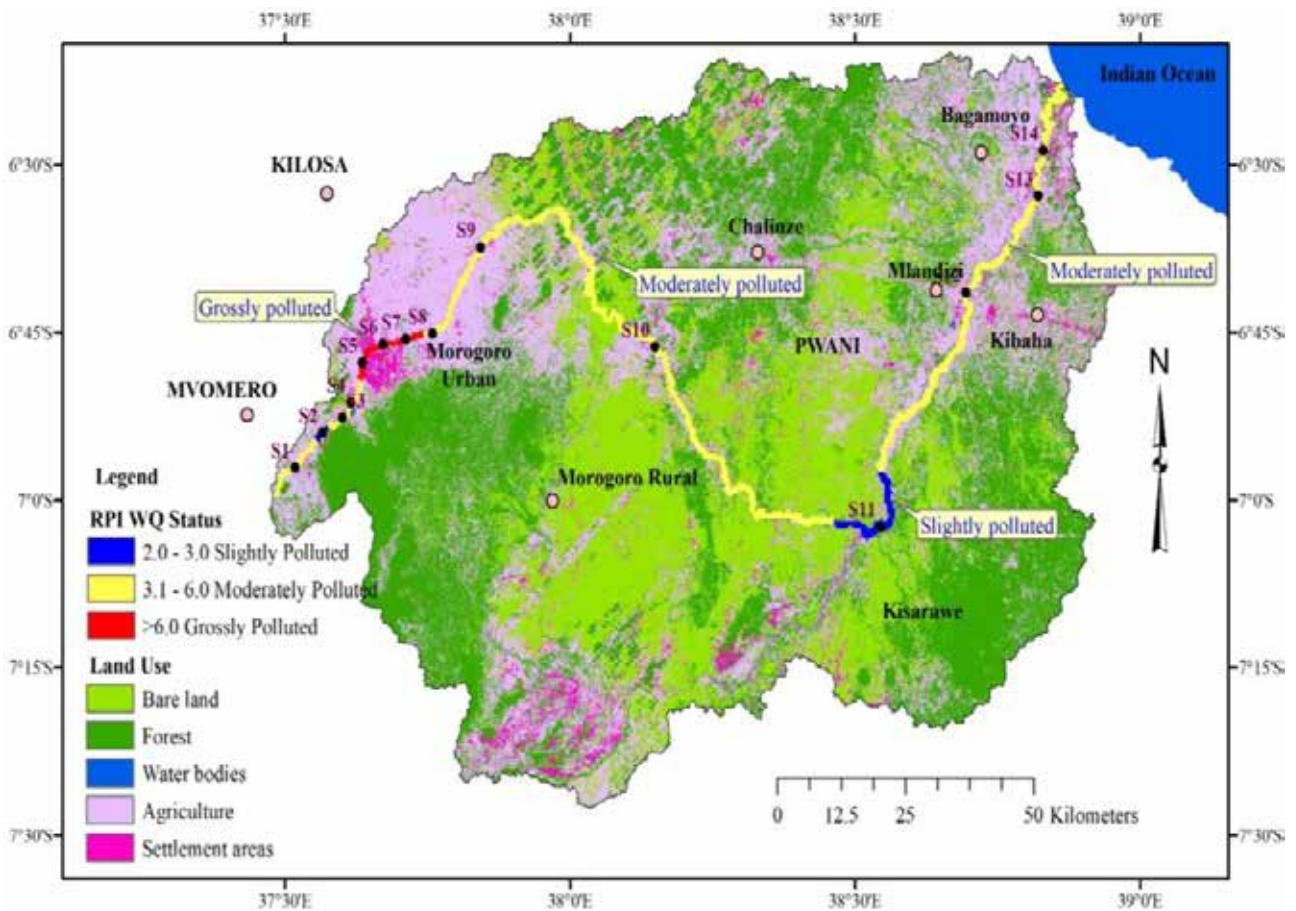
Figure 111: Land use characteristics of Ruvu river basin
(Aphao and Sharma, 2018)

The water quality in bare land and forest seems to be improving mostly due to self-purification of the river and no direct interaction with human activities. Water characteristics and RPI results in Figure 11-2 define the trend of river health. The trend shows that the water quality was exponentially impacted by the Morogoro urban at sampling location S6-S8 and started self-purification as it goes further to S14. These results most likely represents many other areas in Tanzania.
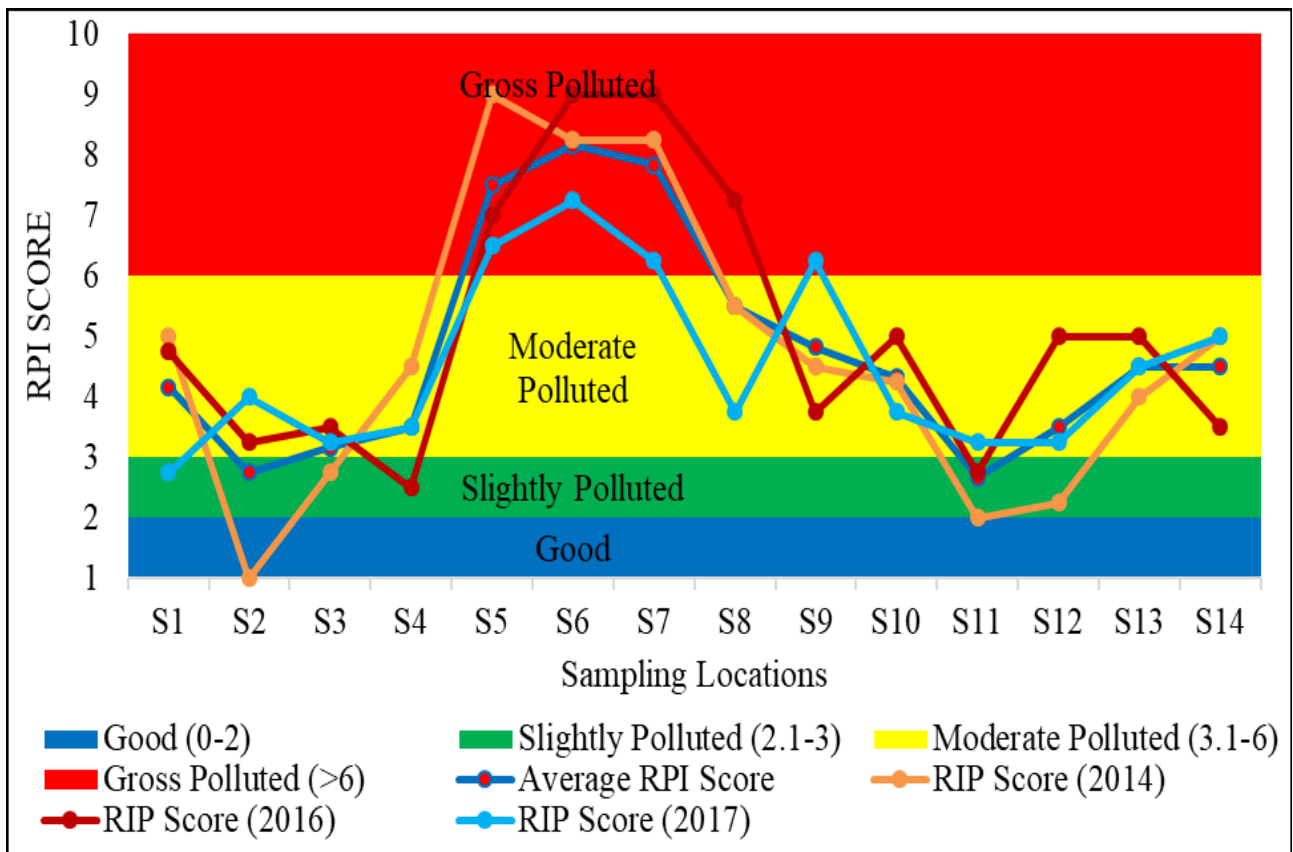
Figure 112: Variation of water quality of Ruvu River based on RPI
(Aphao and Sharma, 2018)

b) Water use by various sectors

Water is used for various purposes including domestic use, hydropower production, recreation, irrigation and livestock watering, fisheries, biodiversity conservation, industrial production and navigation, each of which has different implications for the state of the environment. Demand for, and availability of each of these uses, drives the current and future state of the water resources in the country in both quantity and quality. The total water withdrawal in mainland Tanzania is estimated to be 5,184 million m³. Agriculture is the largest water withdrawal sector with almost 90% of total, and in particular irrigation (85%), while the municipal sector use 10% and industry less than 1% as depicted in Figure 113.
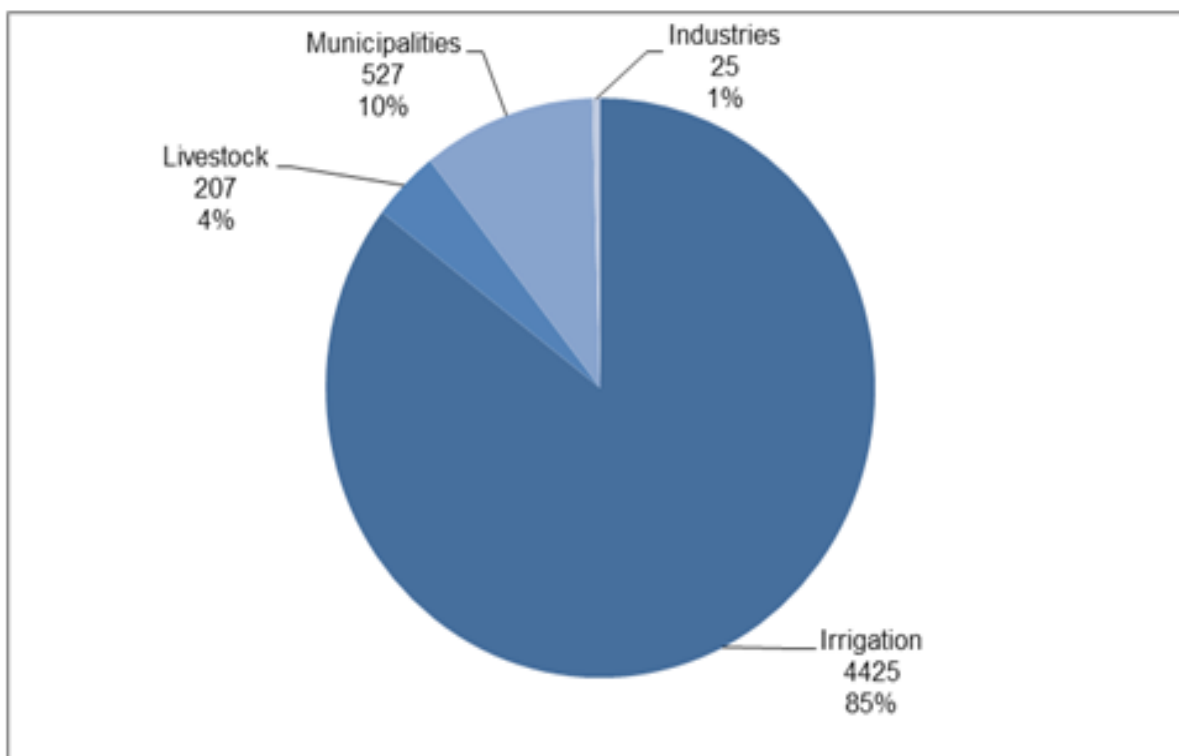
Figure 113: Water withdrawal by sector

c) *Water quality degradation*

Surface water quality

Previous studies revealed deteriorating water quality in major lakes and river systems countrywide including Lake Victoria, Lake Tanganyika, Lake Nyasa, Msimbazi River in Dar es Salaam city), Ngerengere River (Morogoro), Pangani River (Tanga) and Mirongo River in Mwanza region(URT, 2008; 2011). Most recent studies (Aphao and Sharma, 2018; Hellar-Kihampa, 2017; and Mtoni, *et al.*, 2017), have also indicated trends in water quality deterioration. Table 11-2 presents results of the analysis of water samples for selected parameters at different sampling locations of the Ruvu River in the year 2014-2017 (Aphao and Sharma, 2018). The basin and the sampling locations are indicated in Figure 11-1.

The water quality parameters were converted into a single value National Sanitation Foundation Water Quality Index (NSFWQI) that captured such parameters as Biochemical Oxygen Demand (BOD); Dissolved Oxygen (DO); Faecal Coliforms (FC); and classifies water quality into 5 categories starting from 0 to 100 score is as shown in Table 11-3. Table 11-3 shows that the average NSFWQI for the study period was 53.2, which is between 51-70, indicating that water quality of the river in study stretch is in the medium range. This is below category A (excellent) and B (Good Water Quality). These presents a picture of many water sources and basins in Tanzania and may be useful to managers and policy makers to tackle the water quality issues of water sources in Tanzania.

Figure 114: Sampling points

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Table 112: Average water quality of Ruvu River for the year 2014-2017

Sampling locations	NSFWQI Score (2014)	NSFWQI Score (2016)	NSFWQI Score (2017)	Average NSFWQI Score	Category	Status of pollution	Colour code
S1	47.2	54.2	57.2	52.8	C	Medium	Yellow
S2	63.0	60.4	60.3	61.2	C	Medium	Yellow
S3	64.8	62.1	65.1	64.0	C	Medium	Yellow
S4	54.1	67.3	63.8	61.7	C	Medium	Yellow
S3	64.8	62.1	65.1	64.0	C	Medium	Yellow
S5	47.5	46.4	54.4	49.4	D	Bad	Orange
S6	35.3	39.8	57.0	44.0	D	Bad	Orange
S7	38.4	32.4	52.5	41.1	D	Bad	Orange
S8	50.2	44.3	57.8	50.8	D	Bad	Orange

Sampling locations	NSFWQI Score (2014)	NSFWQI Score (2016)	NSFWQI Score (2017)	Average NSFWQI Score	Catego-ry	Status of pollution	Colour code
S9	51.4	53.4	56.6	53.8	C	Medium	Yellow
S10	51.0	51.3	57.0	53.1	C	Medium	Yellow
S11	53.5	58.9	58.6	57.0	C	Medium	Yellow
S12	49.1	48.5	53.3	50.3	D	Bad	Orange
S13	49.8	55.4	57.9	54.4	C	Medium	Yellow
S14	43.6	53.4	58.3	51.8	C	Medium	Yellow
Average	49.9	52.0	57.8	53.2	C	Medium	Yellow

(Source: Aphao and Sharma, 2018)

Table 113: NSFWQI Classification

Numerical range	Category	Descriptor word	Colour code
91-100	A	Excellent Water Quality	Blue
71-90	B	Good Water Quality	Green
51-70	C	Medium/Average Water Quality	Yellow
26-50	D	Bad/Fair Water Quality	Orange
0-25	E	Very Bad/Poor Water Quality	Red

Some significant impact emerging from the impairment of water sources are drying up of some rivers and shifting the flow in the rivers and make it seasonal. Drying up of water in major rivers has resulted in harm to the society and economy of the country. For example drying up of the Katavi river has led to efects on wildlife in the park including death which in turn can affect tourism industry. On the other hand mining in rivers such as Zigi-Amani, Lupa-Chunya, Epanko, Ruvu Kibungo and elsewhere has resulted in severe damage to water sources, quality and quality.

Some of the water quality assessment studies conducted in the country between 2006 and 2016 (Hellar-Kihampa, 2017) are summarized in Table 11-4. The information includes types of parameters measured and types of water sampled; locations where the studies were conducted and summary of the key findings obtained. In all these studies, quality of water was found to be affected by different stressors related to human activities.

Table 114: Water quality status in major water sources in Tanzania

Location	Water Type	Parameter	Status
Thigithe River	Surface water	Trace elements	High levels of As and Hg in downstream site where artisanal mining is performed
Maji ya Chai River, Arusha	Surface water	Natural organic matter	Water quality influenced by precipitation and humic substances
Dar es Salaam City	Wastewater discharged into river systems	Nutrients and toxic metals	Poorly treated industrial effluents contaminate urban rivers with nutrients and toxic metals
Mount Meru	Ground water	Stable isotope compositions of nitrogen-nitrate and oxygen-nitrate and concentration of nutrients	80% of all water sources had nitrate concentration higher than background concentration of 10 mg/l
		Total coliform (TC), faecal coliform (FC), Escherichia coli (E. coli) and faecal streptococci (FS)	Ground water sources contaminated by bacteria due to the positioning of pit latrines, inoculation of microbes by exposed buckets and inefficiency of the casing material.
Great Ruaha River	Surface water	Nitrogen and phosphorus	High levels of ammonia and nitrite in some locations associated with anthropogenic activities
Kilimanjaro Municipality	Wastewater	Toxic metals, nitrogen, and faecal coliforms	Concentrations of toxic metals in water released into the environment exceeded WHO limits
Dares Salaam City	Ground water	Inorganic ions	Water quality influenced by seawater intrusion and anthropogenic inputs
Pangani River Basin	Surface water	Toxic metals	The presence of low levels of metal contaminants with concentration patterns indicating anthropogenic inputs.
Msimbazi River, Dares Salaam	Surface water	Industrial pollutants	Levels of Cr exceeding the Who and TBS standards.
Kinondoni District, Dares Salaam	Groundwater	Faecal and total coliform bacteria	water samples from boreholes were contaminated with bacteria in quantities higher than the TBS limit

Location	Water Type	Parameter	Status
Pangani River Basin		Nutrients and inorganic ions	Inputs of nutrients (N-compounds) from human activities; levels of inorganic ions mostly indicate natural sources
		Organic contaminants	Water samples contaminated by organ chlorine pesticide residues from historical agricultural applications.
South-eastern Tanzania	Surface water and groundwater	Isotopes and major ions	Elevated NO_3 – concentrations in a few shallow aquifer samples imply sewage infiltration from domestic waste-water.
Temeke District, Dares Salaam	Drinking water	Physico-chemical parameters	Significantly high levels of chloride exceeding the allowable WHO limit
Inter-tidal areas of Dares Salaam			Polycyclic aromatic hydrocarbon (PAH) contamination of surface sediments and oysters
Mzinga Creek and Ras Dege, Dar es Salaam	Mangrove ecosystem	Toxic metals	Low levels of Cd, Cr, Cu, Hg, Pb and Zn in water, suspended particulate matter and oysters. Contributed by industrial and agricultural activities and transportation activities in the nearby Dar es Salaam port

Groundwater quality

The potential sources of groundwater pollution include domestic and industrial wastewater, leachate from solid waste dumpsites and mining tailings, storm water and poor agricultural practices. Furthermore, groundwater from recent sediments in the coastal plain is vulnerable to marine intrusion, particularly where groundwater-pumping rates are high. Marine intrusion has been occurring in the coastal aquifer of the Dar es Salaam Region and Bagamoyo in Coast Region.

The high concentration of chloride (salinity) in groundwater is the main problem especially in the coastal and central regions of the country (like Singida, Shinyanga, Lindi and Mtwara). In Lindi and Mtwara regions, there is high carbon dioxide in groundwater resulting in pH values of 4.0 which causes groundwater to be corrosive. High iron content in groundwater has been observed in Mtwara and Kagera regions while high nitrate levels are found in the Dodoma and Singida. High fluoride concentrations (exceeding 14 mg/L) occur in both the Rift zones in Northern and South-Western Tanzania including Shinyanga, Tabora, Dodoma, Singida, Mbeya, Arusha and Kilimanjaro Regions.

High Fluoride concentration have been reported in Regions such as Arusha, Shinyanga, Singida and Kilimanjaro. Generally human beings ingest fluoride mostly from drinking water sources. At low or optimum concentrations of 1.0 to 1.5 mg/L, fluoride stabilizes the skeletal system by increasing the size of apatite crystals and reducing their solubility. Fluoride concentration of between 0.7-1.2 mg/L has dental caries prevention effects especially in children. In excessive exposure (3-6 mg/L) it can result in a number of adverse impacts including skeletal fluorosis, while beyond 10 mg/L it leads to crippling fluorosis. The maximum permissible level for fluoride ingestion set by World Health Organization (WHO) is 1.5 mg/L. Until 2009 the allowable standard in Tanzania was 8 mg/L (Water Utilization, Control and Regulation, amendment Act, 1981). Since 2009 it was adjusted downward to 4 mg/L (Water and Wastewater Quality Monitoring Guidelines for Water Utilities, 2014). Figure 11-6 presents results indicating fluoride concentrations in different ground water sources (boreholes) in Arusha region.
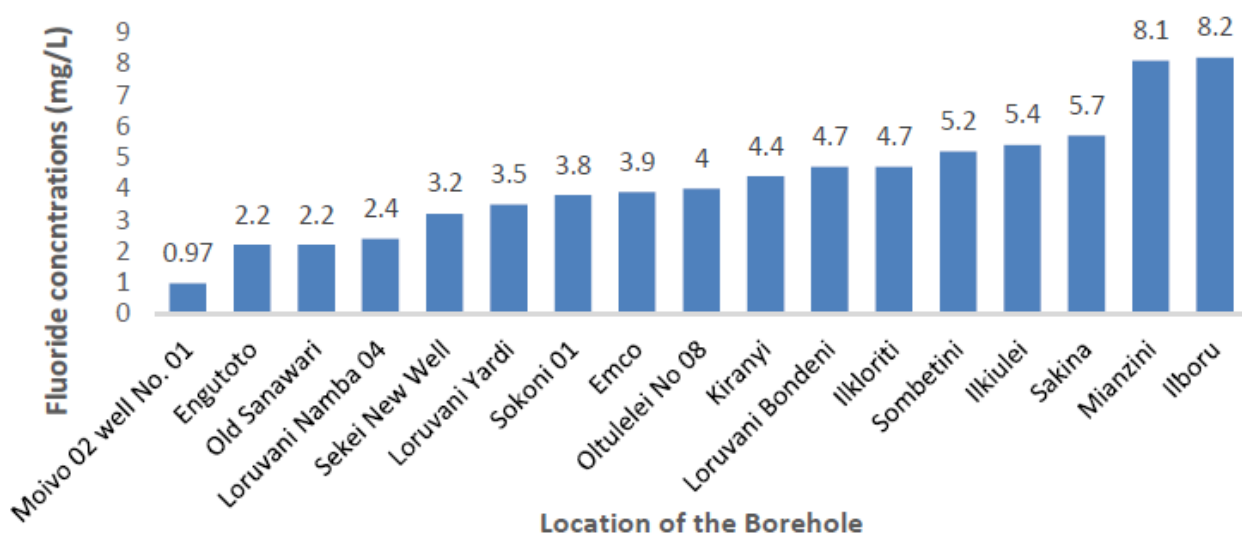
Figure 115: Boreholes locations and fluoride concentrations in Arusha City

11.5   Impacts

a) Water borne diseases

Diarrhoea, dysentery, cholera and other waterborne diseases are common public health problems throughout Tanzania which represent about 80% of disease incidences in rural areas. In urban areas, the rate of occurrence of the diseases is highest in unplanned settlements. Faecal contamination has been reported to be most prevalent in the neighbourhood of the populated urban areas. Health studies have found that 60–80% of outpatient cases are due to consumption of unsafe water and poor sanitation.

b) Economic loss

Degradation of the quality of water results in degraded aquatic system and limits usage of water including high treatment costs. The economic losses emanating from pollution of water is therefore significant.

c) Burden on time spent to fetch water

Deterioration of water quality and increased inaccessibility of water to the population inflict the burden on distance and time spent by mostly women and children to collect water for domestic uses. This is particularly the case in rural areas where the proportion of the population with access to improved sources of water within 30 minutes is less than 50%.

d) Water use conflicts

Water use conflicts have been experienced in almost all water basins in the country as a result of competition for water resources. Civil conflicts over water resources between pastoralists and farmers, have been raging in Tanzania for decades as farmers and herders scramble for resources.

11.6   Response

a) Access to water supply

The first phase WSDP was implemented between 2007 and 2014 and the second phase is being implemented between 2014-2019, while the third phase is to be implemented between 2019 and 2025. WSDP phase II which is currently being implemented has four components, namely: (i) Water Resources Management (WRM); (ii) Rural Water Supply and Sanitation (RWSS); (iii) Urban Water Supply and Sewerage (UWSS); (iv) Sanitation and Hygiene and Program delivery support. The total financial requirement for program implementation is USD 3,275,386. Figure 11-6 presents financial requirements by components including WRM-USD 803,601 (25%) RWSS-USD 862,394 (26%), UWSS-USD-1,348,103 (41%), Sanitation and Hygiene-USD 150,000 (5%) and Programme Delivery Support – USD 111,289 (3%) (URT, 2014).
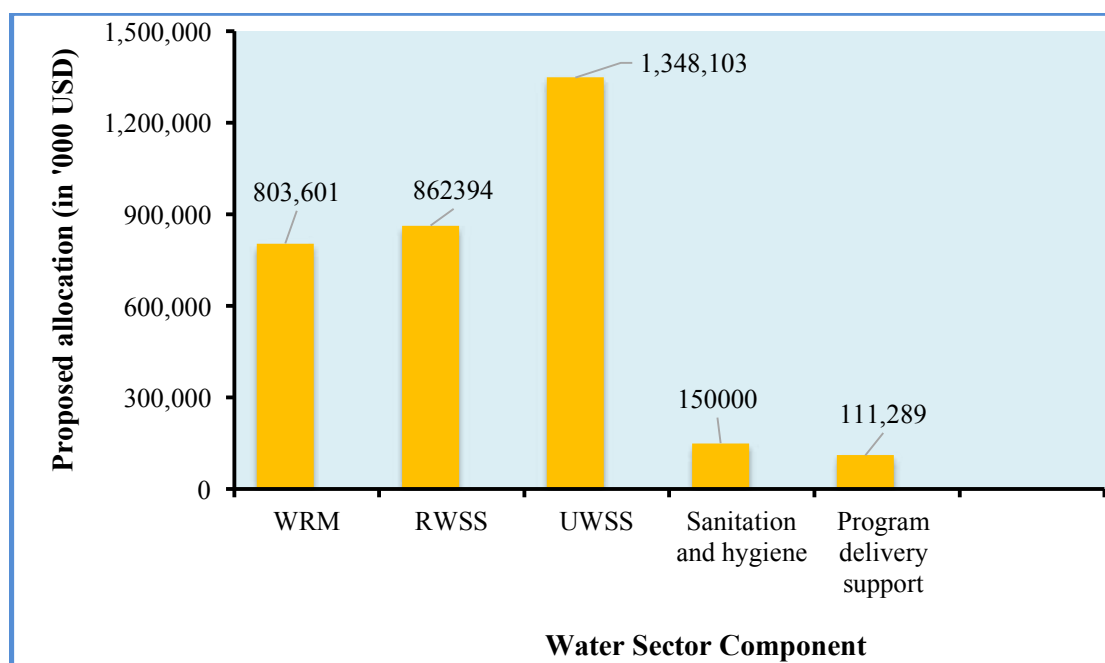
Figure 116: Component Proposed WSDP II Allocation

b) Policy, Plans, Strategies and Programmes

The Government has formulated a number of policies, plans, legislation, strategies and programmes. Some of these include: National Water Policy (2002); National Water Sector Development Strategy (NWSDS)(2005-2015); Water Quality Management and Pollution Control Strategy (2011); Water Sector Environmental Action Plan (2011); Water Resources Management Act (2009); The Strategy for Urgent Action for Conserving Marine and Coastal Environment, Lakes, Rivers and Dams (2008); and Water Supply and Sanitation Act (2009).

c) Exploration and development of new water sources

Exploration of new potential areas for drilling boreholes has been carried in many parts of the country. For example the potential resources available from the unexploited Kimbiji aquifer in Dar es Salaam city is currently estimated to at 135-150,000 m³/day. Again the construction of the Kidunda Dam water project in Morogoro Region Tanzania is expected to start soon. The dam is targeting to improve water supply in Dar es Salaam and Coast regions.

d) Identification, demarcation and protection of water sources

In response to the implementation of the Strategy for Urgent Actions on Land Degradation and Water Catchments (2006), efforts have been undertaken by the Ministry of Water to identify, demarcate and conserve water sources. Between 2014 and 2018, a total of 298 water sources were identified and conserved. Out of these, 18 have been gazzetted as protected water sources.

e) Environmental inspection and water quality monitoring

Various Government Ministries and Agencies carry out regular inspections in industries, mining sites and hotels in an effort to control pollution from these potential sources of water pollution. The inspections are carried out by the Ministry of Water, National Environment Management Council (NEMC), Government Chemist Laboratory Agency (GCLA), and Local Government Authorities.

CHAPTER TWELVE

CLIMATE CHANGE

12.1   Introduction

The impacts of climate change and variability are consistently and increasingly felt at the global, national and local scales. These impacts are manifested through increasing temperature, decreasing rainfall, and increasing frequency and intensities of extreme weather and climate events, particularly strong winds, floods and droughts, which are often associated with devastating socio-economic and ecological implications.

Analysis of recent climatological data and observational evidence from local communities are overwhelmingly indicating some signals of increased climate variability and climate change over most parts of the country. Increasing temperature, notably over highland areas are observed in most parts of the country, late rainfall onset and early withdraw (cessation), decreasing rainfall amount and seasonal shift in rainfall patterns are becoming more common. The risks associated with climate change are already evident in various economic sectors essential for Tanzania's livelihood and sustenance, including water and energy resources, food security, ecosystems/biodiversity and human health. In most vulnerable communities, the impacts of climate change pose a direct threat to people's survival.

12.2   Drivers

a) Economic development

The main driver of climate change is economic development. Economic development and activities in terms of industrial development and transportation with respect to developed countries have subsequently leading to climate change. The impacts of climate change have crossed borders and so impacting developing countries due to lowadaptive capacity.

b) Dynamics of land use, land use change and forestry

Tanzania has relatively low contribution to causes of global warming compared to other countries. Its little contribution is through deforestation and forest degradation where it is estimated to be at 469,420 ha per annum.

Again in Tanzania the dynamics of land use, land use change as well as heavy dependence on fossil fuel for energy is also considered to be among major climate change related drivers to deterioration of the ecological systems. The national energy balance in Tanzania is dominated by biomass which accounts for 85% of the total energy used in the country, and that among the factors contributing to deforestation include unsustainable charcoal production for domestic and industrial use. Also the intensification of agriculture has exerted pressure on natural resources, and thus contributes to natural carbon pool, hence increasing agriculture's contributions to climate change impacts.

12.3   Pressure

a) Rapid population growth and poverty

The rapidly growing Tanzanian population with decreasing per capita arable land, increases demands for food and pressure on the available land resource for food production. Hence, this population trend is pressing much on land cover change and so necessitating emission of GHGs and changes in environmental conditions. The association between population growth and environmental changes is presented in earlier chapters including land degradation and forest degradation.

12.4   State

a) Major drivers of weather and climate events

In the year 2017, severe weather and extreme climatic events were reported in different parts of the country. Global and regional weather and climate drivers in addition to local forcing collectively enhanced the weather and climatic conditions in the country. Weak la Nina that developed over the equatorial Pacific from previous year through February 2017 changed to neutral ENSO that spanned from March to September 2017 before it gradually retreated back to a weak la Nina condition during the last quarter of the year 2017. The weak la Nina condition partly contributed to rain deficiency over the bimodal areas during OND 2017 season (URT, 2017).

Neutral Indian Ocean Dipole (IOD) phase was also observed in the Indian Ocean in the beginning of the year 2017 (January-March) before it shifted to positive phase during April to late August 2017 and then changed back to neutral phase towards the end of the year. However, Positive Sea Surface Temperature Anomalies (SSTA) continued to dominate in the western Indian Ocean and negative SSTA continued to persist in the eastern Indian Ocean during April through September 2017. These conditions favored development of convective rainfall activities in the East African region especially the coastline. In addition, enhanced low level easterly wind anomaly was observed during February 2017 over the northern basin of Indian Ocean penetrating towards the hinterland of Tanzania, these winds weakened during March and picked up again during April and persisted through May, but this time they decelerated as they approached the coastline of Tanzania. These wind anomalies were partly exacerbated by the presence of warm SST along the western Indian Ocean, causing influx of abundant moisture from the Indian Ocean towards the country. In turn, convection activities were enhanced over different parts of the country. This condition is partly linked with the heavy rainfall events that were observed over different parts of the country especially coastal areas during February, April, and May 2017 (URT, 2017).

In contrary, anomalous easterly wind were observed over central Africa during April implying weakened westerly winds towards the country(URT, 2017). This condition is associated with the below normal rainfall observed over the western part of the country during April. For individual severe (heavy) rainfall events that occurred during 2017, especially those in April, October, and December, the existence of quasi stationary systems that are responsible for rain development over the respective areas were the major factors. Examples are existence of equatorial trough and the Inter Tropical Convergence Zone (ITCZ) in the region were associated with well-developed thunderstorms.

In recent years Tanzania has experienced an increase in frequency and intensity of extreme events such as strong wind, heavy rainfall, hailstorm and higher temperatures. These extremes are normally associated with devastating socio-economic impacts including loss of life and properties, and destruction of infrastructure. The last four years, 2015, 2016, 2017 and 2018 have also been characterized by record breaking extreme events, consistent with global observation and trends as documented in IPCC report. For example in November 4[th]2015, Tukuyu Meteorological Station recorded 327.8 mm of rainfall in 24 hours, which is the highest ever-recorded 24 hours rainfall since the establishment of the station in 1928. On 9[th]April 2016, Mbambabay, Ruvuma region recorded 247.6 mm of rainfall in 24 hours, which is the highest amount on record since the station was established in 1951. On 8[th]May 2017, Tanga station recorded 316 mm of rainfall in 24 hours, the highest ever, since the establishment of the station in 1968 (TMA, 2019).

Apart from extreme rainfall events, the country experienced extreme temperatures, in some cases greater than 35^{0}C. For temperature extremes, major impacts were associated with excessive body water loss through sweating, thirst, drying of mouth, headache, impaired concentration, and Skin rushes especially for babies, and general body discomfort (TMA, 2019).

c) Temperature Distribution

Temperatures across the country are normally characterized by relatively less fluctuation throughout the year. The annual long term average temperature over different stations in Tanzania ranges from 14.4-26.4 ^{o}C. Regions with the highest temperatures are along the coast and western parts of the country. The season with high temperatures starts from October, continuing through February or March, whilst the cold season is from May to August. The annual minimum air temperature (Tmin) and Maximum air temperature (Tmax) across the stations in Tanzania ranges from 9.6-22^{0}C and 19.1-30.7^{o}C respectively.

Annual Mean, Maximum and Minimum Temperature Anomalies

In the year 2017, the country experienced warmer temperature with annual mean of 24.1^{o}C, which is 0.7^{o}C above the long-term average (1981-2010). Higher positive temperature anomalies were observed almost over the entire country except for Pwani, Tabora, and Ruvuma regions, which observed near average temperature.

The country experienced annual maximum temperature (Tmax) of 29.2^{o}C which is 0.5 ^{o}C above the long-term average and annual minimum temperature (Tmin) of 18.9 ^{o}C which is 0.9^{o}C above the average. Minimum temperature anomalies across regions are higher when compared to the maximum temperature anomalies.

Monthly Maximum Temperature Anomalies

The country experienced anomalously warmer monthly maximum temperatures (Tmax) in the range of 0.1-2.6^{o}C above the long-term average. Over most stations, January was the warmest month in the year with anomalies exceeding 1.5 ^{o}C.The highest Tmax anomalies were observed over northeastern parts of the country.

On the other hand, May was the coolest month in the year. Below average Tmax were observed mostly in the north eastern and central parts of the country. For example, same station recorded anomaly is 1.6°C below the long-term average which is the second lowest Tmax anomaly since the station was established in 1958. Climatologically June and July are the coldest months in most parts of the country. This cooling condition in May over the northeast parts may be attributed to the reduced incoming solar radiation due to enhanced cloud cover and heavy rainfall events observed over those areas in May.

Monthly Minimum Temperature Anomalies

The country experienced anomalously warmer monthly minimum temperatures (Tmin) in the range of 0.1-2.5°C above long-term average. From June to September, most regions in the northern, central and western parts of the country experienced anomalous warmer monthly Tmin 2.8°C, 3.0°C and 2.5°C in June, July and August respectively. These anomalies are the highest on record in the respective months since the station was established in 1959. On the other hand, during September, October and November, Kibaha station in the northern coast recorded anomalous coller night temperature (Tmin) of 2.5°C below the long-term average.

d) Temperature projections 2050 and 2100

The projected change in mean seasonal and mean annual temperature for the year 2050 and 2100 is presented in Figure 12-1. Generally the entire country is projected to experience an increase in temperature, though the temperature increase varies from zone to zone. More warming is projected over the Western side of the country, whereby a warming of up to 3.4⁰C is projected by 2100. A warming of less than 1.76ºC for 2050 and 3.28ºC for 2100 is projected over parts of the northern coast regions and north-eastern highlands, and a warming in excess of 1.77°C for 2050 and 3.3ºC for 2100 is projected over the Lake Victoria zone, and central Tanzania zone while a warming in excess of 1.39ºC for 2050 and 3.18ºC for 2100 is projected for the southern coast including Mtwara and Lindi regions.
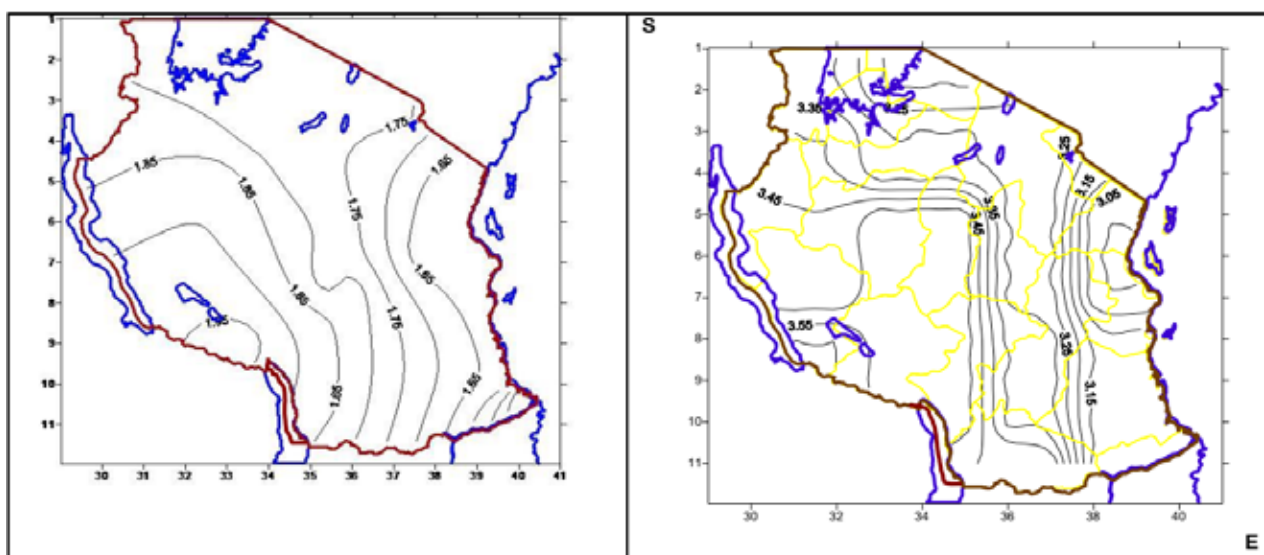

Figure 121: Projected change in mean annual temperature by 2050 and mean annual temperature by 2100

e) Rainfall Distribution

The rainfall distribution and variability in the country is driven by multiple factors including East African Monsoon, Elnino Southern Oscillation (ENSO), and Westerlies from Congo, Tropical Cyclones, and Inter-Tropical Convergence Zone (ITCZ). ITCZ and its migration north and south across the equator are among the main factors affecting distribution and variability of rainfall in Tanzania and the entire East Africa. The migration of ITCZ lags behind the overhead sun by 3-4 weeks over the region. The ITCZ migrate to southern regions of Tanzania in October-December, reaching southern part of the country in January-February and reverses northwards in March, April and May.

Due to this movement, some areas experience single and double passage of the ITCZ. The areas that coincide with single passage are known as unimodal areas. These include the southern, southwestern, central, and western parts of the country, which receive rainfall from November to April or May (NDJFMA, also known as Msimu rains). Areas that experience double passage are known as bimodal, and include northern coast, northeastern highlands and Lake Victoria basin. These regions receive two distinct rainfall seasons; the long rain season (also known as Masika in Swahili), which starts mainly in March and continues through May (MAM) and the short rainfall season (also called vuli in Swahili) which starts I October and continues through December (OND). January and February is the transition period (relatively dry) for bimodal areas while June, July, August, and September are dry months for the entire country.

Annual Rainfall Distribution

In 2017, the country received annual total rainfall of 1041 mm, which is 3.2 mm above the long-term average. Most parts of the country experienced normal rainfall with exception of few areas in the southwestern parts and Kagera region that experienced below and above normal rainfall respectively.

Seasonal Rainfall Distribution

Normal rainfall was observed over most parts of the country during MAM, OND and NDJFMA rainy seasons. However, few patches of above normal rainfall were observed over the northern coast and western part of Lake Victoria during MAM and OND season. In addition, few patches of below normal rainfall were observed over central and southwestern highlands in NDJFMA season.

Monthly Rainfall Distribution

In year 2017, most parts of the country received normal to above rainfall particularly in February, March, May, September, October, and November, while January and July received below rainfall.

Cumulative Rainfall

In climate change statement (URT, 2017), cumulative rainfall analysis was used to characterize rainfall performance compared to long-term average for different areas in the country. In the bimodal areas, cumulative rainfall trends for Dar es Salaam, Zanzibar, Tanga and Morogoro

indicate below normal rainfall from March to April, followed by above normal rainfall in May. In OND seasons, Dar es Salaam, Tanga, and Morogoro received above normal rainfall. The cumulative rainfall trend for Bukoba and Arusha indicate above normal rainfall, during MAM and OND rainy seasons, while below normal rainfall was observed in Mwanza. Moshi received normal rainfall during MAM season and above normal rainfall during OND season.

In the unimodal areas the trend of cumulative rainfall during November 2016 to April 2017 season indicates below normal rainfall. Rainfall amount lower than 200 mm compared to long-term average were recorded at Dodoma, Kigoma, Tabora and Mbeya stations. However, Mtwara and Iringa regions received above average rainfall in March and April. Generally, cumulative rainfall indicated below normal rainfall across most parts of the unimodal areas during the Msimu rainy season (URT, 2017).

f) Rainfall projections 2050 and 2100

Rainfall projections indicate that some parts of the country may experience an increase in mean annual rainfall of up to 18 to 28% by 2100, particularly over the Lake Victoria Basin and North-Eastern Highland (Figure 12-2). An increase of about 10-12% in 2050 and 18.2-28.3% in 2100 is projected over Lake Victoria Zone. The North Eastern Highlands areas are projected to experience an increase of up 13.4% in 2050, and 16.3% in 2100. The South Western Highlands and Western Zones of the country are projected to experience an increase in annual rainfall by up to 9.9% in 2050 and by up to 17.7% in 2100. The North Coast Zone is projected to have an increase of about 1.8% in 2050 and 5.8% in 2100 while the Central Zone is projected to have an increase of up to 9.9% in 2050 and up to 18.4% in 2100. The Southern Coast Zone is projected to have a decrease of up to 7% in 2050 and an increase of annual rainfall of about 9.5% in 2100.
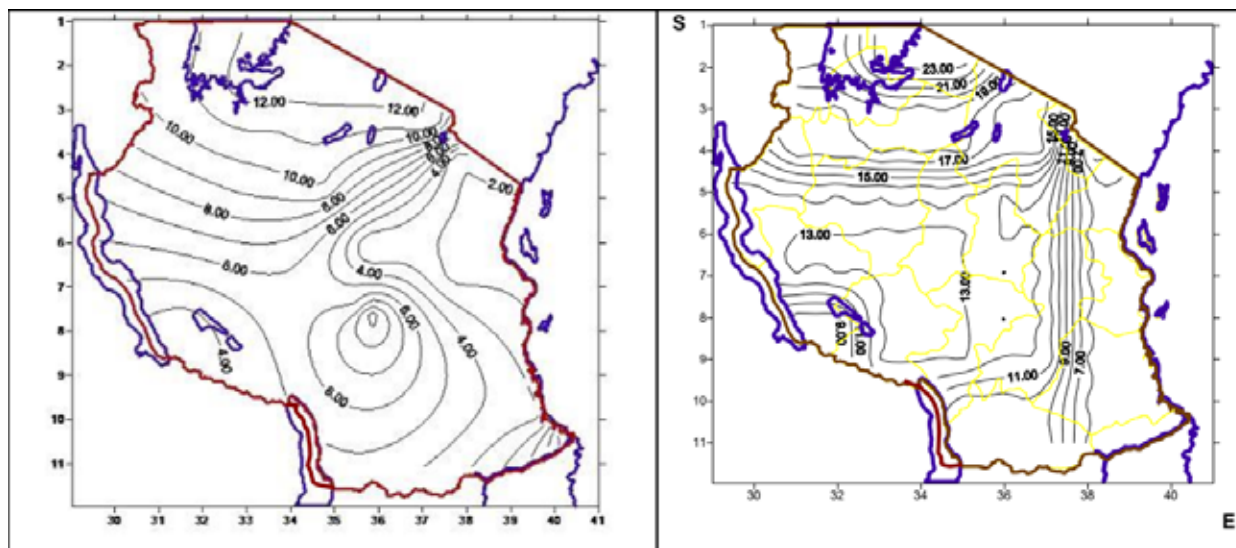
Figure 122: Projected percentage change in mean annual rainfall by 2050 and mean annual rainfall by 2100

A Case of Lake Victoria Basin - Tanzania

Tanzania is rich in both seasonal and permanent rivers that contribute to the Lake Victoria waters. Major rivers in Tanzania side Lake Victoria basin include Kagera, Simiyu, Mbalageti, Duma, Mori, Mara, Ngono and Mwisa. All rivers are gauged in order to monitor the amount

of discharge variation over the year. Figure 12-3 is an indicative of a dropping water level in Lake Victoria Basin (EAC - LVEMP, 2018).

Figure 123: Bismarck rocks showing the drop in water level of Lake Victoria

Analysis of discharge data for the period of 2005 to 2015 was done for major rivers entering Lake Victoria in Tanzania. Simiyu catchment being a pilot catchment under LVEMP II, indicated an increase in river discharge as shown in Figure 12-4. Analysis of discharge data for Kagera River indicated an average daily flow of 208.39m ^{3}/s for a period of 1997 to 2004 and an average flow of 230.29m^3/s for a period of 2007 to 2014 (refer Figure 12-5). Mara River flows for Mara at Mara Mine also experienced increase in river flows during the same period (EAC - LVEMP, 2018).
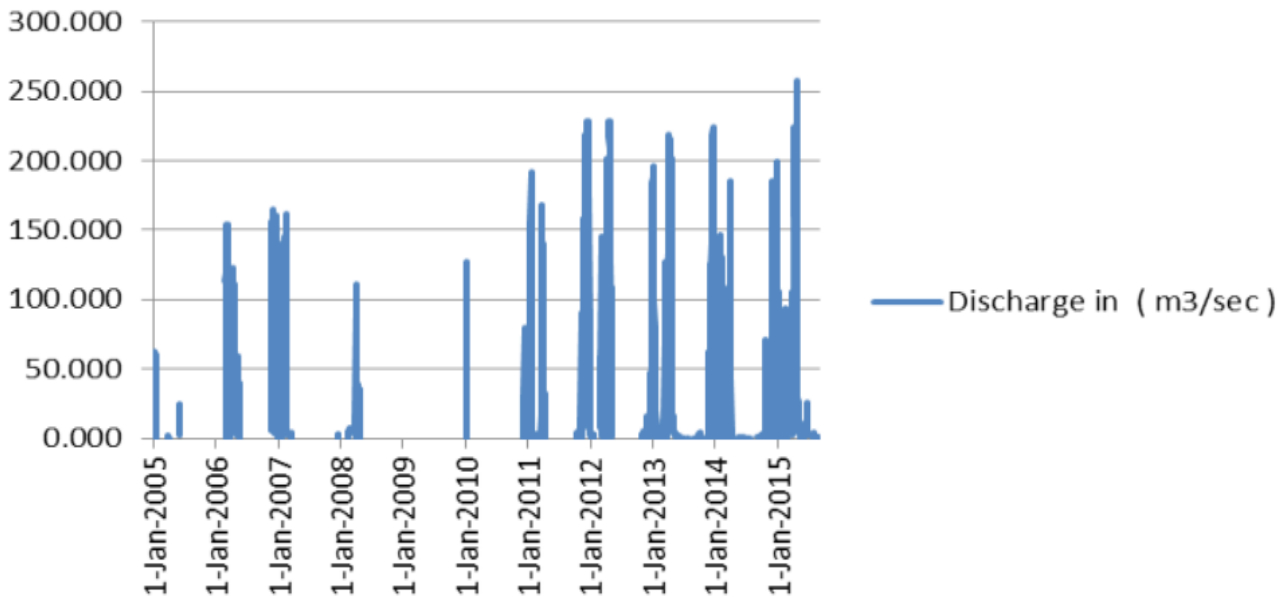
Figure 124: Daily flows for Simiyu River at Road, 2005-2015
(EAC - LVEMP, 2018)
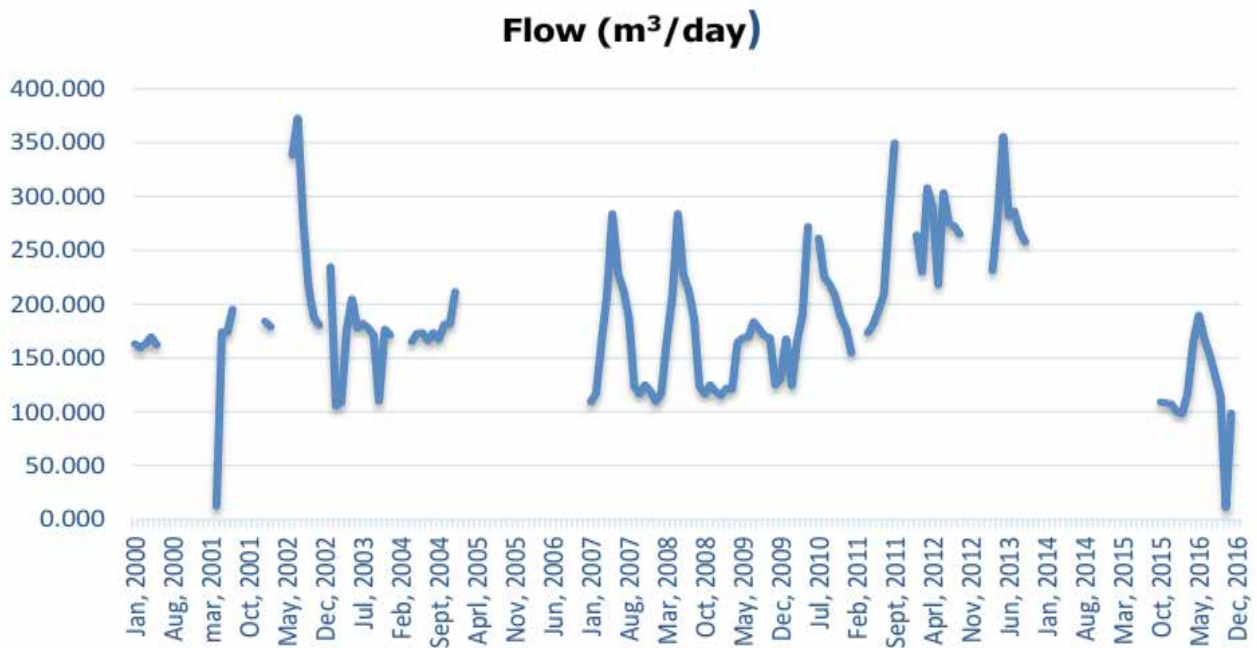
Figure 125: Daily flows for Kagera River at Kyaka Ferry, 2000-2016
(EAC - LVEMP, 2018)

Improvement in rivers discharge and flow is possibly an indication for positive impact for implementation of Sustainable Land Management interventions and enforcement of environmental law (WRMA of 2011 and EMA of 2004) in the project area through the Project support. Among the interventions implemented in the catchment include buffer zone (60m) protection, contour farming, tree planting, establishment of tree nurseries and community sensitization. Formation of Water User Associations (WUA) was done in all districts that are within Simiyu catchment for the purpose of ensuring sustainable management of water resources. WUA formation was coupled with provision of alternative livelihood sub-projects to Communities who depended on the 60m riparian zone as their source of income

through agricultural productions. The provided livelihood sub projects aimed at supporting communities to generate income out of 60m riparian zones in environmentally friendly manner (EAC - LVEMP, 2018).

On the Lake water level, the records indicate an uptrend in water level of the Lake as shown in Figure 12-6. An increase of 0.69masl in the water level was observed in the period between 2012 and 2015 (from 1132.88m amsl to 1133.57m amsl). The increase may be due to either increased inflow into the lake as well as rainfall falling directly over the lake surface. Also, this may be due to controlled/regulated outflow and abstractions (EAC - LVEMP, 2018).

Mwanza south water level records are available from 2005 - 2015. The datum for Mwanza south station is 1131.50m amsl. Figure 12-6 shows Lake Water level at Mwanza South.
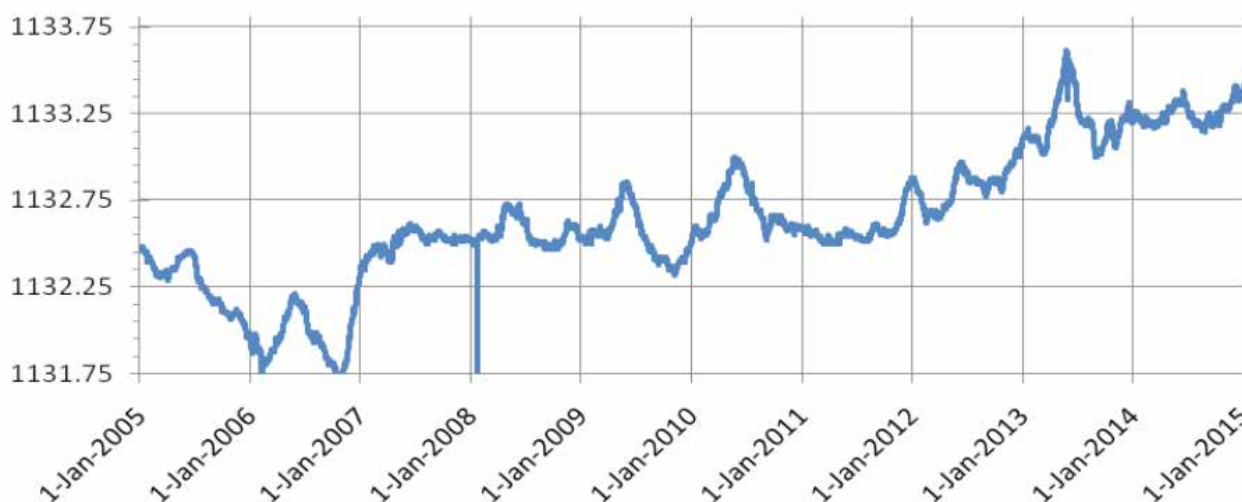
Figure 126: Lake Water level (m) at Mwanza South port, 2005-2015
(EAC - LVEMP, 2018)

12.5   Impacts

a) Economic losses

For most of the developing countries including Tanzania of which socio-economic development and livelihoods are strongly linked to their dependencies on natural resources and rain-fed agriculture, Initiatives and efforts towards poverty eradication and reaching zero hunger are significantly affected by the trends and patterns of climate extremes. Unfortunately, extreme events are projected to increase and will continue to have greater impacts, particularly on climate sensitive sectors such as water, health, forestry, agriculture and food security.

Economics of climate change, it is projected that future climate change could be much worse, leading to significant economic costs to the country. The study revealed that: Current climate change variability already costs Tanzania around 1% of GDP annually and it could go up to 2% of GDP by 2030; An additional 0.3 million to 1.6 million people will become vulnerable to sea level rising by 2030; About USD 500 million is required annually to reduce current vulnerability to climate change, and a further USD 100-150 million per year will be required to build capacity and enhance resilience to future climate change. Climate extremes therefore poses a serious threat to the achievement of various socio-economic development

strategies and plans including the achievement of TanzaniaDevelopment Vision 2025, Five-Year Development Plan (2016-2021) and the Sustainable Development Goals (SDG).

b) Weather and climate related impacts

The impacts of observed severe weather and extreme events included loss of lives and property, and damages of infrastructures. Between 2015 and 2018 more than 150 deaths were caused by floods that left more than 2000 people homeless. These floods in Dar es Salaam, Korogwe, Lushoto, Mwanza, Morogoro, Coast, Arusha, Manyara and Kilimanjaro have a further effects on properties and infrastructures in the country. For example on 26th October 2017, transportation network across the city of Dar es Salaam were paralysed for more than six hours following heavy rainfall event that caused overflows in some rivers connecting the city. The main public transportation system (UDART) that serves thousands of people to commute to their residences in Dar es Salaam city was also stopped due to severe flooding over Jangwani area. Also, death of four people, damage to houses and infrastructures such as roads and bridges were reported across different suburbs of Dar es Salaam and Pwani.

c) Agriculture sector

The agriculture sector in Tanzania is particularly vulnerable to climatic change because it is customarily dependent on rainfall. Since more than 60% of Tanzanian population directly rely on agriculture for their livelihoods; thus, 10% decrease in rainfall would make most of areas unsuitable for cultivation. Changing climate has resulted in a general decline in agricultural productivity, including changes in agro-diversity. The prevalence of crop pest and diseases is also reported to have increased, posing more challenge to agriculture.

The changing climate has impacted on various livelihood systems of the area, including reduced agricultural production and food security, affected livestock systems by impelling livestock keepers to migrate to distant places in search of water and pastures.

d) Energy sector

Frequent and persistent droughts evident in the past decade have caused drying up of major hydropower dams consequently the energy mix has progressively been declining in recent years. With acerbated impacts of climate change, these traditional sources of energy are under threat. As a result of increasing climate variability, over the last years, the country has experienced increasing incidents of recurrent and prolonged droughts with severe implications on hydro power generation. A good example of impacts of climate variability has been observed in Mtera HEP in the Great Ruaha River (URT, 2017).

e) Infrastructure

Increased rainfall due to climate change have caused flood that led to damage of transport, communications and buildings infrastructures (Figure 12-7). This situation led to the Government to spend substantial amount of funds to restore infrastructures.

Figure 127: Road and bridge damage by floods at Dumila, Morogoro region

f) Livestock sector

Most of the livestock are concentrated in the semi-arid areas (including, Arusha, Dodoma, parts of Iringa, Kilimanjaro, Manyara, Shinyanga, Mwanza, Singida, Mara, Tabora and parts of Rukwa) which are more suitable for livestock than any other form of agriculture. These areas are characterized by relatively low mean annual rainfall with stronger spatial and temporal variability, and therefore not very reliable for production of food and cash crops. Concentration of ruminant livestock in these areas is also attributed to low prevalence of tsetse flies and less competition for land for arable agriculture. However, the sector is affected by various climate change impacts, drought being the most serious. There has been as a result of severe and recurrent droughts, particularly in the northern parts of the country. Changes in the mean temperature and rainfall, and the increased variability of rainfall, have resulted to prolonged length of dry seasons and increased severity of periodic droughts that reduces water and pastures availability for the livestock. Warming is predicted to increase disease vectors which will consequently increase the incidences of vector-borne diseases of livestock, such as trypanosomiasis, East Coast Fever, and Rift Valley Fever.

g) Health sector

According to the WHO UNFCCC Climate Change and Health Country Profile for Tanzania, under a high emissions scenario, mean annual temperature is projected to rise by about 4.7°C on average from 1990 to 2100. If global emissions decrease rapidly, the temperature rise is limited to about 1.2°C.

Flooding causes extensive indirect health effects, including impacts on food production, water provision, ecosystem disruption, infectious disease outbreak and vector distribution. Vector-borne diseases, diarrhea diseases and malnutrition are all influenced by seasonal, inter-annual climate variability, and are predicted to increase with increasing temperatures. In Tanzania, increased temperatures and changes in rainfall patterns as a result of climate change are widely recognized to entail potentially serious consequences for human health, including an increased risk of diarrheal diseases. Studies show significant relationship between temperature and the incidence of cholera in the country. For a 1 degree Celsius temperature increase the initial relative risk of cholera increases by 15 to 29 percent. It is projected the number and costs of additional cases of cholera that can be attributed to climate change by 2030 in Tanzania for a 1 and 2 degree increase in temperatures, respectively. The total costs of cholera attributable to climate change are shown to be in the range of 0.32 to 1.4 percent of Tanzanian GDP in 2030.

h) Forestry and Wildlife sectors

Climate change impacts on forest ecosystems and biodiversity are expected to vary depending on vegetation species. The common impacts to all forests types include loss of biodiversity; disappearance of wildlife habitats, increased risk of bush fires, limited availability of forest products (timber and non-timber products) and ecosystem shift (for example, forest to woodlands, or woodlands to grasslands).

i) Water sector

Water resources in the country include rivers, lakes, wetlands, springs, reservoirs groundwater aquifers, and many water bodies that are shared with neighbouring countries. Increasing rainfall variability and prolonged droughts cause serious pressure in the country's available water resources. Severe and recurrent droughts in the past few years triggered a decrease in water flows in rivers, hence shrinkage of receiving lakes, declines of water levels in satellite lakes and hydropower dams. Furthermore, some of the perennial rivers have changed to seasonal rivers and some wetlands have dried up.

j) Fisheries sector

One of the most striking signs that climate change has an impact to marine fisheries is the destruction of coral reefs which is a critical habitat for fishes in the coastal environments. Destruction of coral reefs due to coral bleaching caused by rise of sea surface temperature is among the factors impacting marine fisheries. Sea level rise which is associated with global warming may cause sea water to rise above optimal levels of some corals. Further climate change is impacting fish migration patterns thereby affecting fish recruitment and stocks in traditional fishing sites, especially for artisanal fisher folks. Sedimentation in freshwaters is negatively affecting fisheries in fresh water bodies, for example, by destroying breeding and feeding sites. This problem is aggravated by drought and frequent floods resulting from climate change.

k) Shrinking of rangelands

Climate change is expected to further shrink the rangelands which are important for livestock keeping communities in Tanzania. Shrinkage of rangelands is likely to exacerbate conflicts

between livestock keepers and farmers in many areas.

12.6   Response

Various initiatives have been undertaken at the national level and local levels by various stakeholders to address the challenge of climate change between 2015 and 2018. National policies, legislations, regulations, strategies, plans and guidelines addressing management of oil and gas production. These include:- National Energy Policy (2015); The National Petroleum Policy of Tanzania (2015); Petroleum Act (2015); Paris Agreement on Climate Change (2018); National Framework for Climate Services (2018); and The National Petroleum Policy of Tanzania (2015).

The country has also developed and implemented programmes and projects including:Adaptation Fund project implemented in the Coastal regions of Tanzania (2017); Developing Core Capacity to Address Adaptation to Climate Change in Productive Coastal Zones of Tanzania (2012- 2018); Implementation of Concrete Adaptation Measures to Reduce Vulnerability of livelihood and economy of Coastal Communities of Tanzania (2012-2018); Mainstreaming Environmental and Climate Change into development plans and, national policies 2012-2015; and Africa Adaptation Programme project (2010- 2012).

Implementation of these initiatives has enabled the country to build resilience in various areas of the country to climate change impacts including: construction of 780 m sea wall at Barack Obama Road (Figure 12-8); Construction of 500 m long wall at Mwalimu Nyerere Memorial College in Kigamboni; reconstruction of 860m sea wall in Pangani; Restoration of 1,000 ha degraded mangrove areas in Rufiji, and Restoration of 3,000 m^2 of coral reef in SindaKigamboni.

Figure 128: The Vice President of the United Republic of Tanzania, Mama Samia-Suluhu inspecting seawall project in Dar es Salaam

Furthermore through implementation of the various initiatives, the Government established The National Carbon Monitoring Centre at SUA Morogoro. The centre is responsible for developing, maintaining, analyzing and updating carbon database which facilitate taking stock of country contribution in sequestering carbon dioxide, and developed Tanzania Forest Reference Emission Level in 2018 which makes the country to qualify and benefit from REDD financing mechanism. In addressing climate change impacts, other strategic plans by the Government is to increase the proportion of districts with climate change and disaster risk reduction strategies by 60% coming the year 2020/21(URT, 2016).

Other initiatives include:
a) National REDD Framework for Reducing Emissions from Deforestation and Forest degradation.
b) Implementation of Dar es Salaam Rapid Transit (DART) project. This is an ambitious project to reduce emissions and alleviate the chronic congestion faced by commuters in Dar es Salaam City.
c) The private sector, local government authorities, civil societies and Non-Governmental Organizations play an important role towards reduction of greenhouse gas emissions through tree planting campaigns, conservation as well as production of efficient firewood and charcoal cooking stoves. Tanzania Traditional Energy Development Organization (TaTEDO) is among the leading national development engaged in designing and producing fuel efficient cooking stoves for various groups (households, schools, prisons, colleges and hospitals) and it is also involved in promotion of sustainable charcoal production methods.

CHAPTER THIRTEEN

EMERGING ENVIRONMENTAL ISSUES

13.1   Introduction

Emerging environmental issues are those that are starting to become of concern but have not yet been generally recognized. These issues may be local, regional or global; and may be caused by political, social, economic, technological, financial, institutional, or cultural changes, or may be due to natural causes (e.g., drought, floods, etc). As such recognition as an emerging environmental issue can also be based on newness of the issues which could be a result of new scientific knowledge, which could be in the form of new data, evidence, theory or model; new technological development; a heightened level of awareness; and new ways of responding to a known issue.

The emerging environmental issues discussed in the Second State of the Environment Report (2014), include Waste Electrical and Electronic Equipment (E-waste), Invasive Alien Species (IAS), Genetically Modified Organisms (GMOs) and Biofuels. These issues have received substantial policy and legal attention and therefore they no longer fit under this category. This Chapter provides a discussion on the selected current emerging environmental issues which include nanotechnology and antimicrobial resistance (AMR) in the environment.

13.2   Nanotechnology

13.2.1 Overview

Nanotechnology refers to the science of manipulating, modifying andutilizingof functional materials, devices and systems through control ofmatter on the nanometre scale (1–100 nm) and exploitation of novel phenomenaand properties (physical, chemical, biological) at that length scale. A nanometer is one millionth of a millimeter-approximately 100,000 times smaller than the diameter of a human hair. The extreme surface-to-volume ratio of nanoparticles is a key attribute that accountsfor their range of superior performance characteristics. At this scale unique optical, magnetic, electrical, and other properties emerge which allows for the development of light-weight materials with high strength, high conductivity or high chemical reactivity.

In Tanzania, nanotechnology is still a very new topics, although globally is now maturing rapidly with more than 300 claimed nanotechnology products already on the market. Nanotechnology shows great promise for providing many breakthroughs that will change the direction of technological advances in a wide range of applications. Nanotechnology already has had a major impact on electronics, coatings, construction, food technology, telecommunication, environmental technologies, medical technologies and drug development, nano-biocide applications and energy production, water purification and the utilization of solar energy, among others. A few examples of applications of nanotechnology are presented in Table 131.

Table 131: Examples of nanomaterials for different applications

Applications	Nanomaterial used
Electronics, ICT and photonics	Carbon nanotubes, fullerenes, graphene
Pharmaceuticals and medicine	Nanomedicines and carriers (nanobiotechnology)
Cosmetics and personal care	Titanium dioxide, zinc oxide, fullerenes, gold
Catalysts and lubricants	Cerium oxide, platinum, molybdenum trioxide
Paints and coatings	Titanium dioxide, gold, quantum dots
Environmental and water remediation	Iron, polyurethane, carbon nanotubes, graphene
Agrochemicals	Silica as carrier
Food packaging	Gold, nanoclays, titanium dioxide, silver
Composite materials	Graphene, carbon nanotubes

(Source: Roisteet al, 2017)

Concerns have been raised that the very properties of nanomaterials that make them so attractive could potentially lead to unforeseen health or environmentalhazards. With its limitless potentials, there are many environmental, health and safety related concerns due to extremely ambivalent effects of nanomaterials. For example exposure to nanomaterials has been associated with a number of health effects including pulmonary inflammation, genotoxicity, carcinogenicity and circulatory effects. Studies have revealed that nanoparticles can enter the human body through the lungs, intestinal tract, and skin. It is therefore important to address how the benefits of emerging nanotechnology can be realized while minimizing potential risks.

13.2.2 Drivers

a) Industrial development

Nanotechnologyis being considered as the driving force behind a new industrial revolution. It hasemerged as a versatile platform that could provideefficient, cost-effective and environmentallyacceptable solutions to the global sustainability challengesfacing society. It can permit remarkable technologicaladvances and innovations in many industrial sectors including the chemical, pharmaceutical, pulp and paper, food and information industries, as well as energy production and consumer items. For instance, the rise in demand for miniaturization of electronics products coupled with increased consumer demand for smaller and more powerful devices at affordable prices has made nanotechnology more popular among industries.

b) Poverty reduction

Nanotechnology may be a critical enabling componentof sustainable development when used wisely and when the social context of their application is considered and thus alleviate poverty. This is critical for many developing countries and particularly for Tanzania

to achieve the quantum leap to a middle-income status by 2025.

13.2.3 Pressure

a) Demand for effective and environmental friendly technology

Increasing demand for effective and friendly technologies has been dictating the desire for exploring innovative and more advanced and innovative technologies to increase the efficiency of production systems. As such currently, no matter what size, companies and various institutions are constantly looking to increase productivity, efficiency, and performance.

b) Poverty

Improvement of quality of life has been exerting pressure on the need for research and development of new materials and friendly technologies. This is also linked with the poverty reduction initiatives and improvement of quality of life including provision of clean water, solar energy, diseases detection, diseases vector control, foods and stored products preservation, and food security through improved agriculture.

13.2.4 State

In Tanzania and Sub-Sahara Africa in general, nanotechnology is still new and thus at its infancy. Indeed, there is so far minimal understanding and appreciation of the potential benefits and opportunities of nanotechnology application. Further, research is inadequately promoted and the related infrastructure is insufficient. In addition, the policy and regulatory framework governing, particularly the manufacturing processes of nanomaterials is rather inadequate.

Only recently, using nanomaterials, an innovative low-cost Nanofilter® water filtration prototype has been developed at the Nelson Mandela Institute of Science and Technology (NM-IST), Arusha, that provides affordable, safe and clean drinking water. The Nanofilter is a sand-based water filter which uses nanotechnology to cleanse contaminated water and make it safe for drinking. While the sand traps debris, the nanomaterials remove heavy metals, fluoride and biological contaminants.Water that passes through the filter is cleanand safe to drink. After 800 liters of water have been filtered, the nanomaterials generally need to replaced, although this varies in accordance with local water quality. It worth noting that the filter does not need any kind of electrical power, solar power, UV treatment, nor any chemical treatment. Figure 13-1 shows the water treatment prototypeusing a Nanofilter.

Figure 131: Nanofilter water treatment prototype

13.2.5 Impact

Impacts of nanotechnology are yet to be observed and documented in Tanzania. However, based on research and its application elsewhere, has indicated that nanotechnology has certain negative impacts on environment in many ways, such as increased toxicological pollution on the environment due to the uncertain shape, size, and chemical compositions of some of the nanotechnology products. In terms of environment, for example, while nanotechnology is still being tested to tackle industrial pollution especially over large water bodies, the fact of the matter is that their very size can make it hard to exactly determine how long the Nanoparticles will remain part of the local environment after they have been released into it.

\13.2.6 Response

a) Research and development

While the developed world are seeking innovations and intellectual property on novel nanomaterials, devices and manufacturing processes, developing countries are engaged in trying to gain a fuller understanding of the direction and impacts of nanotechnology and impacts of nanotechnology technological transformations, and also determining how emerging technologies transformations, could affect their futures.

In Tanzania the commission of Science and technology (COSTECH), has identified Research Priorities for Tanzania 2015-2020. These underscore the importance of innovation as a means to bring about economic transformation, since mere investment in R&D alone will not bring about the required transformative development and progress needed to realize TDV 2025 (COSTECH, 2016).

13.3 Antimicrobial Resistance (AMR) in the Environment

13.3.1 Introduction

Since their introduction into medicine in the 1940s, antibiotics have been extensively and effectively used in health; agriculture; aquaculture and livestock. These include medicines that are active against a range of infections such as those caused by bacteria (antibiotics), viruses (antivirals), fungi (antifungals) and parasites (including antimalarials). Antibiotics are suspected to be persisting in the environment due to their inability to naturally biodegrade or continued prevalence because of continuous release (Kihampa, 2014).

Antibiotic resistance genes, antibiotic-resistant bacteria and antibiotic residues are found not only in people and animals but throughout the environment. The environment is increasingly being recognized for its potential role in the spread of clinically relevant antibiotic resistance. Three main pathways for introduction of AMR in the environment include through animal waste; human waste; and industrial waste.

13.3.2 Drivers

a) Population growth

Population growth coupled with increase in the demand for public health services and thus medical care has triggered AMR in the Environment. This is also the case with increasing livestock population for which antibiotics dispensing presents high risk for spread of antimicrobial resistance among domestic animals with potential to contribute antimicrobial resistance to human beings and the environment.

b) Poverty

The burden of resistant infection is disproportionately borne by the less privileged. Poor people are not only typically at a greater risk of becoming infected but they are also less likely to be able to access health care, including antimicrobials.

13.3.3 Pressure

a) Inadequate waste management

Antimicrobial resistance in the environment is partly due to inadequate waste management from pharmaceutical production facilities, waste water treatment plants, domestic household, animal husbandry and agriculture.

b) Inappropriate use and overuse of antibiotics

Antibiotics are still used empirically in hospitals, illustrated by a study conducted in the Bugando Medical Centre medical adult ward whereby about half of the patients were given ceftriaxone for an average of 7 days, without laboratory tests (GARP Tanzania Working Group, 2015). As such antibiotics are prescribed by physicians and other healthcare workers inappropriately, such as without confirmation that an infection should be treated with an antibiotic, or they may be purchased directly by consumers without recourse to the healthcare system.

c) Inadequate regulatory system of antibiotics

Excessive and sometimes unnecessary consumption of antibiotic due to dispensing without a prescription suggest that there is inadequacy in the enforcement of The Tanzania Drug Policy of 1993 which among others provides assurance on the improvement of the rational use of medicines. This is also the case with Standard treatment guidelines and the NEMLIT which were designed to provide standardized guidance for the appropriate 9 provision of healthcare for specific diseases and conditions. The treatment guidelines, in particular, serve as a platform for rationalizing prescribing practices, improving patient outcomes and optimizing the use of limited resources.

13.3.4 State

Few studies have reported occurrence of antibiotics in water resources, effluent from industries, sludge, manure, soil, plants and organisms across the country.

a) Wastewater treatment plants

Wastewater treatment plants (WWTPs) are considered to be among the most significant source of antibiotics contaminants in the water system. A study was conducted in seven waste stabilization ponds of Dar es Salaam City which included those located at the University of Dar es Salaam; Mabibo; Vingunguti; Buguruni; Kurasini; Mikocheni; and Lugalo (Kihampa, 2014). Antibiotics amoxicillin, ampicillin and ciprofloxacin concentrations ranged from below detection limits (bdl) to 0.367 mg/l and bdl to 0.037 mg/l were measured in wastewater influents and effluents samples, respectively.Among the three compounds amoxicillin showed fairly high concentrations as compared to ampicillin and ciprofloxacin in the influents and effluents samples.The findings suggest that the conventional treatment of municipal wastewater by WSPs seems to be insufficient for removal of antibiotics from wastewater, this implies that WSPs could be an important source of antibiotics pollution in urban surface water.

b) Livestock and human interactions

In a study by Katakweba *et al* (2015), 587 faecal samples were collected from humans, pigs, beef, dairy cattle, exotic and indigenous chickens to investigate the relatedness of antibiotic resistant bacteria from humans and animals in Tanzania. The aim was to quantify the public health risks posed by handling animals, their waste and using animal products. Results revealed that antibiotics that are commonly used in Tanzania namely. Tetracyline and Sulphamethoxazole/ trimethoprim had higher resistance. These findings indicate that

prolonged use of these antibiotics because indicator bacteria to develop resistance against them and resistance genes observed from the same antibiotics suggest that they circulate between animals, chickens and humans sharing the same environment.

c) The Indian House Crows (Corvus splendens)

In a study involving a total of 100 house crows in Dar es Salaam City, the presence of antimicrobial resistant *Salmonella spp.*was demonstrated in the Indian house crows' population and provided an indication of potential public and poultry health risks associated with these birds in the coastal area (Katani et al, 2015). The occurrence of antibiotic resistant *S. Typhi* and *S. gallinarum* among Indian housecrows has both veterinary and public health consequences as they may be transmitted to poultry and humans. This therefore provides further rationale for the public action on eradicating the house crows.

13.3.5 Impacts

a) Development of antibiotic resistance

The most important issue of antibiotic release into the environment is related to the development of antibiotic resistance which has resulted in the reduction of therapeutic potential against human and animal pathogens.

b) Potential toxic effects on micro-organisms, plants, animals, and ultimately humans.

The environment is key to antibiotic resistance. Bactria in soil, rivers and sewers can develop resistance through contact with resistant bacteria, antibiotic and disinfectant agents released by human activities. People and livestock can then be exposed to more resistant bacteria through food, water and air. As such the impact of antibiotics and antimicrobial resistance in the environment has become a major concern lately and it is essential to understand the interaction of antibiotics with ecosystems.

c) Economic burden

AMR can result into enormous costs related to treatment of the affected population. In terms of environment non-performance of conventional wastewater treatment plants including for example waste stabilisation ponds can subsequently develop multiple spinoff effects with huge economic burden for a country.

13.3.6 Response

a) National Action Plan on AMR

Tanzania has established a National Action Plan (NAP). This NAP addresses actions needed to be taken in order to combat antimicrobial resistance (AMR) in the country. The plan is coherent to the WHO Global Action Plan on antimicrobial resistance with the following strategic objectives: improve awareness and understanding of antimicrobial resistance through effective communication, education and training; strengthen the knowledge and evidence base through surveillance and research; reduce the incidence of infection through effective

sanitation, hygiene and infection prevention measures; optimize the use of antimicrobial medicines in human and animal health; and develop the economic case for sustainable investment that takes account of the needs of all countries and to increase investment in new medicines, diagnostic tools, vaccines and other interventions (URT, 2017).

b) Government Policies and Regulation

The Tanzania Drug Policy of 1993 is the current national policy on medicine use. The objective of the drug policy is to provide all Tanzanians with access to essential pharmaceutical products of proven quality at affordable prices. It also states that the government will improve the rational use of medicines, which is where the National Essential Medicine List (NEMLIT) plays a major role. Standard treatment guidelines and the NEMLIT were designed to provide standardized guidance for the appropriate 9 provision of healthcare for specific diseases and conditions. The treatment guidelines, in particular, serve as a platform for rationalizing prescribing practices, improving patient outcomes and optimizing the use of limited resources.

For animals, there are also several policies in place. These include the National Livestock Policy of 2006; the Veterinary Act of 2003; the Food, Drugs and Cosmetics Act of 2003; the Fisheries Policy of 1997 and the Fisheries Act of 2003. Others include the East African Community Sanitary and Phytosanitary (EAC-SPS) Requirements (2012).

c) Strengthening laboratory capacity

The Ministry of Health and Social Welfare (MoHSW) has made substantial efforts to strengthen and expand laboratory capacity, and efforts are under way to accredit all regional, zonal and national laboratories to meet standards for quality services and patient safety. A SWOC analysis reported by Eliakimu, E. (2019) has revealed much strength in the Tanzanian health sector indicating that increasing investments in laboratory services, in medicines Regulatory Authority and Pharmacy Council, and strengthening management teams at all levels of service delivery, including Medicines and Therapeutics Committees; and strengthening advocacy on rational use of antimicrobials both in humans and livestock will improve AMS.

d) Development of training manual

The Tanzania Food and Drug Administration (TFDA), in collaboration with the MLDF, has developed a training manual for veterinary medicine sellers.

CHAPTER FOURTEEN

SCENARIO ANALYSIS

14.1 Introduction

Scenarios analysis explores different policy approaches and societal actions towards a sustainable future, based on available data, past trends and models concerning how the future could unfold for the purpose of improving decision making (UNEP, 2007). As such, it provides a dynamic view of the future by exploring various trajectories of change that lead to a broadening range of plausible alternative futures as illustrated in Figure 14-1. Scenario analysis has been used effectively as a tool to develop plans and policies for development, environment and adaptation.
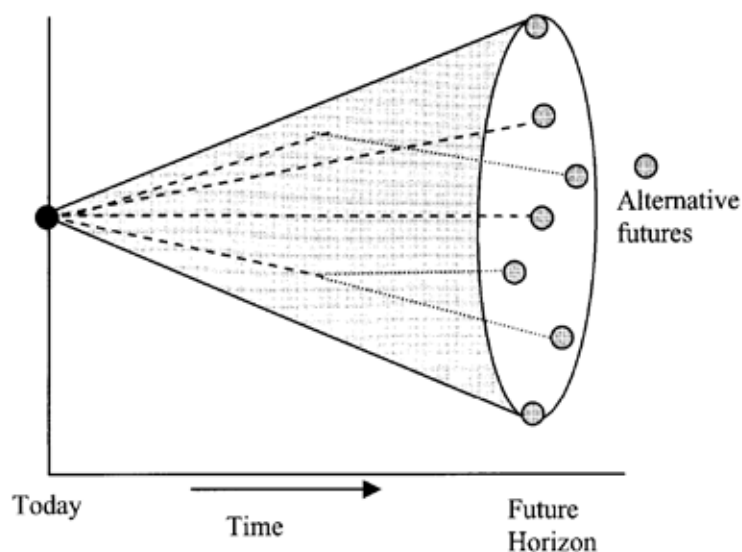
Figure 141: Conceptual diagram of a scenario analysis approach (Liu *et al*, 2008)

In this report, three scenarios have been considered in the analysis of the situations and policy actions which include (i) Business as usual iii) Policy Reform and iv) Sustainability scenarios.

       a) Business as usual (BaU) scenario analysis

Business as Usual (BaU) scenario or No-Action scenario entails retaining the *current status* quo. It assumes that there will be no significant change in priorities, or no major changes in technology, economics, or policies, so that current status can be expected to continue unchanged, and therefore environmental and resource managers continue working without considering new ideas to enhance decision making and environmental conservation and therefore changes are not necessary. BaU scenario assumes that even the existing damages or impacts to the environment and ecosystem at large will not be mitigated to deter further deteriorations. BaU scenarios have long been considered as a baseline to compare alternative scenarios.

b) Policy Reform Scenario

The *Policy Reform scenario* assumes a situation whereby government/managers realise the need of taking actions on policies and guidelines to give direction in the overall development path. In this case, policies are reviewed and or revised while new policies and guidelines are issued to accommodate new and emerging issues in the development arena.

c) Sustainability scenarios

The *Sustainability Scenario* presents a situation whereby environmental and resource managers and/or decision makers work very closely within themselves and in consultation with stakeholders. As they think of the future, they build on what is already known (including traditional environmental knowledge and practices), analyse the situation and implications of their actions into the future. In this case, they make effective use of key planning tools such as Strategic Environmental Assessment, Environmental Impact Assessment, integrated environmental/ecosystems assessment, strategic planning, participatory planning, Public Private Partnership, cost benefit analysis and good governance. The issue of financial resources should be secured insuring the sustainability for the future plans.

14.2   Land Degradation

Land degradation is attributed by poverty, rapid population growth, economic growth, climate change, culture and beliefs. The rate of land degradation is accelerated by unsustainable farming and mining practices; uncontrolled tree and bush clearing and wild fires; overgrazing; inadequate livestock infrastructure; inadequate land use plans; rapid urbanization; insufficient awareness and knowledge on relevant land policies and laws and proper management of land and water resources; and insufficient alternative sources for energy and construction materials.

With more than half of the country threatened by land degradation, the *Business As Usual Scenario* would result into increased and intensified land degradation and related impacts countrywide. It is projected that under this scenario, the whole country could be degraded in the next 40-50 years. Suggesting that this scenario (*Business As Usual Scenario*) should not be allow to prevail.

Under the *Policy Reform Scenario*, several policies, strategies and plans are under review including National Environmental Policy (1997); Forest Policy (1998); Land Policy (1995); National Environmental Action Plan (NEAP); Strategy on Urgent Actions to Combat Land Degradation and Water Catchment (2006); and Strategy on Urgent Actions for the Conservation of Marine and Coastal Environment, Lakes, Rivers and Dams (2008). The review, among others, intends to provide comprehensive and clear guidance on issues of relevance in addressing and mitigating land degradation. Further, operationalization of the National Environmental Trust Fund would provide sustainable financial mechanism to support interventions for combating land degradation. In addition, Land Use Framework Plan (2011-2031) need to be implemented to ensure proper land use planning and effective environmental management in the country. Under this scenario, enabling environment and policy tools for addressing land degradation would be put in place and therefore providing supportive platform for effective interventions.

Relevant legislation include Environmental Management Act (EMA) Cap. 191, 2004, which is

a piece of legislation that forms an umbrella law on environmental management in Tanzania. Suffice it to say that future outlook in terms of avoidance of land degradation, calls for review and implementation of all these policies, strategies and plans as well as relevant legislation in Tanzania.

In addition to *Policy Reform Scenario*, the *Sustainability Scenario* will need to be adopted taking into consideration the Sustainable Development Goals (SDGs); African Union's Agenda 2063 Vision; and the Government ambition for industrialization-based economy. In this regard, there is a need to ensure that present policies, plans and strategies are adequately integrated, implemented and financed in the development process to ensure sustainable environmental and socio-economic development.

14.3   Deforestation and Forest Degradation

Deforestation and forest degradation are caused by population growth, poverty and economic growth, social instability in some neighbouring countries, high domestic energy demand and crop farming coupled with unsustainable farming practices. These are exacerbated by climate change, cultural beliefs/bush fires, land tenure, overgrazing, and inadequate enforcement of laws and regulations.

With about 1% of forest cover being lost per year, under the *Business as Usual Scenario*, the forest degradation rate may escalate and coupled with demographic and economic pressures, the forest cover could be depleted in the next 50-80 years.

Under the *Policy Reform Scenario*, several policies, strategies and plans are being reviewed including National Environmental Policy (1997); Forest Policy (1998); Land Policy (1995); National Environmental Action Plan (NEAP); Strategy on Urgent Actions to Combat Land Degradation and Water Catchment (2006); and Strategy on Urgent Actions for the Conservation of Marine and Coastal Environment, Lakes, Rivers and Dams (2008). This can be realized through effective management of forest area, conservation of forest biodiversity, water catchments and soil fertility, and enhancing national capacity to manage and develop the forest sector in collaboration with other stakeholders.

Under the *Sustainability Scenario*, numerous stakeholders need to be engaged to ensure mainstreaming and implementation of forest management related policies, plans and strategies. There must be a mechanism of securing funds to ensure implementation of sustainable forest management plans and strategies. Equally important, there is a need to explore and promote traditional management practices and more alternative energy sources, as well as tree planting campaigns. Under this scenario, public education should be put in place through extension services, radio and television programs, seminars, workshops and symposia. Once there is carefulness in utilization otherwise, wise use, there is the sure possibility of resources availability which goes to enhance sustainable of the forest resources both currently and in the industrialized Tanzania. Mechanisms to enhance Public Private Partnership to promote alternative energy sources and energy efficient technologies such as solar energy, wind power, biogas, natural gas, improved charcoal kilns, and charcoal stoves should be put in place. Likewise, the government should transform and fully utilize NAFORMA data in forest management planning.

14.4   Loss of Biodiversity

Major causes of loss of biodiversity include land degradation; environmental pollution; deterioration of aquatic systems; and deforestation. Other causes of biodiversity loss are habitat loss, fragmentation and degradation; overexploitation or unsustainable exploitation of biodiversity resources for timber, food and energy; mammals for bush meat and recreational hunting. Others are encroachment of protected areas/nature reserves; proliferation of invasive alien species; environmental pollution (e.g. eutrophication); and climate change. Loss of biodiversity is likely to affect and endanger the human and wildlife existence as it is a vital asset for the wellbeing of people and economic growth.

Under the *Business as Usual Scenario*, there would be continued biodiversity loss, unsustainable utilization and associated degradation of a wide range of ecosystem services which currently amounts to at least five percent (5%) of the national GDP and ought to increase steadily.

Under the *Policy Reform Scenario*, a number of interventions are to be undertaken including formulating, reviewing and/or mainstreaming of biodiversity issues into relevant national policies, strategies and legislation; expanding and managing network of protected areas; demarcating and protecting water catchment areas; promoting participatory management of biodiversity resources; and initiating programmes to protect threatened species such as black rhino and elephants. Under this scenario, therefore the Government through implementation of relevant policies, strategies and plans would provide directions in the overall development path, including conservation and sustainable use of biological resources.

Under *the Sustainability Scenario,* in order to achieve sustainability in combating loss of biodiversity there is a need to address drivers and pressures that result in loss of biodiversity. This can be attained through involvement of key stakeholders for effective implementation and monitoring of the key relevant policies, strategies and plans related to conservation and sustainable use of biological resources. Sustainability scenario also requires balancing multiple and often conflicting objectives of managers and stakeholders to sustain the provision of ecological, economic, and cultural values; address priority threats to natural ecosystem functioning; achieve sustainable development and fulfil institutional, policy, and legal framework needs.

14.5   Environmental Pollution

14.5.1 Water Pollution

Water pollution emanates from a number of point and diffuse sources including industrial, municipal, mining and agricultural sources. Domestic wastewater is also one of the major sources of water pollution since over 90% of the population use pit latrines and septic tanks, most of which are sub-standard. Intensive and indiscriminate use and storage of agrochemicals also causes deterioration of water quality and soil pollution.

Under the *Business as Usual Scenario*, environmental pollution could render large number of water sources unsuitable for human and other uses; and the current water borne disease burden of about 40% would increase steadily.

Under *Policy Reform Scenario,* the National Environmental Policy (NEP) of 1997, needs to

be vigorously employed in a manner that will cope and thus address expected expansion of economy and human activities that are likely to affect water quality. Equally important is the The National Water Policy (NAWAPO 2002) which addresses all relevant issues on integrated water resources management including water pollution. Also related to this scenario is the current Water Resources Management Act No. 11 of 2009 and the Water Supply and Sanitation Act No. 12 of 2009. Water Resources Management Act, provides for institutional and legal framework for sustainable management and development of water resources. It also outlines principles for water resources management and provides for the preventions and control of water pollution. The Act also sets standards for receiving waters and effluent to control and prevent water pollution. On the other hand, Water Supply and Sanitation Act No. 12 of 2009 provides for sustainable management and adequate operation and transparent regulation of water supply and sanitation services and also provides for establishment of water supply and sanitation authorities for among others protection and conservation of water resources. Under policy reform scenario for water pollution control all policy and legal frameworks for water management in Tanzania needs to be effectively enforced and reviewed as appropriate.

Under *Sustainability Scenario*, The Government has adopted policies and legislation, which aims at curbing pollution of water bodies needs to be effectively and continuously implementation and whenever necessary reviews should be made in order to align them with the future environmental changes and specific needs for water pollution control. Equally important is the need for public awareness and participation on environmental health and sanitation as well as promotion of cleaner production initiative. For effective implementation of these policies and measures, mobilization of adequate financial resources is important. This scenario also calls for inclusive participatory approach taking on boars all the relevant stakeholders.

14.5.2 Air Pollution

The air pollution sources include transport activities, industrial processes, mining, domestic biomass burning, uncontrolled waste disposal, chemicals management, agriculture and animal husbandry. The air pollution problem is more acute in urban areas principally due to concentration of socio-economic activities. In general, the pollutant density level in the air around urban and industrial areas is relatively higher than that found in rural areas. According to, (Krupnick, A., 2007)**,** air pollution control in developing countries including Tanzania has received less attention than other environmental issues such as deforestation and water pollution. In the midst of a worsening air-pollution situation, the policy response has been slow, and tends to be based on command-and-control rather than economic incentives. As the country looks forward for industrialization, which also suggest more likely events of air pollution, this attitude must be changed.

Under the *Business as Usual Scenario* air pollution will result into human health and the environment as well as the climate change related impacts. The common human health air pollution related problems include respiratory diseases and lung cancers as well as the general nuisance to people. On the otherhand, air pollution results into such environmental effects as acid rain, eutrophication, and ozone depletion among others. Tis suggest that *Business as Usual Scenario* should not be allowed to prevail.

Under *Policy Reform Scenario,* reform and review or formulation of policies related to air

pollution prevention and control should be made to counter the drivers of air pollution namely urbanisation and economic growth, which are closely linked with inadequate enforcement of relevant legislation and regulations as well as inadequate urban planning. In addressing these issues. Currently Environmental Management (Air Quality Standards) Regulations, 2007 is the one that regulate air pollution related issues in Tanzania. These Regulations, among others, prescribe criteria and procedure for measurement for air quality; establish ambient air quality standards and establish emission standard for various sources of air pollution. They also define enforcement powers. Formulation of the Air quality standards that aims at providing prevention and regulating sources of air pollution is in line with the requirement of these regulations.

In pursuit of industrialization and sustainable developmentagenda, the existing air pollution control policies and regulation are likely to be overshadowed by the economic growth and the anticipated future development strides. Under *Sustainability Scenario,* air quality policies, guidelines, legislation, programs and guidelines should thus be continuously reviewed and monitored to ensure that they are updated to keep pace with the industrialization process and thus sustainable air quality control and management in the country. This is because according to (WHO, 2019), the health effects of air pollution are serious as one third of deaths from stroke, lung cancer and heart disease are due to air pollution. This is having an equivalent effect to that of smoking tobacco, and much higher than, say, the effects of eating too much salt.

14.5.3 Noise Pollution

Noise pollution is a growing problem in the country particularly in urban areas. The accumulation of noise pollution whether by accident or in incident will likely distrust and add up to a negative physiological and psychological healthcare experience. Major sources of noise pollution include industrial activities, social activities (bars, nightclubs, social halls and advertisements), small-scale service industries in residential areas, road traffic, construction activities, and air traffic. Noise pollution is anticipated to increase particularly in urban areas due to current economic growth and associated industrial expansion.

Under the *Business as Usual Scenario*, social conflicts and health impacts that results from noise pollution will continue to prevail and may escalate into social unrests and noise health effects as well as physical and psychological health consequences of regular exposure to elevated sound levels. These may result into among others productivity losses in the workplace, and communication difficulties and fatigues which should not allowed to prevail.

Under *Policy Reform Scenario*, The National Environmental Policy (NEP) of 1997 is the one that will provide an overall framework for management of the environment including noise pollution in the country. The policy reform scenario for noise pollution control will also require enforcement of the National Environment (Noise and Vibrations) (Standards and Control) Regulations, 2013, which were formulated by NEMC. Other relevant policies include The Transport Policy (2002), which aims at enhancing transport safety and environmental protection, through taking steps to review and update national legislation in transport operations and safety requirements. In line with NEP and other relevant policies, strategies and plans should be put in place to provide guidance for addressing noise pollution issues at all levels.
To address social conflicts and health impacts that results from noise pollution *Sustainability*

scenario requires stakeholders to ensure enforcement and compliance to Noise and Vibration Regulations (2011) and other related measures in order to address noise pollution. Further to this, adherence to strategic urban development planning is vital in addressing the problem of noise pollution. This is because according to (Raje, F. et al., , 2018), a combination of infrastructure, policy, regulatory and softer measures may provide the most effective way to address traffic congestion and, thus, air pollution in urban centers. (IEG, 2007), has also reported that the infrastructure-environment nexus addresses the challenge of meeting the demand for infrastructure services while maintaining or improving the quality of the environment (including air quality). In addition, continuous air quality monitoring, public awareness and community participation needs to be promoted.

14.6   Deterioration of Aquatic Systems

Aquatic systems in Tanzania are deteriorating at an alarming state; thereby decreasing their capacity to provide ecosystem services. Environmental challenges facing aquatic systems are erosion in watersheds; deforestation in lake and river basins; indiscriminate disposal of domestic and industrial wastes and urban pollution; poor agricultural practices; inappropriate use of agro-chemicals, and intensive fishing using inappropriate methods that pose threats to the aquatic environment and its biodiversity. As the country endeavours to transform the economy to middle income status, deterioration of the ecosystem will likely be expected unless deliberate efforts are taken. This is because according to (Cosgrove, W and Locks, D, 2015), throughout the world, demographic, economic, and technological trends have accelerated people's ability to knowingly and unknowingly modify the environment. As such humans have become the principal driver of environmental change.

Under the *Business as Usual Scenario*, estimated deforestation rate of 469,420 ha per annum in Tanzania will continue and the wetlands, 75% of which are currently affected, will be inexistent in the near future, signalling severe impacts on aquatic systems in Tanzania and thus calling for urgent reforms.

Under *Policy Reform Scenario,* this scenario involves review and implementation of relevant sectoral policies, plans and strategies for water, wetland, fisheries, energy, industry and trade policies, among others, to accommodate emerging issues in relation to deterioration of aquatic systems as a result of anticipated industrial investments and increased human activities, impacts of which include   among others decrease in productivity, reduction in fish yields and biodiversity, water shortage and increase in potential health risks such as vector-borne diseases in Tanzania.

Among key sectoral policies is the new Tanzania National Water Policy (NAWAPO) of 2002 including the Integrated Water Resource Management (IWRM). Others include National Tourism Policy of 1999 (which among others encourages the development of sustainable and quality tourism which is ecologically friendly and environmentally sustainable), National Environmental Action plan (2014), which encompasses all development sectors with the focus on the conservation of environment and sustainable development, as well the National Environmental Policy, NEP (1997), Which sets goals committing the country to sustainable development of its natural resources.

Among the drivers related to deterioration of aquatic systems include population growth, economic growth, poverty and climate change. To counter these drivers and minimise the related impacts, *sustainability scenario* will balance integration of economic, social and

environmental/ecological dimensions involving various factors including, government, NGOs and other stakeholders involved in environmental and ecological systems. The sustainability scenario will further require a system dynamics approach for Ecologically Sustainable Development (ESD) in various sectors such as urban coastal systems, water resources, waste management, etc. As such the Government, in collaboration with other stakeholders, will need to implement various measures (including relevant policies and strategies) to control degradation of aquatic resources. Furthermore, effective implementation of the Strategy on Urgent Actions on Conservation of Marine and Coastal Environment, Lakes, Rivers and Dams is crucial.

14.7   Water Accessibility and Quality Degradation

Water quality problems are mainly due to both natural and human beings related factors including inadequate sanitation facilities thus disposal of untreated effluents into receiving water bodies. Indiscriminate disposal of domestic and industrial wastes into water bodies; destruction of catchments areas; and inappropriate use of pesticides and other agro-chemicals, are a cause of water pollution or drying of water sources. This also has resulted in decreased accessibility of water for various uses. In addition, inadequacies in sanitation facilities is also a cause for consumption of unsafe or untreated water, contributing to the spread of cholera and other water borne diseases, particularly in unplanned urban settlements and rural areas. The expected industrial revolution as the country endeavours to transform the economy into middle income status is likely to worsen the access as well as degrade the water from various sources. The magnitude of the problems is also expected to be exacerbated by the impacts of climate change if appropriate mitigation measures are not designed and implemented.

Under the *Business as Usual Scenario*, impacts such as water borne diseases, economic losses, burden on time spent to fetch water and water use conflicts sometimes that results into deaths among population will continue to prevail.

Under *Policy Reform Scenario,* relevant policies and legal frameworks need to incorporate issues that addresses the increasing demand for water and improvement of its availability, accessibility as well as ensuring water quality cope with anticipated economic growth as well as increased human activities. The key related policies and legislative framework include the National Water Policy (2002); National Water Sector Development Strategy (NWSDS) (2005-2015); Water Quality Management and Pollution Control Strategy (2011); Water Sector Environmental Action Plan (2011); Water Resources Management Act (2009); The Strategy for Urgent Action for Conserving Marine and Coastal Environment, Lakes, Rivers and Dams (2008); and Water Supply and Sanitation Act (2009).

Under *Sustainability Scenario* all stakeholders should participate fully in the planning and implementation of policies and legislation related to water management. Effective implementation of the strategies related to water management and the Integrated Water Resource Management is key to sustainable management of water quality and availability. Under this scenario it might also be imperative to review and update some of the legislations to align them with the future environment in order to cope with the pressures and eventually alleviate or addresswater accessibility and quality degradation impacts including among others; water borne diseases and various economic losses.

14.8   Climate Change

Major cause of climate change is greenhouse gas emission, a human problem that results from different economic activities. In recent years, climate change effects in Tanzania have been noticed in various sectors including agriculture and food security; livestock; water; energy; forestry; health; wildlife; tourism; industry; coastal and marine resources; human settlements; and wetlands. It is expected that there will be an increase in extreme weather events associated with flooding, droughts, and cyclones and tropical storms, which will be more intense, frequent and unpredictable.

Under the *Business as Usual Scenario*, costs related to climate change, for instance the already current costs amounting to around 1% of GDP annually and which go up to 2% of GDP by 2030 will further escalate. *Business as Usual Scenario* also implies that the achievement of various socio-economic development strategies and plans including the achievement of Tanzania Development Vision 2025, Five-Year Development Plan (2016–2021) and the Sustainable Development Goals (SDG) will be derailed resulting to negative impacts on various sectors of economy such as Agriculture sector, Energy sector, Infrastructure, livestock, health, among others.

Under *Policy reform scenario*, The National Environmental Policy adopted in 1997 as well as the National Environmental Action plan (1994) (which encompasses all development sectors with the focus on the conservation of environment and sustainable development) need to among others, mainstream climate change issues and hence provide overall policy guidance in addressing climate change. Furthermore, the government is developing the National Adaptation Plan (NAP) to address medium and long term adaptation issues. Mainstreaming of climate change issues into sectoral policies to adequately address climate change in various sectors is important. Apart from these, the government has developed some strategies, plans and programmes, all aimed at addressing climate change. Some of these include the National Climate Change Strategy, and the National Adaptation Programme of Action (NAPA).

Under *Sustainability scenario*, effective implementation of various policies, guidelines, legislation and plans as stakeholders' commitment to enhance community adaptation to climate change at various levels and establish mitigation measures. *Sustainability scenario* will require stakeholders' corporations to take a long-term view of the climate change and hence bring long-term continuity for mitigation measures that may not be quite obvious in the short-term. Under this scenario it is imperative to have policies/strategies/ plans on climate change that can be adequately and effectively implemented sustainably. The expectation is for example a situation that will limit greenhouse gas emissions and puts in place measures to restrain deforestation and discourage emissions. At the base of all these adequate funding, public awareness and participation is crucial for effective implementation of various policies and measures with regard to climate change.

14.9   Nanotechnology

Nanotechnology is an emerging technology which is viewed as key enabling technology of the 21st Century. It is expected to act as significant driver of innovation, technological and economic competitiveness, and societal developments over the next decades. It is considered to be capable of addressing socio-economic and environmental problems concerning energy, transportation, pollution, health, and food. Much as it is critical for future

development, in Tanzania this technology is still new and not so much of its products are in place.

Under the *Business as Usual Scenario*, research and development and thus adoption of nanotechnology in Tanzania will not occur. Even if it occurs various negative impacts associated with this technology will not be addressed.

Under *Policy Reform Scenario*, a number of policies and legislation, which have bearing in addressing nanotechnology associated negative impacts on the environment need to be enhanced and implemented. Under this Policy Scenario, deliberate efforts should be made to see to it that nanotechnology is captured as a key research agenda in theNational Research and Development Policy (2010), which among others calls for prioritization of research areas that have direct benefits to national economic growth, societal and human welfare. Also under this scenario, The National Science and Technology Policy (1996), especially the need for allocation of funds for science research and technology development (about 1% of GDP) needs to be implemented.

Sustainability Scenario, hinges on capacity building, stakeholder's awareness creation and involvement in Research and development in nanotechnology. This is because currently, most R&D institutions in Tanzania do not have adequate capacities to address and undertake nanotechnology research activities. Under this scenario therefore among others, there is a need to create an enabling environment to facilitate effective research undertaking in nanotechnology. This scenario also calls for collaboration between various research and development institutions both locally and abroad, largely because of not only knowledge transfer but also knowledge sharing among local research and development institutions as well as collaboration with the research and developed research institution from the developed countries.

14.10   Antimicrobial Resistance (AMR) in the Environment

Antibiotics are suspected to be persisting in the environment due to their inability to naturally biodegrade or continued prevalence because of continuous release.Antibiotic resistance genes, antibiotic-resistant bacteria and antibiotic residues are found not only in people and animals but throughout the environment. The environment is increasingly being recognized for its potential role in the spread of clinically relevant antibiotic resistance. Three main pathways for introduction of AMR in the environment include through animal waste; human waste; and industrial waste.

Under the *Business as Usual Scenario*, the identified negative impacts associated with AMR including development of antibiotic resistance, potential toxic effects on micro-organisms, plants, animals, and ultimately humans and huge economic burdens will perpetuated.

*Policy Reform Scenario*will involve review of various health related policies and legislation to capture and take on board issue related to AMR. Some of the policies include the National Health Policy (2007) and the Primary Health Care Service Development Programme (2007). Both these and other related strategies and/or programs are contextualized by the Health Sector Reforms of 1994, with an initial emphasis on improvement of access, quality, and efficiency of health service delivery. Being new and emerging issue, this scenario also call for research and development in AMR, and the relevant policies that needs to be reviewed and implemented include the National Research and Development Policy (2010) and well

as The National Science and Technology Policy (1996), among others. This scenario will lessen the AMR in the Environment pressure related to inadequate waste management, inappropriate use and overuse of antibiotics and inadequate regulatory system of antibiotics and in the process.

Like the *Policy Reform Scenario, Sustainability Reform Scenario* calls for a need for effective implementation of the relevant national policies and strategies through involvement of relevant stakeholders at all levels. Capacity building and awareness-raising is also important among medical, livestock and other stakeholders on handling and administration of antimicrobial medicines. Relevant sectors will also need to strengthen regulatory and controls in the administration of antimicrobial medicines. This scenario also calls for more research on the subject matter to identify possible management options and possibly even replacement of the antimicrobial medicines. It is through this scenario that the identified impacts of AMR namely; Development of antibiotic resistance, Potential toxic effects on micro-organisms, plants, animals, and ultimately humans as well as the AMR associated economic burden can be can be addressed.

CHAPTER FIFTEEN

POLICY OPTIONS FOR ACTION

The Government and other stakeholders at various levels have been devising ways and means of curbing the environmental degradation challenges in Tanzania. However, a need for continuously addressing these challenges in a more concerted manner still exists, especially now that the country is preparing to transform the economy into middle income status, which is likely to be coupled with more and diverse environmental challenges. This suggest that appropriate measures need to be designed and effectively implemented as also discussed under policy and sustainability scenarios in the previous chapter. The proposed broader options for actions are presented in **Table 15-1**. These broad actions are not exhaustive and are meant to facilitate further narrowing down to specific actions for execution.

Table 151: Policy options for action

Issue		Options for action	Responsible Sector Ministry/Institution
1. Land degra-dation	1.1	Periodic review of relevant sectoral policies aimed at curbing land degradation	Ministry responsible for Land, Water, Natural Resources, Local Government, Environment; Land use Planning Commission, Academic and Research Institutions, NGOs and CBOs.
	1.2	Continue with reviews, formulation and implementation of appropriate strategies and plans aimed at curbing land degradation	
	1.3	Strengthen enforcement of legislation related to land degradation and implementation of existing strategies and programs on land degradation.	Ministry responsible for Lands, Energy, Water, Agriculture, Livestock, Forestry, Wildlife, Local Government and Environment; Land use Planning Commission, NGOs and CBOs.
	1.4	Enhance enforcement and implementation of the National Land Use Master Plan Framework (2011-2031)	Ministry responsible for Land, Land use Planning, Local Government and Environment; MOW, MNRT, Commission, Academic and Research Institutions, NGOs and CBOs
	1.5	Enhance restoration and management of environmentally sensitive areas (with potential of being degraded easily) such as rivers, valleys, beaches and wetlands	Ministry responsible for Lands, Water, Natural Resources, Energy, Agriculture, Livestock, Forestry, Wildlife, Local Government and Environment; Land use Planning Commission, NGOs and CBOs.
	1.6	Enhance promotion of sustainable agricultural practices	Ministry responsible for Agriculture, Education, Livestock and Local Government, NGOs and CBOs.
	1.7	Promote and upscale use of traditional knowledge in land management	Ministry responsible for Agriculture, Livestock and Local Government; NGOs and CBOs.
	1.8	Strengthen rangeland resources management	Ministry responsible for Agriculture, Forestry, Livestock and Local Government; NGOs and CBOs.
	1.9	Enhance mainstreaming of policies, plans and strategies related to land degradation in the development planning process and budgets to ensure sustainable environmental and socio-economic development	Ministry responsible for Lands, Energy, Agriculture, Livestock, Forestry, Wildlife, Local Government and Environment; Land use Planning Commission, NGOs and CBOs.

Issue	Options for action	Responsible Sector Ministry/Institution
	1.10 Enhance public awareness on the causes and impacts of land degradation to livelihoods.	Ministry responsible for environment, Disaster Management and Early warning system, Ministry of Land, President's Office-RALG and Community development.
	1.11 Develop and implement National Waste Management Strategy	Ministry responsible for Environment, Present's Office–RALG, Health.
	1.12 Promote and upscale economic incentives to encourage investments in restoration of degraded lands.	Ministry responsible for Lands, Natural Resources, Energy, Agriculture, Livestock, Forestry, Wildlife, Local Government and Environment
	1.13 Establish appropriate mechanisms that will enhance access, availability and use of alternative and affordable energy sources	Ministry responsible for Lands, Natural Resources, Energy, Local Government and Environment; Land use Planning Commission, NGOs and CBOs.

Issue		Options for action	Responsible Sector Ministry/Institution
2. Deforesta-tion and forest degra-dation	2.1	Continue with reviews, formulation and implemen-tation of appropriate policies, legislation, strategies and plans aimed at curbing deforestation and forest degradation.	Ministry responsible for Forestry, Wildlife, Local Govern-ment and Environment.
	2.2	Strengthen Public Private Partnership on alternative energy sources and energy efficient technologies	MoE, MoM, MNRT-TFS, VPO DOE, PO RALG, TAFORI, TaTEDO, NGOs, CBOs
	2.3	Promote and upscale use of traditional knowledge that enhance environmental conservation.	Ministry responsible for Forest, Energy, Environment, Agriculture, Livestock, Local Government, Community Development, Private sector, NGOs/CBOs.
	2.4	Strengthen national campaigns on tree planting and growing, as well as restoration and conservation programmes.	Ministry responsible for Forest, Environment, Local Gov-ernment; Private sector; NGOs/CBOs.
	2.5	Enhance awareness on sustainable forest manage-ment	Ministry responsible for Forest, Environment, Local Gov-ernment: Private sector, NGOs/CBOs.
	2.6	Promote and upscale use of alternative energy to charcoal and firewood in order to reduce pressure on forest and forest products	Ministry responsible for Forest, Energy, Environment, Lo-cal Government: Private sector, NGOs/CBOs.
	2.7	Enhance promotion of energy conservation initia-tives	Ministry responsible for Forest, Energy, Local Govern-ment; Private sector, NGOs/CBOs.
	2.8	Promote sustainable utilization and management of forest resources.	Ministry responsible for Forest, Energy, Local Govern-ment; Private sector, NGOs/CBOs.
3. Biodiversity loss	3.1	Periodic reviews, formulation and implementation of appropriate policies, strategies and plans aimed at adequately curbing loss of biodiversity.	Ministry responsible for Environment, Natural Resourc-es, Fisheries, Wildlife.
	3.2	Periodic review and implement the National Biodi-versity Strategy and Action Plan (NBSAP)	Ministry responsible for Environment, Wildlife, Lands, Forestry, Water, Local Government; academic and Re-search Institutions; NGOs/CBOs.

Issue	Options for action	Responsible Sector Ministry/Institution
	3.3 Strengthen capacity building and awareness on the management of terrestrial and aquatic ecosystems.	Ministry responsible for Environment, Forestry, Water, Wildlife, Fisheries, Lands, Local Government; academic and Research Institutions; NGOs/CBOs.
	3.4 Enhance international cooperation to ensure that Tanzania benefits from transfer of its genetic resources.	Ministry responsible for Environment, Agriculture, Forestry, Water, Foreign Affairs, EAC, Wildlife, Lands, Local Government; academic and Research Institutions; NGOs/CBOs.
	3.5 Periodic review and implementation of National Strategy on Wetlands (2010).	Ministry responsible for Environment, Agriculture, Livestock, Forestry, Water, Lands, Local Government; academic and Research Institutions; NGOs/CBOs.
	3.6 Strengthen monitoring and conservation of endangered and threatened species.	Ministry responsible for Wildlife, Environment, Forestry, Water, Lands, Fisheries, Tourism, Local Government; Academic and Research Institutions; NEMC, NGOs/CBOs, Media.
	3.7 Enhance research and dissemination of findings on wildlife and biodiversity management and conservation.	Ministry responsible for Wildlife, Science and Technology, Local Government, Environment, Forestry, Livestock, Academic and Research Institutions, COSTECH, NEMC, Private sector, NGOs/CBOs.
	3.8 Strengthen land use planning and management in order to safeguard the loss of wildlife habitats and biodiversity.	Ministry responsible for Land, Land use Planning, Local Government and Environment; Academic and Research Institutions, NGOs and CBOs
	3.9 Enhance participation of Public Private Partnership in the management of wildlife habitats and biodiversity.	Ministry responsible for Local Government, and Environment; Private sector; NGOs/CBOs, Media
	3.10 Enhance awareness programs on wildlife habitats and biodiversity conservation to communities.	Ministry responsible for Wildlife, Science and Technology, Local Government, Environment, Forestry, NGOs/CBOs.
	3.11 Promote aquaculture as an alternative to exploitation of wild species	Ministry responsible for Fisheries, Local Government, Environment; Private sector; NGOs/CBOs; Academic and research institutions

Issue		Options for action	Responsible Sector Ministry/Institution
4. **Environmental pollution**	4.1	Periodic review, formulation and implementation of appropriate policies, strategies and plans aimed at curbing environmental pollution.	Ministry responsible for Environment, Water, Health, Industries and Trade, Transport and Local Government.
	4.2	Strengthen enforcement of Environmental legislation and by-laws for prevention of environmental pollution.	Ministry responsible for Environment, Water, Health, Transport and Local Government, Private sector, NGOs/CBOs
	4.3	Enhance investment and upscale the use of modern waste management technologies and infrastructures.	Ministry responsible for Local Government, Water, Health and Environment; Urban Water Supply and Sanitation Authorities, Private sector; NGOs/CBOs, Media
	4.4	Strengthen water quality monitoring for all major groundwater and surface water bodies to ensure compliance with the national environmental standards.	Ministry responsible for Water, Local Government, Transport and Environment; Urban Water Supply and Sewerage Authority Authorities, Private sector; NGOs/CBOs.
	4.5	Promote and encourage investments in cleaner production technologies to address air, water, land and noise pollution.	Ministry responsible for Local Government, Water, Health and Environment; Urban Water Supply and Sanitation Authorities, Private sector; NGOs/CBOs, Media
	4.6	Strengthen enforcement of regulations to address noise pollution	Ministry responsible for Local Government, Health, Environment, Industries; Home Affairs; TBS; Private sector; NGOs/CBOs, Media.
	4.7	Promote Public Private Partnership tin environmental pollution control as well as investing in municipal waste management system	Ministry responsible for Local Government, Water, Health and Environment; Urban Water Supply and Sanitation Authorities, Private sector; NGOs/CBOs, Media
	4.8	Enhance public awareness on effects of environmental pollution and Develop a centralized national database of municipal waste in the country.	Ministry responsible for Local Government, Water, Health and Environment; Urban Water Supply and Sanitation Authorities, Private sector; NGOs/CBOs, Media
	4.9	Strengthening of institutions in terms of technical, human resource and financial capacities to effectively manage municipal waste and enforce legislation is of paramount importance.	Ministry responsible for Local Government, Water, Health and Environment; Urban Water Supply and Sanitation Authorities, Private sector; NGOs/CBOs, Media

Issue		Options for action	Responsible Sector Ministry/Institution
5. Deterio-ration of aquatic sys-tems	5.1	Periodic reviews, formulation and implementation of appropriate policies, strategies and plans aimed at curbing deterioration of aquatic systems.	Ministry Responsible for Environment, Fisheries, Local Governments, Home Affairs.
	5.2	Strengthen enforcement of relevant legislation for protection of aquatic resources.	Ministry Responsible for Environment, Fisheries, Water, Local Governments, Home Affairs, Defence; NEMC, BMUs, NGOs, CBOs
	5.3	Strengthen implementation of various strategies and programs related to aquatic resources (e.g. National Strategy for Urgent Action to Conserve Coastal and Marine Environment, Lakes, Rivers and Dams).	Ministry Responsible for: Environment, Water, Transport, Lands, Agriculture, Minerals, Forestry, Fisheries, Local Government Authorities and Other relevant sectors; NGOs/ CBOs
	5.4	Enhance conservation and sustainable use of man-groves and coastal forests.	Ministry Responsible for: Forestry, Fisheries, Environ-ment, Local Government, Lands, Minerals; NEMC, NGOs/CBOs.
	5.5	Strengthen institutional and human capacity in management of aquatic resources	Ministry Responsible for: Fisheries, Environment, Water, Local Government, Forestry; Academic and Research In-stitutions; CBOs and NGOs.
	5.6	Promote research and dissemination of findings on aquatic resources management.	Ministry responsible for Fisheries, Water, Science and Technology, Local Government, Environment ,Agricul-ture, Forestry, Livestock, Academic and Research Insti-tutions, COSTECH, NEMC, Private sector, NGOs/CBOs.
	5.7	Strengthen regional cooperation on management of trans-boundary aquatic resources.	Ministry Responsible for: Environment, Foreign Affairs, East African Cooperation, Water, Fisheries, Local Gov-ernment Authorities
	5.8	Enhance public awareness on sustainable use of aquatic resources.	Ministry responsible for Environment, Fisheries, Water, MNRT, NEMC, Private sector.

Issue		Options for action	Responsible Sector Ministry/Institution
	5.9	Strengthen protection and conservation of water catchment areas.	Ministry Responsible for: Water, Lands, Agriculture, Environment, Fisheries, Local Government, Energy, Private sector and NGOs.
	5.10	Strengthen management of Transboundary aquatic resources.	Ministry Responsible for: Environment, Foreign Affairs, East African Cooperation, Water, Fisheries, Local Government Authorities
	5.11	Enhance participation of Public Private Partnership in the management and investment in aquatic resources	Ministry responsible for Fisheries, Water, Science and Technology, Local Government, Environment, Forestry, Livestock, Private sector, NGOs/CBOs.
	5.12	Strengthen coordination efforts at all levels in management of aquatic resource.	Ministry Responsible for: Water, Lands, Agriculture, Environment, Fisheries, Transport, Industries, Local Government, Energy, Private sector and NGOs.
6. Water quality degradation and accessibility	6.1	Periodic reviews, formulation and implementation of appropriate policies, strategies and plans aimed at curbing water quality degradation.	Ministry responsible for Water, Local Government and Environment; Urban Water Supply and Sewerage Authority.
	6.2	Strengthen enforcement of legislation related to water resources management and water supply and sanitation.	Ministry responsible for Water, Local Government and Environment; Urban Water Supply and Sewerage Authority; Private sector, NGOs/CBOs.
	6.3	Strengthen implementation of integrated water resources management plans.	Ministry responsible for Water, Local Government, Environment; Urban Water Supply and Sanitation Authorities, Water Basin Board, Private sector; NGOs/CBOs.
	6.4	Enhance investment and upscale in modern wastewater management systems	Ministry responsible for Local Government, Water, Health and Environment; Urban Water Supply and Sanitation Authorities, Private sector; NGOs/CBOs, Media.
	6.5	Strengthen integrated solid waste management systems	Ministry responsible for Local Government, Environment; NEMC, Private sector; Public, NGOs/CBOs.

Issue	Options for action	Responsible Sector Ministry/Institution
	6.6 Enhance public awareness, participation and education regarding conservation of water sources.	Ministry responsible for Water, Local Government, Environment; Private sector; NGOs/CBOs.
	6.7 Strengthen integrated management of trans-boundary water resources	Ministry responsible for Water, Local Government, Environment; Private sector; NGOs/CBOs.
	6.8 Promote and upscale rain water harvesting technology.	Ministry responsible for Water, Local Government, Environment; Urban Water Supply and Sanitation Authorities, research and academic institutions, Private sector; NGOs/CBOs.
7. Climate change	7.1 Periodic reviews, formulation and implementation of appropriate policies, strategies and plans related to climate change.	Sector Ministries, Local Government Authorities.
	7.2 Strengthen mainstreaming of climate change adaptation into sectoral policies, strategies, programs, plans and budgets.	Sector Ministries, Local Government Authorities, private sector; Research and Academic Institutions, NGOs/CBOs.
	7.3 Enhance public awareness and understanding on climate change adaptation and mitigation.	Sector Ministries, Local Government Authorities, private sector; Research and Academic Institutions, NGOs/CBOs.
	7.4 Strengthen implementation of the National Climate Change Strategy and Action Plan.	Sector Ministries, Local Government Authorities, private sector; Research and Academic Institutions, NGOs/CBOs
	7.5 Strengthen early warning system to enhance resilience.	Sector Ministries, Local Government Authorities, private sector; Research and Academic Institutions,
	7.6 Develop and implement sustainable national climate change financing mechanism.	Sector Ministries, Local Government Authorities, private sector; Research and Academic Institutions, NGOs/CBOs.
	7.7 Promote Public Private Partnership on climate change initiatives.	Sector Ministries, Local Government Authorities, private sector; NGOs/CBOs
	7.8 Enhance capacity to communities on adaptation to climate change	Sector Ministries, Local Government Authorities, TMA, private sector; Research and Academic Institutions, NGOs/CBOs.

Issue		Options for action		Responsible Sector Ministry/Institution
8. Antimicro-bial Resis-tance (AMR) in the Envi-ronment	8.1	Periodic reviews, formulation and implementation of appropriate policies, strategies and plans related to AMR in the Environment		Ministry responsible for, Education, Science and Technology, Ministry responsible for health and social welfare , Ministry responsible for Agriculture and livestock development, Local Government
ronment	8.2	Strengthen laboratory capacity for diagnosis and analysis of AMR in the Environment		Ministry responsible for health and social welfare , Ministry responsible for Agriculture and livestock development, Local Government
	8.3	Strengthen research and development capacity		Ministry responsible for health and social welfare , Ministry responsible for Agriculture and livestock development, higher learning institutions
	8.4	Develop training manual on AMR in the Environment		Ministry responsible for health and social welfare , Ministry responsible for Agriculture and livestock development, Tanzania Food and Drug Administration (TFDA)
	8.5	Enhance public awareness on AMR in the environment		Ministry responsible for Health and social welfare, Ministry responsible for education, science and Technology Private sector; NGOs/CBOs and Media
9. Nanotech-nology	9.1	Strengthen research and development capacity in nanotechnology		Ministry responsible for Science and technology, higher learning institutions, Research and development Institutions, COSTECH
	9.2	Promote public awareness on nanotechnology		Ministry responsible Science and technology, Private sector; NGOs/CBOs and Media
	9.3	Strengthening laboratory capacity		Ministry responsible for Science and technology, higher learning institutions, Research and development Institutions, COSTECH
10. Cross-cut-ting policy options	10.1	Strengthen research and development to support environmental management		Ministry responsible for Science and Technology, Academic and Research Institutions, COSTECH, NEMC, TIRDO, CPCT, CSOs

Issue		Options for action	Responsible Sector Ministry/Institution
	10.2	Enhance environmental data generation, management and dissemination	National Bureau of Statistics, Ministry responsible for Local Government, Academic and Research Institutions, COSTECH, NEMC, TIRDO, CPCT, CSOs
	10.3	Strengthen resource mobilization to support environmental management	Ministry responsible for Finance and Environment; Sector Ministries; LGAs; Development Partners, CSOs
	10.4	Strengthen stakeholder involvement and engagement in environmental management	Ministry responsible for Environment; Sector Ministries; LGAs; TANGO
	10.5	Strengthen coordination and linkages amongst sectors for environmental management	Ministry responsible for Environment; Sector Ministries; LGAs
	10.6	Strengthen monitoring and evaluation mechanisms to support environmental management	Ministry responsible for Environment; Sector Ministries; LGAs

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