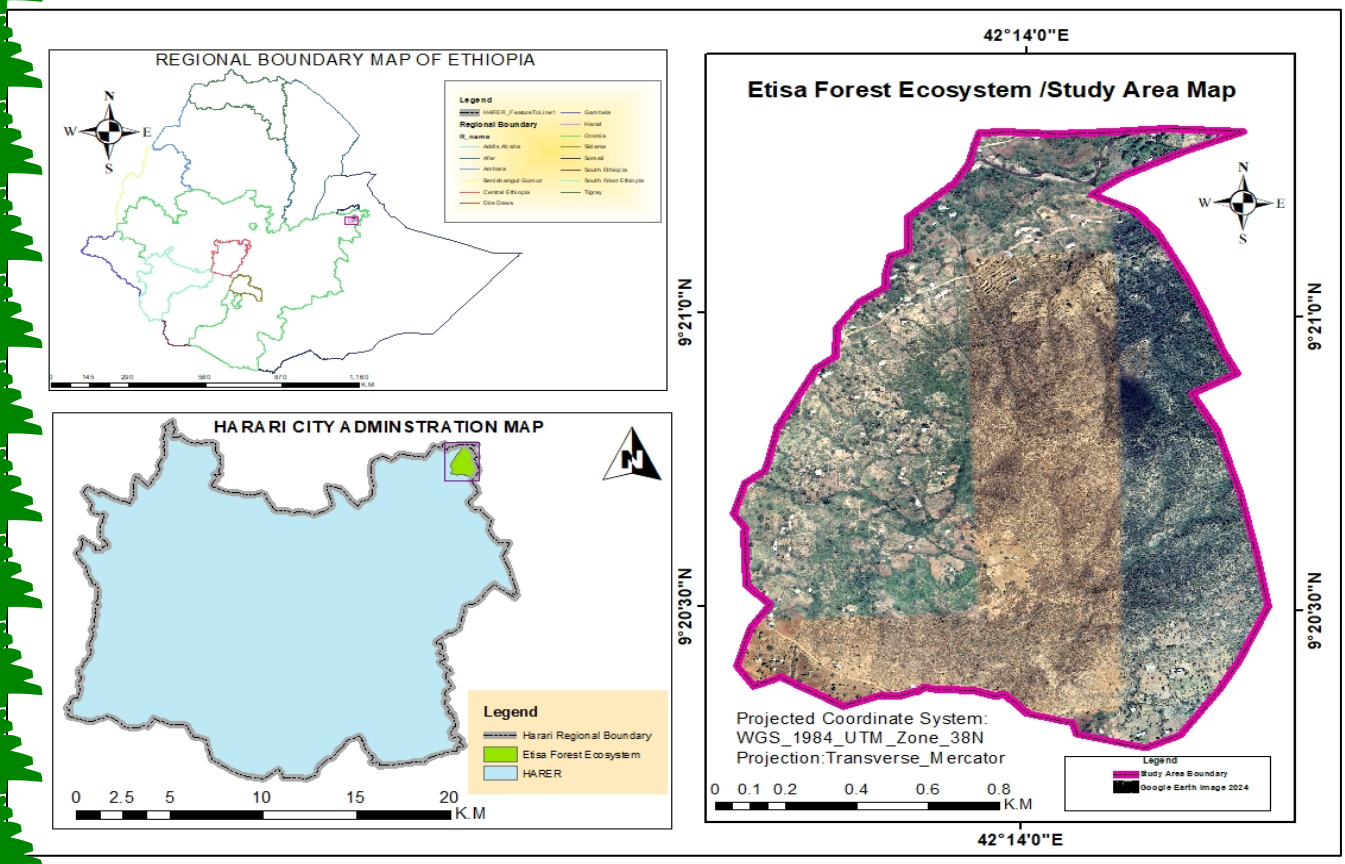
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA ENVIRONMENT PROTECTION AUTHORITY

FACT-SHEET OF ETISA



ADDIS ABABA, 2011

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Acronyms and Abbreviations

AGP: Agricultural Growth Program

Avr : Average

CBD: Convention on Biological Diversity

CBD: Conventions on Biological Diversity

CDM: Clean Development Mechanism

CH4: Methane

Climate Resilient Green Economy

CO2: Carbon dioxide

CO2e: Carbon dioxide equivalent

COP: Committee of Parties

CRGE: Climate Resilience Green Economy

CSA: Central Statics Authority

CSA: Central Statistical Agency

CSA: Central Statistics Agency CRGE

DLUMDR: Department of Land use Management directorate report 2011

DPSIR: Driver Pressure State Impact Response

DPSIR: Driver, Pressure, State, Impact and Response

EPA: Environmental Protection Authority

EPA: Environment Protection Authority

ERCS: Ethiopian Red Cross Society

FAO: Food and Agriculture Organization

FGD: Focal Group Discussion

FGD: Focal Person Dissection

FGD: Focus Group Discussion

FGD: Focused Group Discussion

GDP: Gross Domestic Product

GHG: Green House Gas

GHG: Green House Gas

GIS: Geographical Information system

GIS: Geographical Information System

GTP: Growth and Transformation Plan

HWSSA: Harari Water Supply and Sanitation Authority

IPCC: Intergovernmental Parties for Climate Change

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation of Nature

IUCN: International Union for Conservation Nature

KI: Key informants

MAOD: Meteorology Agency office

Max: Maximum

MEFCC: Ministry of Environment Forest and Climate Change

Mi: Minimum

MOWR: Ministry of Water Resource

Mt: Million tones

N2O: Nitrous oxide

NGO: None Governmental Organizations

NMA: National Metrology Agency

RF: Rain Fall

SOER: State of Environment Report

SWC: Soil and Water Conservation

T: Temperature

UNFCCC: The United Nations Framework Convention on Climate Change

UNFCCC: United Nations Framework Convention on Climate Change

WMO: World Meteorological Organization.

1. General Background

1.1. Environment for Green Economy Development

The Green Economy is an alternative vision for growth and development; one that can generate economic development and improvements in people's lives in ways consistent with advancing also environmental and social well-being. One significant component of a green economy strategy is to promote the development and adoption of sustainable technologies.

Over the last decade, a frequent claim has been that the traditional economic models need to be reformed in order to address climate change, biodiversity losses, water scarcity, etc., while at the same time addressing key social and economic challenges. The global financial crisis in 2008–2009 spurred this debate and these concerns have been translated into the vision of a 'green economy'. Furthermore, in 2015, countries world-wide adopted the so-called 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals. These goals recognize that ending world poverty must go hand-in-hand with strategies that build economic growth but also address a range of various social needs including education, health, social protection, and job creation, while at the same time tackling environmental pollution and climate change. The sustainable development goals thus also establish a real link between the ecological system and the economic system. They also reinforce the need for a transition to a green economy, i.e., a fundamental transformation towards more sustainable modes of production and consumption.

With the advent of modern environmental policy in the 1960s, stringent regulations were imposed on emissions into air and water. However, the focus was more or less exclusively on stationary pollution sources (i.e., industrial plants), which were relatively easy to monitor and regulate, e.g., through plant-specific emission standards. In addition, during this early era there was a strong emphasis on local environmental impacts, e.g., emissions into nearby river basins causing negative effects on other industries and/or on households in the same community.

Over the years, though, the environmental challenges have increasingly been about targeting various types of *diffuse* emissions. These stem from scattered sources such as road transport, shipping, aviation, and agriculture. Pollution from diffuse sources takes place over large areas and individually they may not be of concern, but in combination with other diffuse sources they can cause serious overall impacts. The growing importance of *global* environmental challenges

such as climate change in combination with globalization and more international trade in consumer products, adds to this challenge. Managing these issues often requires international negotiations and burden-sharing, which in itself have proved difficult. The difficulties in reaching a stringent-enough global climate agreement illustrate this difficulty.

Diffuse emissions are typically difficult to monitor and therefore also to regulate. For instance, environmental authorities may wish to penalize improper disposal of a waste product since this would help reduce various chemical risks, but such behaviour is typically clandestine and difficult to detect. Plastic waste is an apt example; it stems from millions of consumer products, is carried around the world by the currents and winds, and builds up micro plastics, particularly in the sea. Many dangerous substances, including chemicals such as solvents and phthalates, are embedded in consumer products, out of which many are imported. Monitoring the potential spread of these substances to humans and the natural environment remains difficult as well. Technological innovation that permits better tracing and tracking of materials should therefore be a priority.

In order to address these diffuse environmental impacts, society has to find alternative – yet more indirect – ways of monitoring and regulating them. This could translate into attempts to close material cycles and promote a circular economy, i.e., an economy in which the value of products, materials and resources are maintained as long as possible. In practice, this implies an increased focus on reduction, recycling and re-use of virgin materials. Material and energy efficiency, as well as sharing of resources (often with the help of various digital platforms such as Uber and Airbnb). In other words, rather than regulating emissions as close to damage done as possible, the authorities may instead support specific activities (e.g., material recycling) and/or technologies (e.g., low-carbon production processes) that can be assumed to correlate with reduced environmental load.

Addressing diffuse emissions in such indirect ways, though, is not straightforward. In several countries, national waste management strategies adhere to the so-called waste hierarchy (see also the EU Waste Framework Directive). This sets priorities for which types of action should be taken, and postulates that waste prevention should be given the highest priority followed by re-use of waste, material recycling, recovery of waste and landfill (in that order). Even though research has shown that this hierarchy is a reasonable rule of thumb from an environmental point

of view it is only a rule of thumb! Deviations from the hierarchy can be motivated in several cases and must therefore be considered.

One important way of encouraging recycling and reuse of products is to support product designs that factor in the reparability and reusability of products. Improved recyclability can also benefit from a modular product structure. However, this also comes with challenges. Often companies manufacture products in such ways that increase the costs of recycling for downstream processors, but for institutional reasons, there may be no means by which the waste recovery facility can provide the manufacturer with any incentives to change the product design. One example is the use of multi-layer plastics for food packaging, which could often be incompatible with mechanical recycling.

While the promotion of material and energy efficiency measures also can be used to address the problem of diffuse environmental impacts, it may be a mixed blessing. Such measures imply that the economy can produce the same amount of goods and services but with less material and energy inputs, but they also lead to a so-called rebound effect. Along with productivity improvements, resources are freed and can be used to increase the production and consumption of other goods. In other words, the efficiency gains may at least partially be cancelled out by increased consumption elsewhere in the economy. For instance, if consumers choose to buy fuel-efficient cars, they are able to travel more or spend the money saved by lower fuel use on other products, which in turn will exploit resources and lead to emissions.

Finally, an increased focus on circular economy solutions will imply that the different sectors of the economy need to become more interdependent. This interdependency is indeed what makes the sought-after efficiency gains possible in the first place. This in turn requires new forms of collaborative models among companies, including novel business models. In some cases, though, this may be difficult to achieve. One example is the use of excess heat from various process industries; it can be employed for supplying energy to residential heating or greenhouses. Such bilateral energy cooperation is already quite common (e.g., in Sweden), but pushing this even further may be hard and/or too costly. Investments in such cooperation are *relation-specific* i.e., their returns will depend on the continuation of the relationships. The involved companies may be too heterogeneous in terms of goals, business practices, planning horizons etc., therefore making long-term commitment difficult. Moreover, the excess heat is in an economic sense a by-

product, implying that its supply will be constrained by the production of the main product. Of course, this is valid for many other types of waste products as well, e.g., manure digested to generate biogas, secondary aluminium from scrapped cars.

In brief, the growing importance of addressing diffuse emissions into the natural environment implies that environmental protection has to build on indirect pollution abatement strategies. Pursuing each of these strategies (e.g., promoting recycling and material efficiency), though, imply challenges; they may face important barriers (e.g., for product design, and by-product use) and could have negative side-effects (e.g., rebound effects). Moreover, a focus on recycling and resource efficiency must not distract from the need to improve the tracing and tracking of hazardous substances and materials as well as provide stronger incentives for product design. Both technological and organizational innovations are needed.

A more formal definition can be regarded as a "system of economic activities related to the production, distribution and consumption of goods and services that result in improved human well-being over the long term, while not exposing future generations to significant environmental risks or ecological scarcities". It implies the decoupling of resource use and environmental impacts from economic growth. It is characterized by substantially increased investment in green sectors, supported by enabling policy reforms. The Green Economy refers to two inter-linked developmental outcomes for the South African economy:

- Growing economic activity (which leads to investment, jobs and competitiveness) in the green industry sector
- A shift in the economy as a whole towards cleaner industries and sectors.

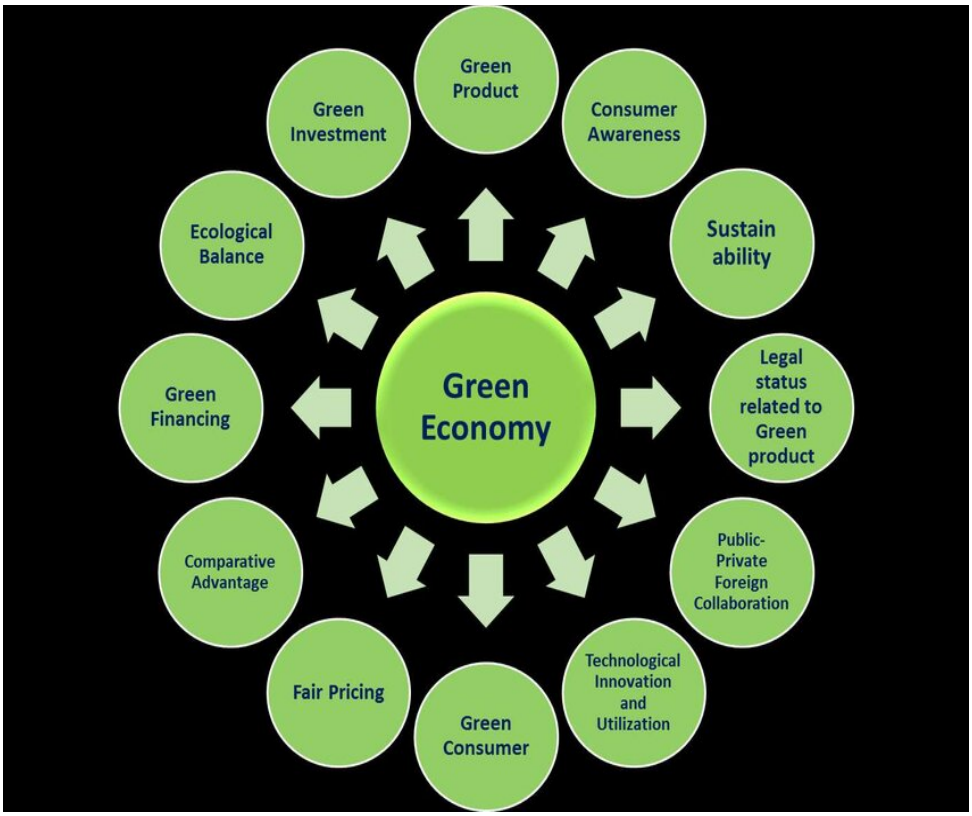

Figure 1 green economy linkage with various factors

1.2. Frameworks /Approaches

2 Social and Economic Environment

2.1 Social Environments

The term, “Socioeconomic Environment” is presented. It refers to the combination of external social and economic condition that influence the operation and preformation of an organization. The socioeconomic environment is part of the overall business environment”.

Social and economic factors include factors such as income, education, employment, community safety and social support. The choices that are available in a community are impacted by social and economic factors. These choices include our abilities to afford medical care and housing and to manage stress. Our "environment" includes both social and physical determinants of health. Social impacts on health are embedded in the broader environment and shaped by complex relationships between economic systems and social structures. These systems and structures

impact the distribution of resources, money and power in a community and around the world. This distribution, known as the socioeconomic environment, shapes how communities and individuals can gain the resources needed to meet their basic human needs. In general, socio-economic impacts focus on how the activity affects human or societal well-being, as well as the use and benefit of any site. For example, the construction of a road may upset people living nearby due to noise and dust pollution, causing health impacts in some cases.

What is a social environment?

A person's *social environment* is their society and all surroundings influenced in some way by humans. It includes all relationships, institutions, culture, and physical structures.

The *natural environment* is the natural world around us: the ground, the trees, the air. The *social environment* is, collectively, all of the things that humans have overlaid on top of our world: our personal and societal relationships, our institutions, our cultures, and our physical surroundings—all of the aspects and products of human activity and interaction.

Sociologists, health researchers, and others study how the *social environment* shapes who we are and how we live, especially how individuals are affected by such factors.

What is economic environment?

The term economic environment refers to all the external economic factors that influence buying habits of consumers and businesses and therefore affect the performance of a company.

Economic environments are the foundation of growth. Economic environments are platforms where individuals trade goods, services, and money to grow their separate wealth. This in turn grows the general wealth of the environment.

Generally Socio-economic development is the process of social and economic development in a society. Its purpose is to maintain the social and material well-being of the nation and its people with the aim of achieving the highest possible level of human development. Further Reading: Economic Growth and Development.

The **Harari Region** (Amharic: ሐረሪ ክልል; Oromo: *Naannoo Hararii*; Harari: ሀረሪ ሑስኒ), officially the **Harari People's National Regional State** (Amharic: የሐረሪ ሕዝብ ብሔራዊ ክልላዊ መንግሥት; Oromo: *Mootummaa Naannoo Ummata Hararii*; Harari: ዚሀረሪ ኡምመት ሑስኒ ሑኩማ), is a regional state in eastern Ethiopia, covering the homeland of the Harari people. Formerly named **Region 13**, its capital is Harar, and the region covers the city and its immediate surroundings. Harari Region is the smallest regional state in Ethiopia in both land area and population. Harari and Oromo are the two official languages of the region. The region was created by splitting the Hundane woreda from East Hararghe Zone. As a result, Harari Region is enclave by Oromia.

Demographics

Ethnic groups of Harari region Oromo (56.41%) Amhara (22.77%) Harari (8.65%) Gurage (4.34%) Somali (3.87%)Tigray (1.53%) Argobba (1.26%) Other (1.17%)

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), Harari has a total population of 183,415, of whom 92,316 were men and 91,099 women. This region is the only one in Ethiopia where the majority of its population lives in an urban area: 99,368 or 54.18% of the population are urban inhabitants. With an estimated area of 311.25 square kilometers, this region has an estimated density of 589.05 people per square kilometer. For the entire region 46,169 households were counted, which results in an average for the region of 3.9 persons to a household, with urban households having on average 3.4 and rural households 4.6 people. Ethnic groups in the region includen the Oromo (56.41%), Amhara (22.77%), Harari (8.65%), Gurage (4.34%), Somali (3.87%),

Tigray (1.53%),and Argobba (1.26%). Languages spoken include Oromiffa (56.84%), Amharic (27.53%), Harari (7.33%), Somali (3.70%), and Gurage (2.91%).

In the previous census, conducted in 1994, the region's population was reported to be 131,139, of whom 65,550 were men and 65,589 women. At the time of that census, 76,378 or 58.24% of the population lived in urban areas. Ethnic groups in the region recorded in the earlier census included the Oromo (66.84%), Amhara (10.7%), Harari (7.1%), Gurage (3.2%), Tigray (2.71%),

and Somali (1.68%). Languages recorded included Oromiffa (72.79%), Amharic (22.97%), Harari (7.61%), Gurage (1.13%) and Tigrinya (1.13%)

According to the CSA, as of 2004, 73.28% of the total population had access to safe drinking water, of whom 39.83% were rural inhabitants and 95.28% were urban.[6] Values for other reported common indicators of the standard of living for the Harari region as of 2005 include the following: 5.7% of the inhabitants fall into the lowest wealth quintile; adult literacy for men is 78.4% and for women 54.9%; and the regional infant mortality rate is 66 infant deaths per 1,000 live births, which is less than the nationwide average of 77; at least half of these deaths occurred in the infants' first month of life.

The Driver-Pressure-State-Impact-Response Framework

The current study tried to use DPSI approaches.

The DPSIR frame work is a variant of the Pressure – State – Response (PSR) framework originally developed by Rapport and Friend (1979) for Statistics Canada and also adopted by other bodies such as UNEP in the GEO and AEO processes.

The “DPSIR” framework is multi-scalable and indicates generic cause and effect relations within and among the following:

• DRIVERS: The drivers are sometimes referred to as indirect or underlying drivers or driving forces and refer to fundamental processes in society, which drives activities having a direct impact on the environment;

• PRESSURES: The pressure is sometimes referred to as direct drivers as in the Millennium Assessment (MA) framework. It includes in this case the social and economic sectors of society (also sometimes considered as Drivers). Human interventions may be directed towards causing a desired environmental change and may be subject to feed backs in terms of environmental change, or could be an intentional or un-intentional by-products of other human activities (i.e., pollution);

• STATE: Environmental state also includes trends, often referred to as environmental change, which could be both naturally and human induced. One form of change, such as climate change, (referred to as a direct driver in the MA framework) may lead to other forms of change such as biodiversity loss (a secondary effect of climate gas emissions);

• IMPACTS: Environmental change may positively or negatively influence human wellbeing (as reflected in international goals and targets) through changes in environmental services and environmental stress. Vulnerability to change varies between groups of people depending on their geographic, economic and social location, exposure to change and capacity to mitigate or adapt to change Human well-being, vulnerability and coping capacity is dependent on access to social and economic goods and services and exposure to social and economic stress;

• RESPONSES: Responses consist of elements among the drivers, pressures and impacts which may be used for managing society in order to alter the human – environment interactions. Drivers, pressures and impacts that can be altered by a decision-maker at a given scale are referred to as endogenous factors, while those that can’t are referred to as exogenous factors

Religion

Religion in Harari Region (2007)[8]

Muslim (69%)

Ethiopian Orthodox (27.1%)

P'ent'ay (3.4%)

Traditional faiths (0.1%)

Catholic (0.3%)

Other (0.1%)

The religion with the most believers in the region is Islam with 68.99%, 27.1% are Ethiopian Orthodox, 3.4% Protestant, 0.3% Catholic, and 0.2% followers of other religions. The population was projected to be 246,000 as of 2017. The religious composition of the population of the region indicated that 60.28% were Muslim, 38.09% Ethiopian Orthodox, 0.94% Protestant, and 0.46% Catholic in 1994.

Kebeles in Harari Region (Harar and its urban kebeles are shown as one unit, Harer Ketema, and the unlabeled territory on the centre-left is part of the urban area. Some maps show a thin strip of land connecting it to the remaining area) Aerial photo of the region.

There are 9 numbered woredas in Harari region. Under the woreda there are 19 city kebeles and 17 rural kebeles. The woredas are:

Urban

- Amir-Nur Woreda
- Abadir Woreda
- Shenkor Woreda
- Jin'Eala Woreda
- Aboker Woreda
- Hakim Woreda

Rura woredas include Sofi Woreda Erer Woreda Dire-Teyara Woreda

Erer is one of the woredas in the Harari Region of Ethiopia. It is 15 kilometer far from Harar Most of the community economic activity are depending on agriculture. The Etisa forest is found in this woreda .

2.1.1 State and trends of Social Environment

2.1.1.1 Population

Population distribution means the pattern of where people live. World population distribution is uneven. Places which are sparsely populated contain few people. Places which are densely populated contain many people. Sparsely populated places tend to be difficult places to live. These are usually places with hostile environments e.g. Antarctica. The environment in Antarctica makes it a very challenging location to live, with cold temperatures, lack of vegetation and geographical isolation few people live here. Altitude and the attendant climatic differences determine the distributional pattern of the Ethiopian population more than any other single factor, but not in the manner it affects global population distribution.

The distribution of Ethiopia's population is influenced greatly by altitude, climate, and availability of good soil. These physical factors explain the high concentration of the population in the highlands. About 14 percent of the population lives in areas with an altitude of 2,400 meters above sea level (m.a.s.l) or higher, in climates similar to the temperate zone outside the tropics. About 75 percent people live between 1,500 and 2,400 masl where temperature is moderate and the rest live below 1,500 masl where temperatures are high. The hot zone encompasses more than half of Ethiopia's territory but contains only 11 percent of the population (Aynalem, undated) Teller *et al* (2007)

Table 1: Population Trend Erer Woreda 200-2024

YEAR(G.C)	Rural population		
	MALE	FEMALE	TOTAL
2020	12968	11828	23193
2021	11640	12116	23756

2022	11917	12403	24320
2023	12193	12691	25448
2024	12967	12979	25946

Source: - ERER WORWDA HEALTH OFICE (2024)

Because of population increment the demand on infrastructure, food security, energy source, health facilities and basic necessities as a whole is increased. As a result Etisa Mountain Forest Ecosystem faced grate problem.

2.1.1. 2 Education

Education is a powerful agent of change, and improves health and livelihoods, contributes to social stability and drives long-term economic growth. Education is also essential to the success of every one of the 17 sustainable development goals.

Education is the most important factor that plays a leading role in human development. It promotes a productive and informed citizenry and creates opportunities for the socially and economically under privileged section of the society.

Considering the enrolment of female students in all level of education primary education, from 2020-2024 is low as compared with male students. This shows that due to disaster problem female students are more vulnerable than male students and females are participated in other lively hood activates to cope the problem

Table 2**:** Students, teachers and number of schools in Erer *Woreda* in Academic year22020-024

NO	Level of School	Number of schools	Students inDara woreda 2020- 2024		
			Male	Female	Total

1	Elementary schools	4	3345	2456	15,683
2	Primary School (7-8)	7	3,998	2949	6,099
3	High School (9-12) preparatory	1	984	849	5833
4	Number of teachers	230	130	100	1254

Source: ERER WOREDA EDUCATION OFICE (2024)

2.1.1. 3 Health

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, and political belief, economic or social condition.

The healthcare sector plays a vital role in society, providing essential services aimed at promoting and maintaining the well-being of individuals. With advancements in technology, shifting demographics, and growing awareness of preventive care, the healthcare sector has undergone significant transformations. This article explores the current state of the healthcare sector and highlights the key factors shaping its future.

In recent years, technology has revolutionized the healthcare sector, paving the way for innovative treatments, improved diagnostics, and streamlined patient care. From electronic medical records and telemedicine to artificial intelligence and wearable devices, these advancements have enhanced efficiency, accuracy, and accessibility within the industry. Medical professionals can now diagnose diseases more accurately, monitor patients remotely, and collaborate across borders for better patient outcomes. While the healthcare sector has traditionally centered on treating illnesses, there has been a notable shift towards preventive care. Recognizing the importance of early detection and lifestyle modifications, healthcare providers now emphasize wellness programs, health screenings, and educational campaigns. By focusing on prevention, the sector aims to reduce the burden of chronic diseases, enhance overall public health, and improve the quality of life for individuals.

Table 3: Health Institutions in Erer Woreda of 2016 and 2017

No	Types of Health Institutions	Year					Remark
		2020	2021	2022	2023	2024	
1	Governmental Health Center	1	1	1	1	1	
1.1	Primary Hospital	0	0	0	0	0	
1.2	Health center	1	1	1	1	1	
1.3	Health post	7	7	7	7	7	
2	Private Health Centers	0	0	0	0	0	
2.1	Primary Health clinics	1	1	1	1	1	
2.2	Number of health professionals'	12	19	22	29	32	

Source: - Erer woreda Woreda Health Report 2024

As indicated on the above tables, the numbers of Governmental Health Institutions and health professionals has constant number but the number of health professionals are relatively increasing year to year in Erer woreda ,

2.1.1.4 *Road and* Transport

Transport is a key component in the distribution of goods within and beyond a country's borders. Transport is a way to ensure stable prices in different markets and It allows traders to regulate the supply of goods at various locations based on changing demand.

Efficient and low-cost transportation expands market areas, facilitates the export of agricultural products, and reduces the real cost of necessary imports. Moreover, transportation enables the movement of people and goods, supporting recreational and leisure activities, as well as employment opportunities.

The total existing road in the *Woreda* is 69 kilometers. Most of the rural roads are seasonal and. The population who has access to Road infrastructure is around 65.5 % of the woreda population. According to focal groups and key informant discussion in Ereer woreda there is a great problem of road infrastructure .

Table 4: Types and length of Roads, existing Debub Ari woreda in the year 2018

No	Road type	Length in km	% of population who has accessto Road
1	Asphalt	0	**0%**
2	All weather rood	33	35%
3	Dray weather rood	36	50%
4	Total	69 k.m	

Source: (ERER woreda transport office)

The quality of the road infrastructure in the woreda is poor quality, which is mainly due to lack of proper maintenance and also the topography is not conducive for rood transport.

2.1.1.5 Water Resource Supply

In Erer *woreda*, there are a number of small stream and three rivers. The three rivers are (Felana , Gfera and Sante) , The above stated surface water resources and various springs were used as a water source to the *Woreda.* And provide considerable amount of water for domestic water use and even for all year round human, animal water consumption and for irrigation purposes. However, the water demand of the woreda is 650m3 /day but elder in the *woreda* under lined that currently due to various environmental problems some streams and springs were dried, while the volume of existing small streams and river as well as the discharge rate of springs has been decreasing from time to time.

2.1.1.6 Electricity

Before the invention of electricity, almost 100 years ago, people used to burn fires, lighten up Diya's, and use whale oil lamps, candles, and kerosene oil lamps to make visibility in the dark. Still, these could have been more efficient in lightening every area and corner. Science has solved this problem and invented a secondary energy source to lighten our every room of life. Scientists such as Benjamin Franklin, Nikola Tesla, and Thomas Edison contribute to our need for and use of electricity.

In today's era, can you imagine life without electricity for just a few minutes? A few hours without electricity wreak havoc in our lives. Much of our works go to waste without electricity because humans depend on electronic items. These electronic items run on electricity or take electricity as an energy source. This 21st century is techno-savvy in which techno gadgets and electronic items like laptops, mobile phones, refrigerators, washing machines, television, computers, and electronic kitchen essentials like mixers, grinders, ovens, microwaves, heaters, etc., surround everyone. Even the construction of the home is incomplete without electric wiring. This is how electricity has impacted our life from birth to death.

Electricity is an essential infrastructure for a given area of economic and social development. In Erer *woreda* the total coverage of Electricity is 35.4 percent, in which only 28 villages have accesses to electric services within 64 village's . The other residents used fuel wood, charcoal as the source of energy and also they used kerosene as a source of light.

2.1.1.7 Communication services

Communication helps you connect with others and share ideas. Effective communication clarifies information, reducing wasted time. Helps builds relationships, teamwork, and trust. Helps to develop your knowledge base, which helps you, make better life to choices.

Effective communication enables individuals and organizations to share ideas, collaborate on projects, and innovate more effectively. This can lead to the development of new products, services, and solutions that drive economic growth.

in Erer *Woreda*, 24 hours telephone services, is available from total kebeles, almost all have access to telephone services generally no problem in communication.

2.1.1.8 Housing

Housing is one of the three basic needs for human being; there is no problem of housing as mentioned during key informant, group discussion in the woreda .

2.1.2. Drivers and Pressure of *Social Environment Change*

Etisa mountains forest Ecosystem is one of highly degraded ecosystem. The main drivers for the deterioration of the ecosystem are mainly population growth and deforestation .The society use forest for fuel wood and for different household's construction materials.

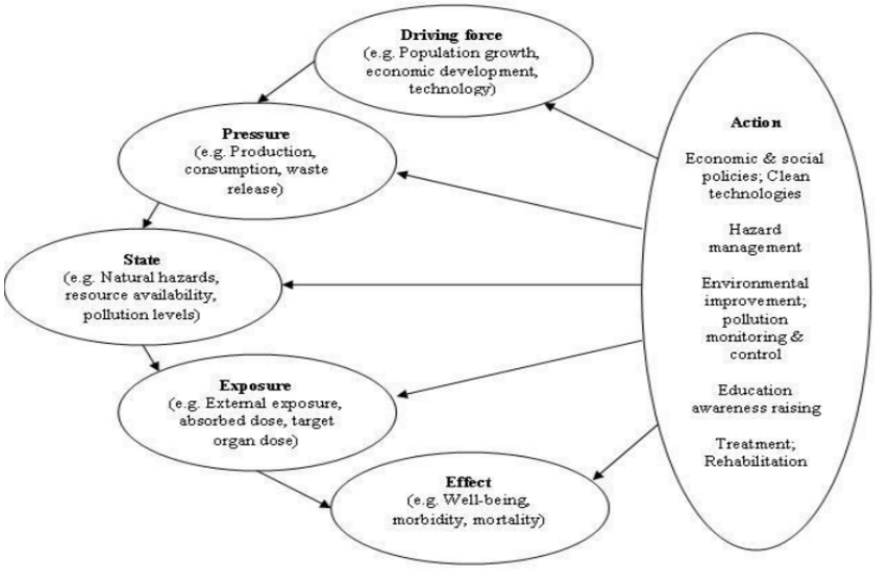

Figure 2The Drivers And Pressure Of Change In The Environment

- Important direct drivers include climate change, nutrient pollution, land conversion leading to habitat change, overexploitation, and invasive species and diseases. that happen intermittently. Changes in ecosystem services can feed back to alter drivers.
- Population growth and demographics, urbanization, economic development, new technological forces, and climate change
- Important direct drivers include climate change, nutrient pollution, land conversion leading to habitat change, overexploitation, and invasive species and diseases. that happen intermittently. Changes in ecosystem services can feed back to alter drivers.
- Low educational background and less exposure to contraceptive technologies aggravate high birth rates among the rural population.
- Even though, currently much attention is given to the provision of primary health care in the households, the provision of family planning services are still low. As a result, there will be much more delivery and an
- The most significant drivers of environmental degradation are land use and land cover changes, resulting from agricultural farmland and settlement expansion.

2.1.3. Impacts *of Social Environment Change*

Humans impact the physical environment in many ways: overpopulation, pollution, burning fossil fuels, and deforestation. Changes like these have triggered climate change, soil erosion,

poor air quality, and undrinkable water. Physical environmental compulsions such as famines, droughts, floods, earthquakes led to human migration to distant places with a consequence of disruption to settled human life. Physical environmental compulsions effect social life by producing new ways of living and set of social relationships.

In Etisa mountain forest area, because of extreme deforestation for the demand of fuel wood and land change for crop use, aggravates environmental degradation.

- Due to deforestation different habitat, , animals and medicinal plant disappear, Due to this the society their life depend on the Etisa Mountains forest ecosystem highly affected, disrupted and the getting of ecosystem service is decreasing like fruits, medicinal plant, decrease water quality and quantity, decrease production and productivity, facilitate animal and crop pastes, etc.
- Due to over degradation of Etisa Mountain forest ecosystem the society who lives surrounding Etisa , have got problem of drinking water and as a result of this women and children go to long distance to fiche clean water this also Couse school dropout specially for women students .

2.1.4. Responses to Social Environment Change

There are many potential policy responses to the environmental challenges

- Mitigation involves reducing carbon dioxide gas emissions and stopping the problem of climate change from growing. This means burning less fossil fuel (coal, oil and natural gas) and producing more renewable energy from technologies such as wind, solar and hydro power.
- Humans impact the physical environment in many ways: overpopulation, pollution, burning fossil fuels, and deforestation. Changes like these have triggered climate change, soil erosion, poor air quality, and undrinkable water.
- Improving the social and economic status of vulnerable groups (women, children and elderly). In line with the policy document, Ethiopia set out a national population programme in accordance with national priorities as stated below
- Expansion of population information, education and communication;

- **Promotion of the status of women**

Both government and non-government organizations are closely working together to lessen the implication of population pressure by expanding network of family planning and contraceptive service delivery, providing in-service training for health professionals and introduce gender specific career counseling, etc.

A number of livelihood strategies were adopted by the communities at a grass root level to reduce their vulnerability to risk situations and recover from the unhealthy events. For instance, income diversification, engaged in off-farm activities, livestock fattening, and changing the cropping pattern from subsistence crop to perennial cash crops. In addition, population policy, family planning policy, forest protection policy and others has practically implemented at grass root level. To alleviate the problem and attain the Millennium Development Goals both the government and society are working together to achieve sustainable natural resourceconservation.

Finally Different response measure were taken to decrease the growth of population they were apply different family planning method. The society who live around Shengam mountain forest ecosystem they were done conservation work and without affecting social and Economic value of ecosystem for the community they were tries to beekeeping and produce nursery.

2.1.5. Outlook for Social Environment

If everything continues as it is practiced as percent, population growth within the study area well be high, over population and the land use /land cover change continue under present condition: soil erosion, land degradation, injured people and livestock by natural and human induced caused would aggravate, this causes an increase and loss of soil fertility and highly affecting agricultural productivityin the Etisa mountain forest ecosystem.

2.2. Economic Environment

2.2.1. State and Trend of the Economic Environment

Agriculture is the most important economic sector in Erer woreda and it will continue to play the leading role in the overall economy development of the region. The livelihood of the people is dependent on agriculture, however, agricultural system in the region is at subsistence level and food insecurity problem is increasing at alarming rate.

According to the current Erer woreda Agricultural office report) , Contribution of Agriculture sector for gross domestic product (GDP) is very high, which is:- Agriculture Sector 80 there is no industry or other sectors in the woreda which can contribute for GDP

2.2.2. Drivers and Pressures of the Economic Condition

The driving force behind economic policy-making lies in the macro-economic objectives. The macro-economic objectives should be environmentally and socially sustainable. Obviously, the macro-economic objectives are: economic growth measured in terms of the percentage change in the Gross Domestic Product (GDP), employment, price stability, and equity. The very concept of studying population dynamics and economic environment is that its interlinked nature. the rate of change in labor force 5%, rate of change in capital asset 5%, rate of industrialization 11.67%. As there are high rates of population growth2.9 in the study area, the demand to satisfy the increasing new comers increases in over exploitation of the available natural resources.

2.2.3. Impacts due to the Economic Condition

The nature of economic growth can be analyzed according to economic sectors. Three indicators of environmental pressure, namely sectorial composition, sectorial rate of growth and a change in sectorial production methods and techniques can be considered to understand the economic growth.

Thus, the agricultural, industrial and service sectors are used. The first two are to have a higher direct impact on the environment than the third sector. Soil fertility is declining every production season. FGD said that, Lack of job opportunity, loss of farming lands, increasing poverty, water pollution and scarcity of farming lands (i.e. one farmer's has the maximum of 0.5 hectare farming lands) were major problems in the woreda. Livestock's per capita production is decreasing due to limited modern technique application, yield enhancing inputs and scarcity of grassing lands. Therefore, the current livelihood strategy and pattern is a challenging task to promote sustainable development by protecting the environment. There is a higher risk and vulnerability to food insecurity.

2.2.4. Response of Economic environment

There are many potential policy responses to the environmental implications of local population

pressure. The population policy of Ethiopia aims at

- We must plant more and more trees, throw garbage in the dustbins, avoid using plastic bags, etc. It cannot be denied that our natural environment is such an important part of our ecosystem. It is important to educate people about how the environment is getting damaged.
- Response measures are actions, policies, and programmes that. Countries, as Parties to the UN Framework Convention on. Climate Change (UNFCCC), undertake in response to climate.
- Closing the gap between high population growth and low economic productivity through Planned reduction of population growth;
- improving the carrying capacity of the environment by taking appropriate environmental protection measures; and
- Improving the social and economic status of vulnerable groups (women, children and elderly).

A number of livelihood strategies were adopted by the communities at a grass root level to reduce their vulnerability to risk situations and recover from the unhealthy events. For instance, income diversification, engaged in off-farm activities, livestock fattening, and changing the cropping pattern from subsistence crop to perennial cash crops e.g., banana ,Coffee ,other spaces (Coro Rima, Jigger) and to develop crop rotation practices from cereal crops to leguminous crops which facilitate soil development/increasing soil fertility to increase production and productivity. In addition, population policy, family planning policy, forest protection policy and health policy (family planning, human health), education policy and sector plan (quality education for all) has practically implemented at grass root level.

To alleviate the problem and attain the Millennium Development Goals both the government and society are working together to achieve sustainable natural resource conservation.

Apart from the above major responses by the Government of Ethiopia, a new plan has been coined and put into practice by different components of the government in this fiscal year Growth and Transformation Plan (GTP II). The planning year is between 2015/16 and 2019/20. GTP's vision in the economic sector is "to build an economy which has a modern and productive agricultural sector with enhanced technology and an industrial sector that plays a leading role in

2.2.5. Outlook for Economic Condition

If everything continues as business as usual, if the population in the study area continues to grow so that subsistence mode of economic situation that based on farming, Animal husbandry fuel wood collection will minimalize the limited natural resources. Then natural environment could not be able to provide the environment service.

2.2.6. Options for future Action

3. Physical Environment of Etisa

3.1. State and Trend Land use Land Cover Change in Etisa Forest Ecosystem

The definition of land use and land cover has been used interchangeably in the land use research community because of the availability of many existing information systems. However, these two terms explain two different issues and meanings. Land cover refers to the observed biophysical cover on the earth's surface including vegetation, bare soil, hard surfaces, and water bodies. Whereas land use is the utilization of land cover type by human activities for agriculture, forestry, settlement, and pasture by altering land surface processes including biogeochemistry, hydrology, and biodiversity. Changes in land use and land cover are caused by direct and indirect consequences of human activities on the environment to have a better life.

Land use / Land cover change plays a vital role in the study of global change. Land use / Land cover and human or natural modification have largely resulted in deforestation, biodiversity loss, global warming, and an increase in natural flooding. Thus environmental problems are often related to Land use/ Land cover change. The land use/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by the man in time and space. The land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning, and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting from changing demands of the increasing population.

Ethiopia is among the countries characterized by diverse vegetation zones (Teketay et al., 2010). However, the high demand for agricultural land due to growing human population has contributed to the deterioration and depletion of forest resources of the country.

Ethiopia is historically passed significant dynamics in LULC for many decades. However, nowadays, LULCCs and degradation are increasing at an alarming rate, playing a significant role in the increasing rate of soil erosion. The need for more cultivated lands has negatively affected the presence of forest and grasslands, eventually fostering soil erosion

Ethiopia is characterized by a rich but shrinking diversity in biological resources such as forest, woody and grassy lands, shrubs, varied wildlife, and fertile soil. It is also renowned for its massive mountain ranges, high flat plateaus, deep gorges, river valleys, lowland plains, extensive wetlands, and deserts. Landscape degradation by soil erosion has increased considerably in the Ethiopian highlands since the deforestation of the natural mountain forests and the cultivation of large areas, resulting in serious danger to our country.

3.1.1. State and Trend of Land Resource in Etisa forest Ecosystem

The existing situation analysis of land use of Harar city showed that about half of the city is currently built-up, while the remaining areas are used for farming and forest. However, some of the areas within the structure plan boundary of the city and also some built-up areas are under the rural kebele administrations of Sukul, AbokerMutti, Segecha, Miyayi, Aw Umer, Sofi and Gelmeshira (refer to the map below).

This is serious problem facing the city and also the rural kebele. Land in the areas with unclear administration are exposed to informal development, deforestation and overall mismanagement. These situations are affecting the lives of farmers, as they sell their right to the use of land without making the necessary preparations as to use the finance and also sustain their lives. The land is developed without the planning consent and construction permit. The upcoming settlements will lack appropriate road and utilities. In addition, government loses money that could have been collected from services delivered, user and service charges and capital gains taxes. The only beneficiaries from these situations are the brokers and land speculators. Considering these, the new structure plan proposal shall emplace an appropriate system of land administration as well as mechanism for control of illegal land grabbing and informal developments.

Land banking is another serious issue that needs attention in Harar city. Harar needs reserve land for development. The ongoing land inventory and cadaster projects will help to identify other government land; which shall be banked. Especially land allocated for temporary uses shall be returned back to the land bank. In addition to these, the city needs other way of acquiring land for development in the future.

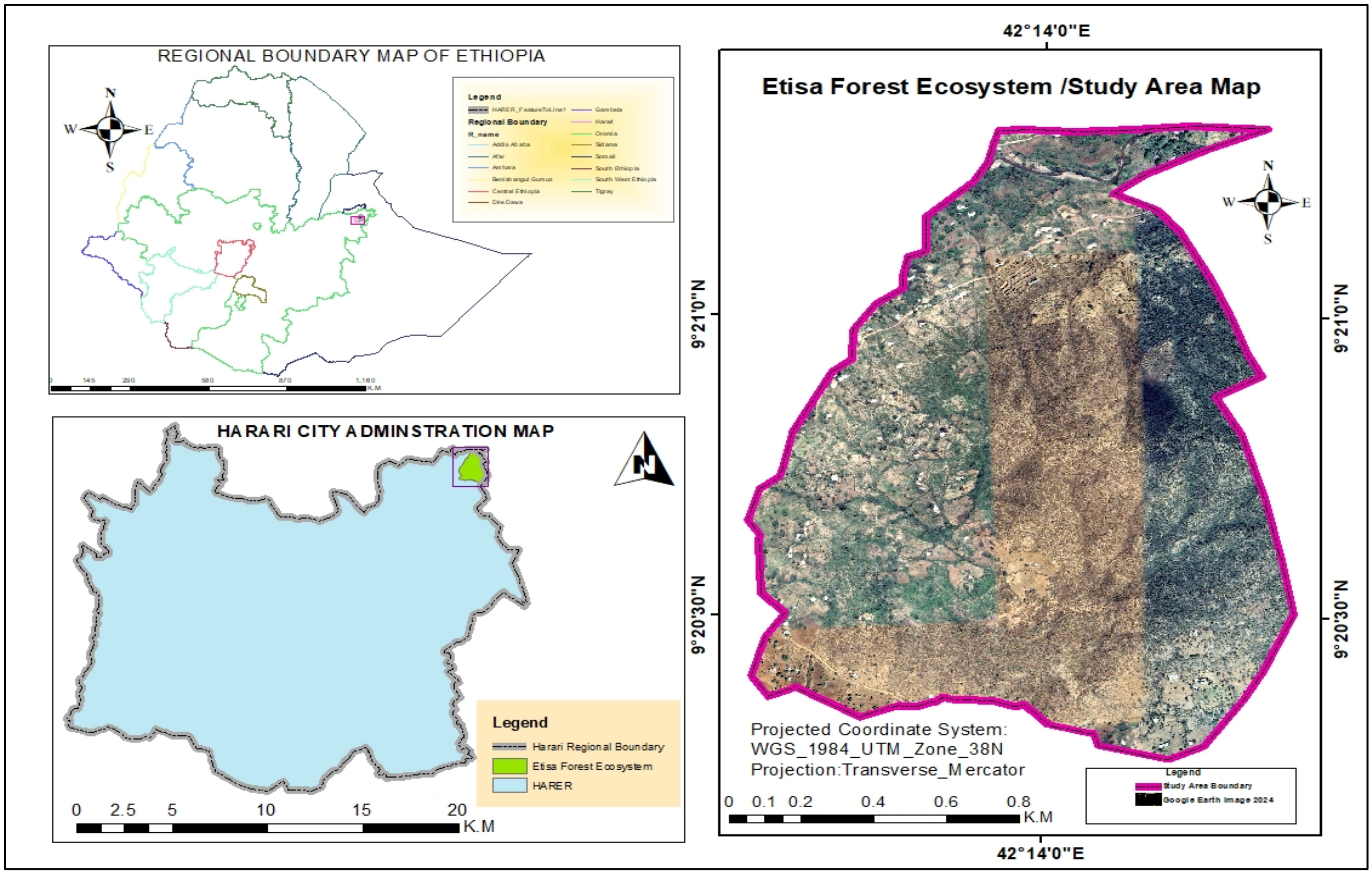

Figure 3: Location Map of Etisa Forest Ecosystem

The study was conducted in Harari Region Erer District in Etisa Mountainous forest ecosystem. Based on the location map shown in the above Etisa forest ecosystem was various vegetation covers and different land uses systems.

Land Use Land Cover Change in Etisa Forest Ecosystem

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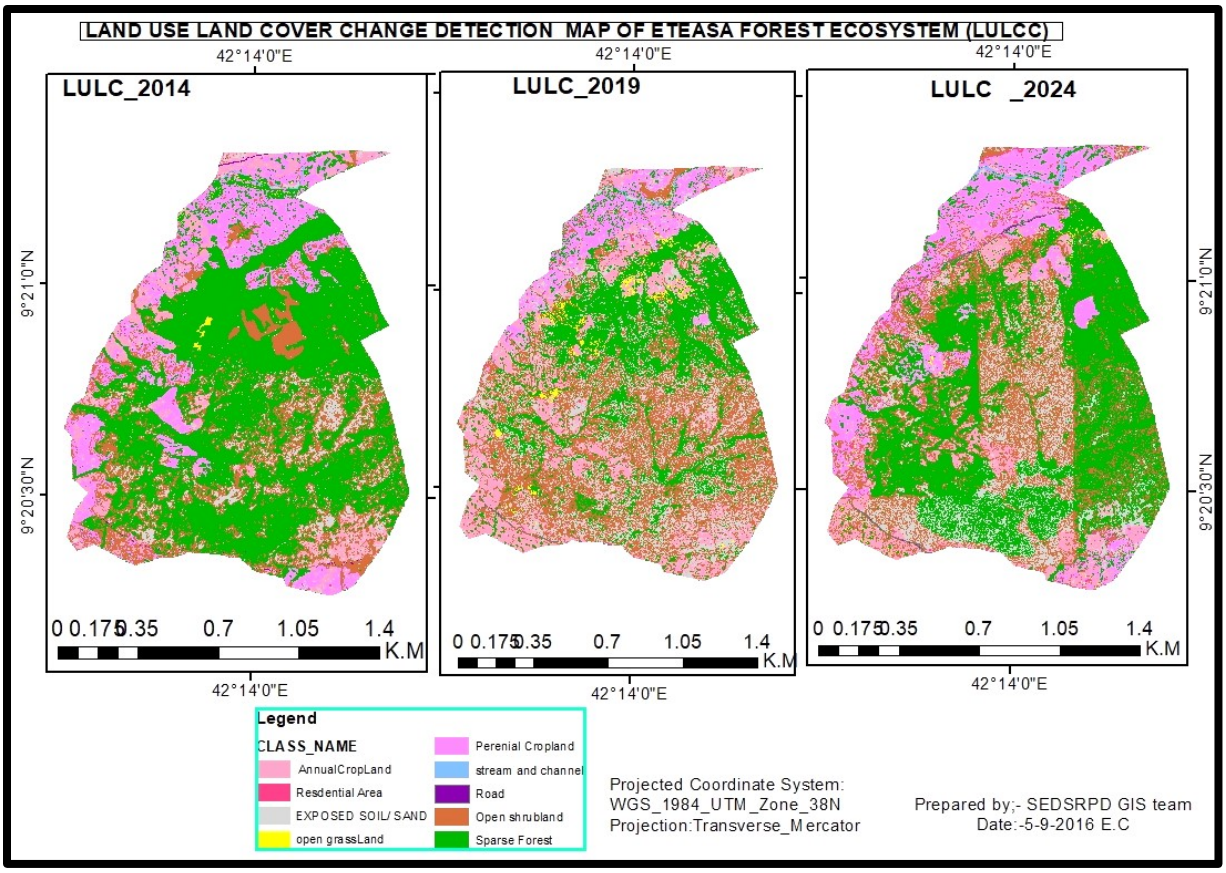

Figure 4: Land Use and Land Cover Change Detection Map of Etisa Forest Ecosystem

Source: - EPA GIS team 2024.

Table 5: Etisa Mountain Forest Ecosystem Land Use Land Cover Detection Analysis /LULCC

	Unit Of Measurement (Hectar)		
Land Class Name	2014	2019	2024
Stream and Channel	0.18	0.28	0.40
Road	0.21	0.55	0.80
Grassland	0.70	2.21	0.82
Open Shrub land	37.52	59.07	46.23
Perennial Cropland	29.10	13.59	27.61
Exposed Soil/Sand	13.42	41.45	28.39
Annual Cropland	14.46	28.82	15.56
Sparse Forest	105.11	54.36	79.87
Residential Area	0.56	0.93	1.58
Total	201.26	201.26	201.26

As indicated in the classification scheme Stream & Channel, Road, Grass land, degraded land, Open shrub land, Annual Cropland, Exposed Soil/Sand, Sparse Forest and Residential Area are the major LULC classes for the study periods. As it has been observed from the above table, Stream & Channel branches was increased 0.18ha, 0.28 ha, and 0.40 ha in 2014, 2019 and 2024 respectively because of the increment of flood the number of stream channels was raised. The construction of road was 0.21 ha in the year 2014, 0.55 ha in the year 2019 and 0.8 ha in the year 2024 this indicates road construction was increased by 0.59 ha.The coverage of grass land in 2014 was 0.70 ha, in 2019 it was 2.21 ha and also it covers 0.82 in 2024. The Shrub land coverage was 37.5 ha in 2014, 59.07 ha in 2019 and also 46.23 in 2024. The annual crops was increased from 14.46 ha to 28.82 ha from the year 2014 to 2019 but it was decline in to 15.56 ha by the year 2024 because of the crop land was changed in to forest land in the year 2019 to 2024.The sparse forest was 105.1 ha in 2014 it was reduced in to 54.36 ha in 2019 and also raised in to 79.87 ha in 2024 due to the forest plantation campaign. Whereas the residential / settlement was 0.56 ha in 2014, 0.93 ha in 2019 and also raised in to 1.58 ha in 2024.

Generally, the above table Stream and Channel, Road, Grassland Open Shrub land, Residential Area, Exposed soil and Annual cropland was increased from the year 2014 to 2024.Whereas Sparse Forest and Perennial Cropland was reduced from the year 2014 to 2024.

According to Erer District Agriculture office report, 2024 E.c, there was 14 water bodies,5557ha of Agricultural land,2250 ha forest and woodland ,900ha shrubs,213 ha settlement and also 125 ha bare land. The office also explained that the average land distribution per household for different purpose was 0.52 ha.

Figure5: The partial view of Etisa Forest Ecosystem

3.1.2. Land Degradation in Etisa Forest Ecosystem

Land degradation is a great threat for the future and it requires great effort and resources to ameliorate. The major causes of land degradation in Ethiopia are the rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production. Inappropriate land-use systems and land-tenure policies enhance desertification and loss of agrobiodiversity. Utilization of dung and crop residues for fuel and other uses disturbs the sustainability of land resources. The supply of inputs such as fertilizer, farm machinery and credits are very low. The balance between crop, livestock, and forest production is disturbed, and the farmer is forced to put more land into crop production.

Unsustainable land-use practices are other drivers of land degradation (physical, chemical and biological) with high economic costs in Ethiopia. Given the extent of the land degradation problem and a limited impact of interventions so far made both by the government and the international community, sustainable land management efforts must be scaled up to cover all the agricultural lands with effective land use policy and coordination of all stakeholders.

Addressing the challenges to land resource through the development of a suite of stronger, more comprehensive and cohesive land use policies focused on protecting and maintaining the land capital and ongoing improvements to current land management arrangements is imperative for a sustainable future.

As a response measure to the state of the land degradation and low productivity, a number of positive steps were taken in terms of community-based watershed management, soil fertility management, establishing climate resilient agriculture, and land certification. However, these measures are limited and need further scaling up.

Land, with so many livelihoods dependent on it, is a critical productive asset to accomplishing the goals outlined in the overall development vision of the country to reach a middle-income status by 2025. Therefore, integrating land tenure and land use with sustainable management is imperative. The security of tenure accorded to different social groups in the land policy needs to translate into reality on the ground (Regional SOE, 2022).

In case of chemical land degradation, In Harari region Soils in areas with large amounts of rainfall tend to be acidic because the water leaches basic cat ions—calcium, magnesium, sodium, and potassium—out of the soil profile, and these cat ions are then replaced by acidic cat ions—hydrogen and aluminium. Soil acidity can lead to elemental toxicities for plants by aluminium, iron, manganese, and zinc due to the increased solubility of these elements at low pH values. Soil acidity can cause limited availability of some macronutrients and micronutrients such as phosphorus, which binds to iron and aluminum oxides in acidic soils (Regional SOER, 2022).

According to Erer woreda Agriculture office, 2024 the proportion of land affected by rill and sheet erosion was middle level, gully erosion was high whereas stream bank and salinization was lower in the surrounding environment.

Figure 6 degraded land through road construction

According to the above figure the forest and land resources were degraded in the case of road infrastructure expansion.

3.1.3. Drivers and pressures of LULC and Land Degradation

Land use-land cover change (LULCC) is driven by the interplay of forcing factors that act at global, regional, and local levels. Previous studies investigated mainly the basic socioeconomic drivers of LULCC. However, these studies less considered climate change vulnerability as a potential driver.

According to Belew B & Eshetu Y.,(2016), The top most influential drivers of LULCC includes population growth (95%), fuelwood extraction (93%), agricultural land expansion (92%), charcoal making (92%), climate change/recurrent drought (79%), and overgrazing (71%) in descending order of percentage of respondents.

The fundamental reasons for LULC changes are identified with asset deficiency that prompted an expansion in the power of production, market openings, strategy mediation, disappointment of versatile limit and expanded defenselessness, and change in social association in asset access. This further upheld by Yirdaw et al. (2017), population pressure and unfeasible land-use rehearses came about in LULC changes and prompted declining in food uncertainty and arrangement of environment administrations, social and political precariousness and decrease in biological system's strength to common atmosphere fluctuation. The same work reveals

population growth articulated change in LULC the most recent two centuries and the progressions will go quicker later on (Roy et al., 2010). This further supported by a study conducted in semi-arid Makueni county, Kenya, population and livestock had made over-cultivation and overgrazing, as a result, increased LULC changes (Mganga et al., 2018). LULC changes greatly influence catchment hydrologic processes such as surface runoff and stream flows (Gyamfi et al., 2016). LULC change significantly impacts the productivity of rangelands. Besides, it impacts the climate and weather conditions from local to global scales (Kayet et al., 2016).

Population Growth: The demographic characteristics mainly population growth and density are indirect factors for LULC conversion through the growing needs for additional lands for farming and grazing as well as demands for tree products (fuel and construction wood).

Based on the projection made by the Central Statistical Agency of Ethiopia (CSA), in the year 2020 Harari region has a total population of 257,073, of whom 129,358were men and 127,715 women. This region is the only one in Ethiopia where the majority of its population lives in an urban area: 128,812 or 50.1% of the population are urban inhabitants. In 2007 the crude population density of Ethiopia was 69 persons per square kilometer. In the same year the gross density of Harari region was 534 persons per square kilometer. This figure is expected to reach 853 & 971 persons per square kilometer in the year 2025 and 2030 respectively. With this regard the region is the third highly populous in the country with highest population concentration in urban areas.

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), for the entire region 46,169 households were counted, which results in an average for the region of 3.9 persons to a household, with urban households having on average 3.4 and rural households 4.6 people. About 69 percent of the population is below the age of 30, indicating that the proportion of the productive age group is small and the dependent age group is large. It also indicates the potential for a further growth of the population.

According to Erer District Administrative office report, (2024), the number of population in Erer District for five Series years was increase as shown in the table below.

Table 6: The number of population in Erer District

Year (E.C)	2012	2013	2014	2015	2016
No.of population	23192	23766	24917	24884	25448
Total					122,207

Based on the above table the total number of population was 122,207 and also the number of population was mention in each year like in the 2012 it was 23192, in 2013 it was 23766, in 2014 it was 24917, in 2015 it was 24884 and also in 2016 it reaches in to 25448.The number of population was increased by the number 2256 from the year 2012 to 2016.This indicates that population increment was one of the driving factor for LULC, land degradation as well as Natural forest degradation in Etisa forest ecosystem.

Urbanization: Ethiopia has experienced the fastest rates of urbanization, and one of the major challenges of urban development in the country has been spontaneously emerging settlements, which have contributed to the country's increasing and unplanned urban growth trends, but spatial drivers for the spontaneity were overlooked. Urbanization can generally be defined as: the concentration of population whose economic activities are more diversified and non-agricultural such as service, commerce and manufacturing.

Unlike the developed countries urbanization in Ethiopia in general and Harari region in particular, is a function of rural problem / push factors / and the urban attraction / pull factors/.Due to various socio economic reasons population flux to urban areas is increasing from time to time which is also true for Harari region(Regional SOER,2022).

Rate of urbanization is the difference between urban population growth rate and total population growth rate and urban population growth rate per annual rate of change of urban population / are useful comparisons to examine degree of urbanization in a country. In the year 2007-2008 the rate of urbanization of Harari region was 0.6 percent per year and it is projected by CSA medium variant to reduce to 0.4 percent per year in the year 2025-2030. On the other hand the Urban growth rate of the region which is estimated 2.0 percent per annum in 2007-2010 is projected to decline and reach 2.00 percent per annum in the year 2025- 2030.

Deforestation

As a country, Ethiopia’s current rate of deforestation is estimated at 150,000 to 200,000

hectares per year and the FAO estimate that fertile topsoil is lost at a rate of one billion cubic meters annually.

In the rural setting, massive deforestation and degradation takes place for farming land and building houses to accommodate the increasing rural population on the same talking in Harari region the deforestation continued unabated despite plantation of bureau of agriculture every notably in Erer District and sofiworeda where plantation and mountains land are amounting to 90000 hectares, rural women cut and sale wood to urban residents in Harar in the region. According to Harari region bureau of agriculture animal and fishery development 2021 data, there are more than 16500 donkeys' out of which most of them are in Erer district with their main functions is loading wood to cities for fire consumptions there is huge food coverage despite safety net and other endeavors. There are a lot of women whose their work for living is collecting and selling woods. This has exposed the soil for wind and running erosions, thus, depleting the soil nutrients (Regional SOER, 2022). Forest products like timber and lumber are also major causes for deforestation in Ethiopia. The annual forest loss is approximately 92,000 ha/year and the gain is about 19,000 ha/year (MEFCC 2017).

3.1.4. Impacts of land use land cover change and Land Degradation

Land use/ land cover change also has impacts on local and regional climate and water resources. The LULCC also affect runoff, evapo-transpiration and surface erosion in a watershed (Esyase, 2010). The destruction of vegetation cover affects rainfall amount. For example, tree canopy and leaf litter can help reduce the impact of raindrops on the ground, hence reduce soil erosion, while roots hold the soil in place and also absorb water.

Flood

In Harari region floods seen to occur and damage notably to Erer waldiya, dodota, and hawayie peasant association and at qile overall years from 2015 to 2021

The flood occurs from end May to end of August last and damages farmers farms be annual or permanent crops, the river once over flown its inundation areas widen to be up to 1.5 ha and most of the time of its coming it changes its course from year to next and each year it goes damaging newer farmers farms around the river known as Erer river.

For example in 2021 in Erer district the flood takes away farm property belonging to 1992 householders. About 8000 eucalyptus trees, 3.54 ha lemon, 2 hectares papaya, 5 hectares of mango. 11 ha of khat, 27 ha of elephant grass of forage 12.5 ha of pepper, 2.7 ha of tomato, 18 ha banana, and 145 ha of sugarcane 20 ha sorghum and 65 ha of maize have been uprooted and taken away with floods.

The damage of flood notably in low land Erer continued its damage on farmer's farm property on the one hand the farmers plough river banking sites as there is shortage of farms, on the other hand the flood is so huge and its way is also as vast as 1.5 ha in width to bridge it with canals. Farmers are also planting ones the flood passes away in areas they assume to be theirs and the damage perpetuate from year to next.

This flood comes through Erer River and goes about 17 kilometres in these damage areas on its way from hilly neighbouring districts as both forests to reduces rain splashes and soil bunds on mountainous are minimal the flood comes with force and uproots even big trees like mango and takes away all in its course of passages (Regional SOER,2022).

Vulnerability to climatic change

Vulnerability to climate change differs substantially across regions. In this region, communities and even households, and the communities that are most vulnerable to climate change also face poverty, health disparities, and other social inequities. Recognizing that, these socio-economic challenges impede the resilience, health, and prosperity of community.

3.1.5. Response measures in improving the status of land use land cover change and Land Degradation

In order to reduce the degradation of land resource around Etisa Forest ecosystem the local community practice soil and water conservation measures.

Figure 7: Degraded land modified due to conservation measures

Figure 8: Watershed activities in the lower catchment of residential area

3.1.6. Outlooks

The medium variant projections of CSA indicate that in 2030 the population of Harari region is estimated to exceed 333,407. As the population continues as this rate resource scrambling as well as forest degradation increases highly, and also the weather condition totally changed into desert, so the existence of live in that area will very difficult.

3.2. State and Trend of Forest Fauna and Flora on Etisa Forest Ecosystem Errer Woreda

The earth is granted with so much diversity in uncountable forms, which is important for our very existence on the planet. The variety of genes, species, and ecosystems are various components of biological diversity, which is important to mankind for various reasons. This includes the source of food, timber, medicines, fiber, etc., support functions, such as flood control, climate regulation, and nutrient cycling, resilience to disturbance and environmental change, source of pollinators and pest control in agriculture and), carbon storage and sequestration, economic, recreational, human health benefits, and social contributions.

The health of the ecosystems on which we depend and on which all other species depend is degrading today at an unprecedented rate. This situation weakens livelihoods, food security, health, and quality of life worldwide, and poses economic and financial risks. This is particularly significant for countries and people that are heavily dependent on natural resources and biodiversity for subsistence needs. Ethiopia's landscape includes a large highland area of mountains and separated plateaus, divided by the Rift Valley, which runs northeast to southwest and is surrounded by lowlands, steppes, or semi-desert. This large diversity of terrain has led to wide variations in climate, soils, and natural vegetation and thus to unique biodiversity and high endemism. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, of which about 15 percent are endemic. It has been said that Ethiopia is the fifth largest floral country in tropical Africa.

The country is also rich in its fanatic diversity. The larger mammals are mainly concentrated in the south and southwest border and adjacent areas of the country. Mountain massifs in the north are also home to many endemic species of mammals, particularly the Walia Ibex, Semen Fox, and Gelada Baboon. About 277 species of mammals, 861 species of birds, 201 reptile species (over 87 snakes, 101 lizards, and 13 species of tortoises and turtles), 145 species of freshwater fish, of which over 87 species are from Baro River and 16 from Lake Abaya, 324 butterflies and 63 species of amphibians are known from Ethiopia.

Ethiopia is endowed with unique ecosystems and biodiversity that provide considerable contributions to people at local, regional, national, and global levels. A great proportion of these biodiversity and ecosystem services are mainly prevailing in the forest and woodland ecosystem of the country. The livelihoods of most of the people in the country are highly interlinked

directly or indirectly with forest resources. It plays enormous environmental, and socio-economic significance and thereby contributes a great role in the sustainable development of the country as well. Forests and woodlands play vital roles in ensuring food security and sustainable livelihoods for millions of households throughout Ethiopia. According to a study report (UNEP, 2016), Ethiopia‘s forests generated economic benefits in the form of cash and in-kind income equivalent to USD 16.7 billion, or 12.9% of the measured value of GDP in the year 2012-13. Recent estimates indicate that about 26-30% of the total coffee production of the country originates from wild and semi-managed coffee forests and the value of wild coffee is estimated at USD 130 million/annum (Tesfaye, 2006; Lemenih, 2009). Furthermore, Since the 1960s, much effort has gone into designating protected areas in Ethiopia with the hope of saving areas of crucial importance for biodiversity conservation. However, most of the forest fauna and flora resources of Ethiopia are highly exposed to degradation at an alarming rate. A century ago, forests covered about 40 % of the total landmass of the country. The spatial pattern of the forest has shown a rapid decrement from 40% in 1900 to 16% in 1954, 8% in 1961, 4% in 1975, and 3.2% (Journal of Resources Development and Management, Vol.67, 2020) and now it is estimated to be 17.35 million ha 15.7% (EFCCC 2015). The major drivers of forest cover decline can be grouped as proximate driving factors and underlying driving factors in Ethiopia. Proximate driving factors include; expansion of resettlement, expansion of agricultural practices, and charcoal burning and cutting trees for fuel whereas, underlying driving factors include; economic, institutional, technological, cultural, demographic, and biophysical factors. The alarming rates of forest fauna and flora degradation have been posing environmental, social, and economic problems. The environmental implications of forest degradation are climate change, siltation of water bodies, degradation of wetlands, soil erosion, and a reduction in agricultural production and eradication of draught.

The study was conducted in the Harare regional state's eerier woreda etesian forest ecosystem. The total forest ecosystem area is estimated to be 2,250 ha shrubs and bushes 900 ha and the plantation of forests is 1,550 ha of land. It contains different forest flora and fauna species from those species the natural forest flora is dominant in the ecosystem.

The data was collected from primary sources, including field visits (FGD) of four surrounding kebeles, key informants with Keble administrators and development agents(DA) while

Secondary data was gathered from published documents, region and woreda reports, and Landsat images to understand the impact of forest cover change and deforestation.

Definition Key terms

- ✓ ***Biodiversity:*** The Convention on Biological Diversity (CBD) defines 'biological diversity' as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems" (CBD, 1992).
- ✓ The Millennium Ecosystem Assessment and TEEB 2004 (The Economics of Ecosystems and Biodiversity) demonstrated that biodiversity underpins ecosystem goods and services that are required for the survival of human societies and the future of all life on the planet. In addition, biodiversity generates considerable economic value through the provision of goods such as food, water, and materials, and services such as climate regulation, pollination, disaster protection, and nutrient cycling.

- ✓ ***Drivers***: Drivers are external factors that affect nature, and, as a consequence, also affect the supply of Nature Contributions to People (NCP). Drivers of change include indirect drivers (all anthropogenic: here Drivers) and direct drivers (both natural and anthropogenic: here Pressures) (IPBES, 2019).
- ✓ Pressures- are human activities that induce changes to the environment, for instance, the discharge of chemical, physical, or biological agents, or land use changes. The intensity of the pressures depends on the technology and extent of activities that vary across geographic regions and spatial scales (Bradley & Yee: 2015).
- ✓ State- refers to the physical, chemical, and biological components of the natural environment (i.e. the living and non-living components).
- ✓ Impacts- are the resulting changes in the quality and functioning of the ecosystem that influence living things including the production of ecosystem goods and services.
- ✓ Responses- are actions taken through policies and regulations to prevent, compensate, ameliorate, or adapt to changes in the state of the environment

- ✓ ***Threats:*** Following Salafsky et al. (2008), threats were defined as "the proximate human activities or processes that have caused, are causing, or may cause the destruction, and/or impairment of biodiversity targets (e.g. unsustainable fishing or logging)." Direct threats are the proximate human activities or processes that have impacted, are impacting, or may impact the status of a tax.

The forest is defined as land occupied with trees (natural and planted, including bamboo) attaining a height of more than 2 meters at maturity, a canopy cover of more than 20%, and covering an area of more than 0.5 ha, with a minimum width of 20 meters (MEFCC 2018).

This forest definition differs from the definition used for international reporting to the Global Forest Resources Assessment (FAO) and from the forest definition used in the National Forest Inventory which both applied the FAO (2015) forest definition with the thresholds of 10% canopy cover, a 0.5 ha area, and a 5 m height. The reason for Ethiopia to change its national forest definition is to better capture dry and lowland-moist vegetation resources. In specific, the reason for lowering the tree height from 5 to 2 m is to capture Termilania-Combretum dense woodlands found in Gambella and Benishangul Gumuz Regional States which in its primary state consists of trees reaching a height of around 2-3 m and above (MEFCC 2016).

Benefits of forest flora and fauna

Biodiversity provides many valuable goods and services for nature's contributions to people. Forests play vital roles in ensuring food security and sustainable livelihoods for millions of households throughout Ethiopia and shelter and food for wild animals. Forest biodiversity provides ecosystem services estimated at 4% of the GDP through the production of honey, forest coffee, natural gums, and timber (IUCN, 2019. Forests also contribute to the economy even if it is with non-marketed products for example through i) soil erosion control which reinforces water infiltration in soils (that is crucial to reload groundwater reservoirs), ii) wood (energy) for households iii) mitigating climate change through Carbon sequestration, iv) recreational (cultural) services for the people, etc. as a source of income generation used as a shelter for wild animals.

The following categorization of ecosystem services has been used by the Millennium Ecosystem Assessment (MEA)

1. **Provisioning services** – ecosystem services that combine with built, human, and social capital to produce food, timber, fiber, or other "provisioning" benefits. For example, fish delivered to people as food require fishing boats (built capital), fisherfolk (human capital), and fishing communities (social capital) to produce.

2. **Regulating services** – services that regulate different aspects of the integrated system. These are services that combine with the other three capitals to produce flood control, storm protection, water regulation, human disease regulation, water purification, air quality maintenance, pollination, pest control, and climate control. For example, storm protection by coastal wetlands requires built infrastructure, people, and communities to be protected. These services are generally not marketed but have clear value to society.

3. **Cultural services** – ecosystem services that combine with built, human, and social capital to produce recreation, aesthetic, scientific, cultural identity, sense of place, or other "cultural" benefits. For example, to produce a recreational benefit requires a beautiful natural asset (a lake), in combination with built infrastructure (a road, trail, dock, etc.), human capital (people able to appreciate the lake experience), and social capital (family, friends, and institutions that make the lake accessible and safe). Even "existence" and other "non-use" values" require people (human capital) and their cultures (social and built capital) to appreciate.

4. **Supporting "services"** – services that maintain basic ecosystem processes and functions such as soil formation, primary productivity, biogeochemistry, and provisioning of habitat. These services affect human well-being indirectly by maintaining processes necessary for provisioning, regulating, and cultural services. They also refer to the ecosystem services that have not yet, or may never be intentionally combined with built human, and social capital to produce human benefits but that support or underlie these benefits and may sometimes be used as proxies for benefits when the benefits cannot be easily measured directly.

FLORA AND FAUNA IN ETESIA FOREST ECOSYSTEM

Ethiopia is a rich biodiversity country with diverse ecosystems ranging from humid forests to deserts. Its flora is diverse, with 6,500-7,000 species, with 15% being endemic. Ethiopia is the fifth largest floral country in tropical Africa. Flora and fauna interact to form ecosystems, with flora using carbon dioxide for oxygen and fauna producing carbon dioxide.

Table 1. Flora (plant) Species are found in the forest ecosystem.

R.no	Scientific name	Amharic name	**Remark**
1	Acacia abyssinica	ቆንጥር	
	Grevillea robusta	ግራቪሊያ	
2	Accacia lbida	ግራር	
3	Accacia brevispica	ቀንጠፋ	
4	Croton macrostachyus	ብሳና	
	Millettia ferruginea	ብርብራ	
5	Mill	ወፍቆሎ	
6	Carba edulis	ጫት	
7	Celtis Africana	አምላቃ	
8	Cordia Africana	ዋንዛ	
9	Olea European	ወይራ	
10	Cyperus digitus	ፊላ	
11	Diospyros abyssinica	ሰለቸኝ	
12	Croton macrostachyus	ብሳና	
13	Ehretia cymosa	ኡላጋ	
14	Ficus Vasta	ዋርካ	
15	Eucalyptus amaldulensis	ቀይባርዛፍ	

Table - list of fruits

No	Scientific name	Amharic name
2	Rhamnus prinoides	ጌሾ/Gasho/

3	Banana	ሙዝ
4	Mangifera indica	ማንጎ
5	Sweet orange	ብረቱካን
6	coffee	ቡና
7	Lemon	ሎሚ
8	Psidium guava	ዘይቱና
9	Avocado	አቮካዶ

Source: woreda administration

Table2. Faunal species are found in the area.

No	Scientific name	Amharic name	Remark
1	Columbus Monkey	ጉሬዛ	
2	Hyena	ጅብ	
4	Tiger	ነብር	
5	Common Bushbuck	ድኩላ	
6	Klipspringer	ሰስ	
7	Warthog	ከርከሮ	
8	Bush Duiker	ሚዳቋ	
9	Jackal	ቀበሮ	
10	Monkey	ዝንጀሮ	
11	Mongoose	ሸለመጥማጥ	
12	Vervet Monkey	ጦጣ	

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8	Bush Duiker	ሚዳቋ	
9	Jackal	ቀበሮ	
10	Monkey	ዝንጀሮ	
11	Mongoose	ሸለመጥማጥ	
12	Vervet Monkey	ጦጣ	

Source:-from filed observation 2024

Table 1 Eteasa Forest Ecosystem Land Use Land Cover Detection Analysis /LULCC

Land Class Name	Unit Of Measurement Hectare		
	2014	2019	2024
River	0.18	0.28	0.40
Road	0.21	0.55	0.80
Grassland	0.70	2.21	0.82
Open Shrub land	37.52	59.07	46.23
Perennial Cropland	29.10	13.59	27.61
Exposed Soil/Sand	13.42	41.45	28.39
Annual Cropland	14.46	28.82	15.56

Sparse Forest	105.11	54.36	79.87
Residential Area	0.56	0.93	1.58
Total	201.26	201.26	201.26

source- LULCC 2024

Drivers and pressures of forest flora and fauna on the forest ecosystem.

The major causes of biodiversity decline are natural land use changes, pollution, and changes in atmospheric CO2 concentrations, The causes of human-induced loss of biodiversity are the fragmentation, threat of fragmentation degradation or loss of habitats, the over-exploitation of natural resources; pollution of air and water (by several activities such as agriculture); the introduction of non-native (alien, or exotic) species and climate change induced biodiversity loss, (Shibru Tedla and Kifle Lemma, 1999).

The Millennium Ecosystem Assessment identified five major drivers of biodiversity loss: pollution, invasive alien species, climate change, overexploitation, and habitat change. These drivers continue to be the main causes of biodiversity loss, with over 80% of vulnerable species threatened by habitat loss, 70% by overexploitation, and 30% by invading alien species. The analysis reveals that pollution affects 10% of threatened species and climate change less than 20%, despite these factors being relatively new. Direct and indirect driving Deforestation and forest degradation are caused by factors such as increased agricultural activities (tree removal and burning, overgrazing), fuel wood and charcoal, and resettlement expansion programs (Walle et al. 2011; Oljirra 2019). Deforestation in Ethiopia is primarily caused by agricultural practices, logging, and urban resettlement. Factors like invading species, insect pests, new settlements, overuse of resources, and logging pose significant challenges to the country's forest fauna and flora ecology. The degradation of Ethiopia's forests is largely caused by the need for wood fuels. Even though the contribution of firewood to forest degradation is doubtful, charcoal is the most popular energy source for cooking in cities, and it is commonly acknowledged that livestock

grazing on forest flora and animals also contributes to forest degradation (Zerga & Gebeyehu 2016).

Source – filed photo 2024

The main drivers and pressures of etiesa forest ecosystems:

The DPSIR model, a systems-thinking framework, is utilized in environmental management to understand complex environmental issues by examining the cause-and-effect relationships between social, economic, and environmental components (Bradley and Yee (2015).

Population growth: with an increased population, there would be more families in search of land for agriculture or looking for fuel wood, or timber (Contreras-Hermosilla 2000). Population growth is a major cause of forest decline, as it leads to increased deforestation and demand for land for agriculture and fuel wood. This growth affects the environment through land productivity, gully formation, groundwater loss, outbreaks of draughts, community conflicts, and

rapid urbanization. It also leads to a decrease in forest flora and fauna, increasing demand for land.

The demographic trend Errer woreda shows increased year to year from the last 5 years population trend indicated in 2012 both male and female populations 23,192 now reached 25,448. As a result of population increment new perennial crop areas increased from116.4 ha to 357.8ha by 259.8 ha and residential areas from 27.74 ha to 66.54 ha by 38.8 ha. Many FGD and key informant respondents indicated population growth as the main factor of change in etesia forest ecosystems.

2. Land tenure system and weak land use policy: land privatization is a topic of considerable disagreement in Ethiopia. The government owns all forest and agricultural land, granting usufruct rights to citizens in the case of farmland and maintaining all management authority in the case of forestlands (Guillozet et al. 2011). Uncertain land tenure systems leading to low investment, including lack of ownership, trigger illegal logging, and the so-called tragedy of the commons (Assefa & Bork 2014). Likewise, weak policy implementation on land use, low capacity of forest institutions, land use conflict, and policy discrepancies aggravate forest cover loss in Ethiopia (Moges et al. 2010). The lack of responsibility among local populations for common forest resources leads to unenforced forest laws and regulations. To protect natural forests sustainably, communities need to gain the power to utilize and protect resources. There is no clear ownership over the forest ecosystem and how to manage and utilize the resources sustainably. Every individual or person enters into the forest ecosystem and then extracts the flora and fauna of the ecosystem from what they went.

3. Institutional factors:

The underlying driving factors of forest cover change in the area include: competing for jurisdictional authority over activities affecting the forest ecosystem weak enforcement capacity; inexperience in enforcing reforestation regulations, and unclear tenure arrangements and boundaries. Ethiopia's land privatization debate revolves around the government's ownership of forest and agricultural land, leading to low investment and illegal logging. The system is also exacerbated by weak policy implementation, low capacity of forest institutions, and policy discrepancies as a result of this etiesa forest ecosystem, which is degrading alarmingly. Forest logging, whether legal or illegal, leads to deforestation. Ethiopia loses about 141,000 hectares of

natural forests each year due to firewood collection, conservation of farmland, overgrazing, and the use of wood for building materials (Oljirra 2019).

5. Invasive alien species (IAPS):

Is one of the major drivers of forest biodiversity loss, thereby altering ecosystem services and socio-economic conditions through different mechanisms? Invasive alien species are animals, plants, fungi, and microorganisms that have entered and established themselves in the environment from outside of their natural habitat. They reproduce rapidly, out-compete native species for food, water, and space, and are one of the main causes of global biodiversity loss at the same time in the Etiesa forest ecosystem there are different types of Invasive alien species. Namely, Prosopis juliflora and Parthenium spp. in the ecosystem resulted from the displacement of native vegetation and fauna, affecting rangeland quality and human livelihoods.

Overgrazing of animals: The grazing animal moves to the grazing ecosystem they tend to exert considerable pressure on the surface, which affects the soil, grass/vegetation, and also planted seedlings. Overgrazing and free grazing are common in the ecosystem this resulted in habitat changes (e.g., grassland to bushland), resulting in declining populations or local disappearance of many grazer wildlife specie

Residential/villagers:

Expansion of settlement is common across most of the protected areas of the forest ecosystem and unprotected areas in Ethiopia. It directly affects wildlife through habitat loss, fragmentation, blockade of movement corridors, and disturbance (IBC, 2005; Tessema et al., 2019). In this regard, the Etiesa forest ecosystem rural settlement is increasing at an alarming rate by deforesting the forest area. There is furthermore, the presence of contact of humans within and around protected areas.

Agricultural expansion: The economic growth in the agricultural sector, on the other hand, is partly attributed to yield increment and partly to the expansion of agricultural land (EBI, 2014a) Ethiopia's agricultural sector has experienced economic growth due to yield increments and land expansion. However, deforestation rates have increased due to small-scale farmers' demand for arable land. The community of Erer Woreda is dependent on agricultural activities as a result of this the cropping area is increased by 259.8 ha of new Land.

Logging and Wood Harvesting:

Deforestation for charcoal making and fuel wood are also the main threats to forests and woodlands, especially in the Rift Valley region (Mckee, 2007; Vreugdenhil et al., 2012). The FGD participants explained that the forest ecosystem is one of the energy sources for rural as well as urban communities. Tree Cutting: is a major threat to the Etiesa forest ecosystem where people practice it for charcoal making, timber production, and household fuel wood consumption and also for income generated or as a source of income. The demand for raw materials for construction and fuel/domestic energy for all rural and local town inhabitants is very high. As a result of this ecosystem forest flora and fauna are decreased from time to time.

Impact of the degradation of forest fauna and flora in Etiesa forest ecosystems

1. habitat destruction and fragmentation

In Etiesa forest ecosystem habitat loss and degradation are caused by deforestation, agricultural expansion, overgrazing, population growth, and invasive alien species pose significant threats to local species extinction, shortage of groundwater, soil erosion, shortage of animal forge, variability of rainfall, outbreak of draught and economic impact on local communities. For example, Zebra, warthogs and the forest flora Podocarpus falcatus, Cordia africana, and Juniperus procera are highly threatened tree species in the area. Because of such forest ecosystem degradation, some flora and fauna species are becoming locally endangered, and the residential communities are economically affected (exposed to poverty).

2. climate change; as a result of deforestation and land degradation forest clearance is high on the site there is rainfall variability, shortage of rainfall, reduced productivity, draught, occurrence of animal diseases, and malaria.

3. Over-exploitation: both fauna and flora of the ecosystem resources are exploited. There is a high rate of soil erosion, loss of soil fertility, decrement of land productivity, drought, and unemployment of youth and women and soon are widely seen.

2. Land use land covers change of forest ecosystem

Perennial crop area, annual Cropland, and exposed soils increased 259.8 ha, 14.36 ha, and 28.03 ha respectively.

Declining of forest area by 25.24ha low faunal and floral populations, their flow, and their movement.

3. Direct loss in the form of the removal of trees: approximately 372.17 ha of trees and shrubs removed, which might have a significant effect on the current ecosystem:-

The loss of trees will lead to a higher degree of soil erosion.

The loss of trees will reduce the ambient air quality since trees act as adsorbents of air pollutants, thereby improving the air quality.

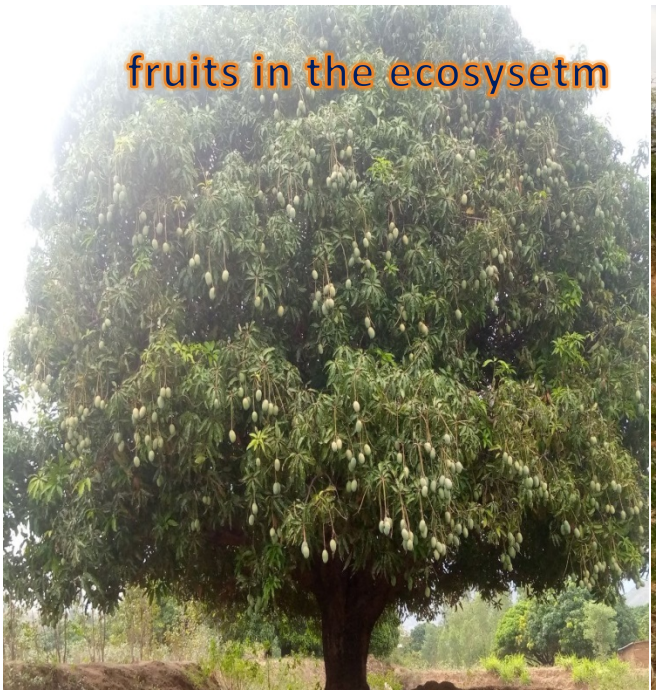
Loss of such large numbers of trees may affect the ecosystem severely in the form of a change in the microhabitat.

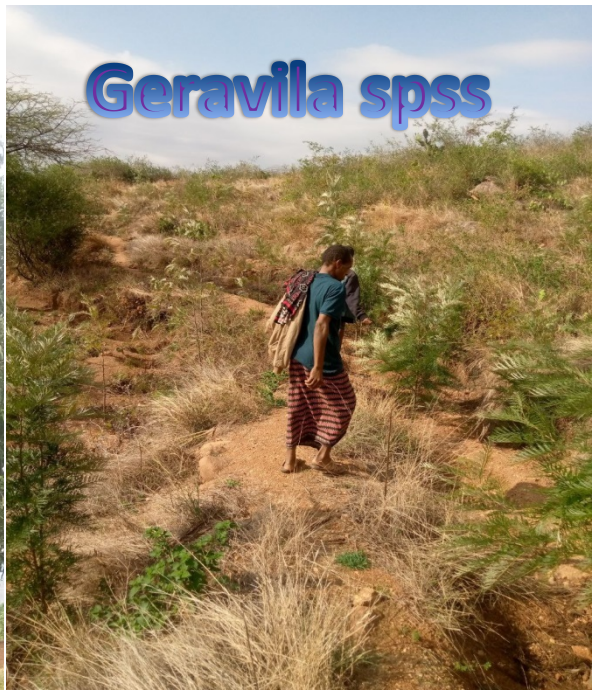
Loss of diversity in agroecosystems increases their vulnerability and thus reduces the sustainability of many production systems.

4. Expansion of Invasive Alien Species: the rapid expansion setraga invasive alien species into the forest ecosystem was another prevailing impact, as confirmed by FGD and key informants as a result of invasive alien species different endemic flora species are threatened. Loss of Indigenous plant and animal species: FGD participants explained that there were numerous plant and wild animal species in the Etiesa forest ecosystem. Currently, plants such as Kamo, Enkoko, Zegba, warka, and koso are disappeared whereas animals like Leopard, keye kebero, dekula, asama, and kerekero are extinct.

5. The variability in amount and distribution of rainfall: FGD participants perceive that the distribution of rainfall was decreased from year to year. Due to this problem, the growing season was changed and correspondingly the temperature was raised highly.

Source from filed photo 2024 -overgrazing and impacts of ecosystem degradation





Source filed photo 2024 ecosystem afforestation

Response taken to improve the status of the etiesa forest ecosystem.

To maintain the ecological balance and reverse forest fauna and flora degradation, all actors communities, governmental and non-governmental organizations, farmers, and private sectors must take an inclusive responsibility.

Awareness Generation**:** for the reason that for human capital to function effectively, both knowledge and technical skills are prerequisites. Therefore, it is recommended that residents and other stakeholders be given access to information about the various plant and animal species, their significance to human society, the environment, and the economy, as well as the ecological processes.

Enhanced Women's participation in conservation and protecting techniques- affects rural men and women's knowledge and how they use it. This includes access to or control over resources and biodiversity, as well as education, training, information, and control over the rewards of production. To ensure the sustainable use of plant and genetic resources, women frequently take the lead in local plant variety selection and development, as well as in seed exchange and management.

Strengthen Soil and water conservation activities and watershed management practices

Land degradation is one of the major challenges in agricultural production in the ecosystem. To prevent the issue of the problem several soil and water conservation methods were introduced to combat forest ecosystem degradation. In the ecosystem, different SWC activities have been practiced from the last 10 years up to now by mass mobilizations like bench terracing, stone terracing, different pits, and also biological measures(planting of different seedlings and afforestation activists was done. so this activity should be going on always to conserve and rehabilitate the ecosystem.

- **Habitat Management or area closure:** both regulatory (for human actions) and habitat management practices, including work devices, need to be utilized for managing and improving habitats by fencing along roadside habitats free from animals and human beings.
- Strengthening government institutions and their management bodies or decision-makers concerned with ecosystems.
- Biodiversity mainstreaming and integrating biodiversity considerations into policies and practices of public and private actors, ensuring its persistence across entire landscapes.

Source from the filed 2024 -SWC activists in the ecosystem

Source -filed photo 2024

Outlook

According to the data obtained from, primary and secondary data, GIS, and land use land cover change detection 2024 the forest ecosystem coverage varies depending on land use land cover change for example annual crop area increased from 14.46 ha to 28.82ha in 2019 and declined to wards 15.57ha in 2024, Exposed soil area increased from 13.42ha to 28.39ha by 46.59% but the forest coverage of the area decreased from 105.11ha to 54.36ha in 2019 and now 79.87 ha in 2024 there are different infrastructures around and on the ecosystem like road leads to forest deforestation.

So the forest ecosystem management continued business as usual for the next 30 years the forest coverage decreased by 37.86 ha 36% which shows that its forest coverage is around 41 ha. Parallel soil exposure also increased by 22.456 ha and reached 50.846 ha. The other land use type like a residential area and annual cropland also increased annually. Population growth would likely continue as the main driver of land-use/land cover change and urbanization would likewise increase. The protected areas will continue to be encroached on by local communities in response to the growing shortage of cultivable and grazing lands.

There for all concerned stakeholders and actors should be:

- Strengthening Green Legacy Initiative:

The „green legacy" initiative contributed to the planting of billions of trees across the country and is growing to an annual activity. The aims for land degradation neutrality and in line with the global goal to restore 350 million hectares of degraded and deforested landscapes by 2030.

- Strengthening the integrated watershed management activities and sustainably using the natural resources.
- They have to work with integration
- Continuation of the integrated soil water conservation activities
- maintaining the sustainability of what has been done
- police and strategy option
- Public awareness of ecosystem services and its management

3.2. Water

Fresh water is the most important natural resource in all socio-economic development endeavors and indispensable input for environmental management. It is an important component of every type of environment where life is found. Successful management of the environment, therefore, can never be achieved in isolation from appropriate management of water resources. Water is a product of the environment, and vice versa, as it comes as rain from the environment and goes through land, which is the major component of the human environment and ends up in the sea or

in the land. Managing water is thus intimately linked with managing the environment—all terrestrial, aquatic and atmospheric resources including human welfare. Based on the bond between water resources and the environment, integrated water resources management is gaining paramount importance worldwide. In pursuit of integrated solutions, it is observed that decision-makers and planners tend to be oriented towards the management of water while preserving the environment through appropriate legal tools and sustainable actions of development. Integrated management of water resources entails coordinated development of water, land and related resources to maximize socio-economic benefits and preserve the sustainability of the ecosystems.

This study was conducted in Erer districts in Etisa Forest ecosystem to get sufficient data about the main drivers, pressures, impacts and responses for those degraded forest ecosystem.

The groundwater potential of the region in general is very poor. This is attributed to the unfavorable geologic material of the region. The eastern, south-eastern, north-eastern and some parts of the western and south-western parts of the Harari Region area are covered by Precambrian Rocks such as granite, granite gneiss and other high metamorphic rocks. Local shallow groundwater potential can be found in alluvial deposits along the major rivers. In the rift valley outside Harari Region, thick sedimentary deposits are present with high groundwater potential. Ground Water resource is the only source of water supply for the urban dwellers of the City and the main for the rural community.

3.3.1. State and Trends of fresh Water resource around Etisa Forest Ecosystem

Harar was one of the first town to get piped water supply in Ethiopia about 120 years ago using “SOFI” spring as a sources (10 l/s), by a family called Haji Abrahim Abdela Muslimano and his son Ahmed Bomba "Hajji Bomba. “. The pipe line system get renewed by a new pipe purchased by the regional government in1989 E.C, then The sofi spring system was backed up during the Italian occupation of 1936 by constructing 100 m3 at Feres-megala that includes developing of springs Jinela Alta, Jinela Basa with the constructions of 600 m3 at Jenila , 600 m3 at Niguss-shira and 100 m3 reservoirs at Tassinary (Medfe Metekosha) and connecting these reservoirs by a series of 125 /150 mm diameter asbestos cement pipelines(Regional, SOE,2022).

Lake Haremaya 1959 EC: as the population increased and some of the spring sources dried up, the Haremaya water treatment plant system with capacity of 60 l/s (5000m3 /day) was developed in 1966 from the Lake Haremaya as a source for Harar, Haremaya and Aweday towns with a total population of 70,000 for design period of 30 years. Due to highly overexploitation of the lake with increased irrigation activity around the Lake and siltation, as well as climate change impact, the lake dried up on the year 2004, and the lake field was totally turned into grazing land, though it is recovering now since last year and now it has some amount of water.

Immediately as emergency, Harari Regional Government has developed 5 emergency wells with a capacity of 5-10 l/s was developed by Pipe foundation finance by the regional government, near to the Lake area called Ifabate, additionally the Oromia Water Bureau has developed two wells in the same area to solve the most horrific danger encountered. The water is collected by collector pipe laid by HWSSA to the 75 m3 Reservoir then pumped to existing Haremaya 200 m3 reservoir. Still the system is serving for the Haremaya and partial Harar towns (Regional, SOE, 2022).

Harar Water Supply and Sanitation Project 2003 initiated to resolve the water problem as a long term solution, with first attempt to have a study on surface water harvesting dam construction that was rejected due to high investment cost. The Federal Government has financed a supplementary study which investigates possibilities further away from Harar at any radius with the priority for ground water and identified a high yielding well field at Hasseliso 80 km from Harar and another well field at Hurso 12 km from Hasseliso. Drilling and development of wells was carried out in Hasseliso, out of which 8 BH with capacity of 18 l/s were selected as productive wells and 4 additional wells with capacity of 45 l/s were developed at Hulahulu area 1 km away from Hasseliso, which is still the main source but most of the wells are replaced due to ground water depletion and dried up. The Utility, realizing the unreliability of this water system due to high operation cost and management coupled with the political unrest additional system as a reinforcing option was designed at Errer ground water supply system, which is in the regional boundary and at the Errer valley that flows to Wabi-shebele Transboundary River.

Harari town in Ethiopia is getting water from 3 ground water sources which lie outside of the regional boundary of the target area. This causes administrative and social challenges for the town’s water supply. Additionally, around 12% of the population practice open defecation and many don’t have access to improved sanitation. The Skybird micro project implemented by the

Ethiopian Red Cross Society (ERCS) Harari Regional Branch aimed to connect HHs to the existing water lines and build communal latrines. Under the Skybird micro project, 100 households, most of which women headed, were able to get access to pipe water and entered agreement with the utility (Harari Water Supply & Sewerage Authority (HWSSA). Water pollution is an immense set of unwanted effects upon water bodies such as lakes, rivers, oceans and groundwater that caused by human activities. This matter requires urgent attention, since water is scarce. This important resource needs detailed scientific research all over the world in order to sustain and keep the water resource from pollution and for its wise utilization. However, no water in nature is absolutely clean. Even as it rains, the precipitation is interact with solid dissolved salts and aerosols in the air prior to reaching the ground, running on the surface and finally percolating through the ground

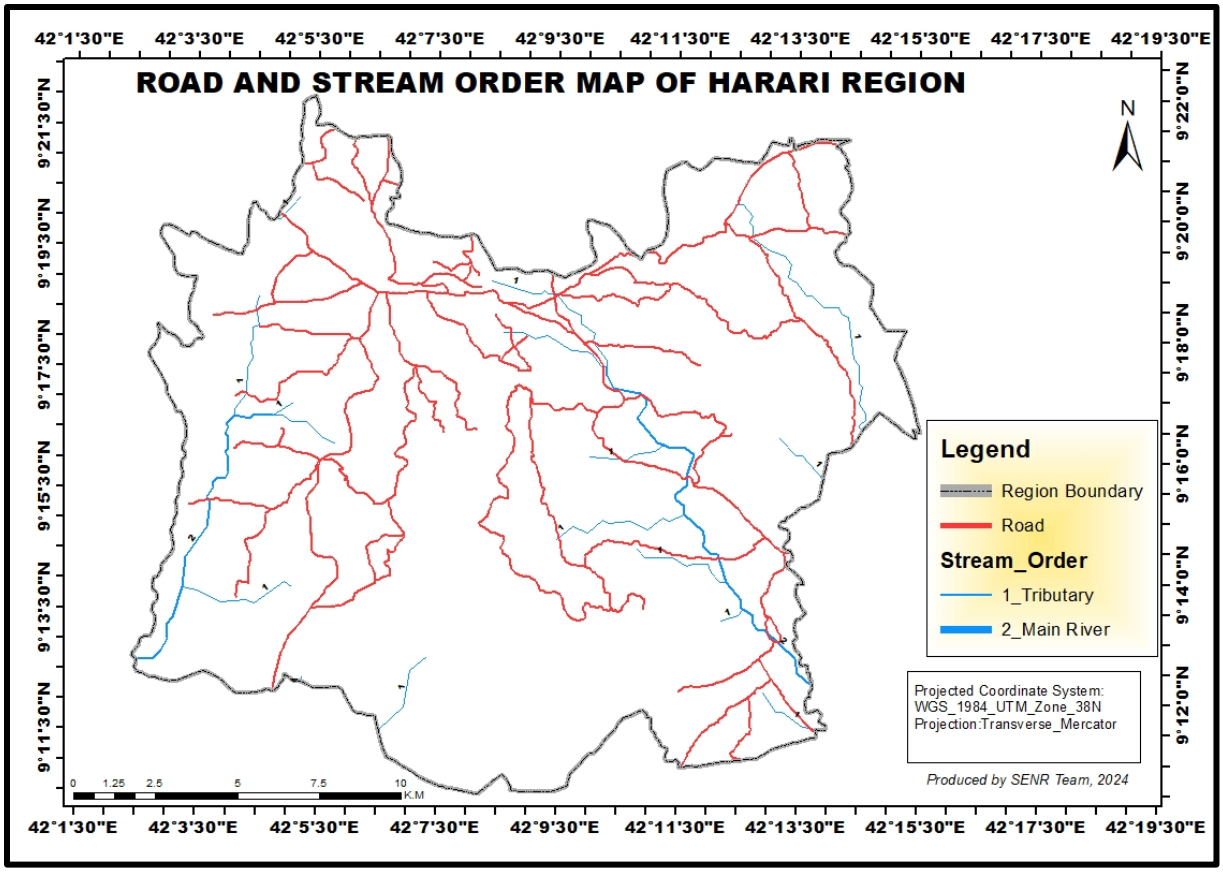


Figure: Stream Order Map in Hareri Region (Source: EPA GIS Team, 2024)

Stream ordering is a method of assigning a numeric order to links in a stream network. This order is a method for identifying and classifying types of streams based on their numbers of tributaries. Some characteristics of streams can be inferred by simply knowing their order.

For example, first-order streams are dominated by overland flow of water; they have no upstream concentrated flow. Because of this, they are most susceptible to non-point source pollution problems and can derive more benefit from wide riparian buffers than other areas of the watershed.

Because all tributaries of main channel have order of 2, the streams can be quickly and easily filtered and its properties and relation to main stream determined. The main disadvantage of that method is the problem with the comparison of sub catchment topology of the same order.

Water Supply and Coverage around Etisa Forest Ecosystem

Safe domestic water supply is an essential component of primary health care and plays a vital role in poverty alleviation. Inadequate water supply and sanitation services impact upon the lives of billions of poor people in the developing world (World Bank, 2004). Two in every ten persons lack access to safe water supply, five have inadequate sanitation, and nine do not have their wastewater treated. Yet, these estimates are believed to underestimate the extent of the drinking water supply problem. In many countries where water supply systems have been installed, the quality of the services provided is poor. Many consumers who are connected face unreliable water supply and when available, it is often not safe to drink (World Bank, 2004).

Harar Region has a total of eight rivers, out of which Erer and Hamaresa Rivers are the most prominent ones. These two rivers are major surface water sources in Harar town and they are located to the east and west of Harar Town respectively. Both rivers are intermittent or seasonal, with water during and for a few months after the rainy seasons. Water flow may be found at some points as a result of base flow. In the dry season, the flow of these rivers becomes discontinuous, spilling over the surface at certain locations. Both rivers, together with their tributary streams and springs, flow from north to south, eventually draining into Wabi Shebelle River in Somali Region. Erer and Hamaresa rivers, along with their tributary streams and springs, used to provide the region with considerable amount of water. However, attributed to severe

degradation of land and vegetation cover as well as various environmental problems, several of their tributary streams and springs have reportedly dried out.

Harar and its neighbour towns were getting previously water from surface water - lake Haramaya, the only surface water source for the surrounding, but due to over-exploration, sedimentation and unwise management in general resulted the lake gradually shrinking and lastly dried up totally in 2004, consequently the water source option shifted forcefully to ground water source, which is currently the only water source.

Erer Water Supply System July 2017: following the ground water level depletion at DD, high administration cost, uncontrolled management system and others the Harari Regional State through grant obtained from Federal Government to finance Erer Water Supply project through SDG (Sustainable Development Goals) program. The provision of water supply system expected to benefit over 30,000 population living in the periphery and outskirt of Harar town and other rural villages of the in the Regional State along the transmission line, namely (Erer, Kelea, AwBahar, Awdigdig, Harewa and Deker).

In general, the Harar water supply system having these three water sources system and challenges, has failed to satisfy the following current demand of the town dweller and remained a bottleneck for other investment. In this connection, effort is being made in collaboration with the regional government and the Ministry that includes conducting overall feasibility study for the source, design and administration, including the financial source securing.

By now and over the past 5 years Argoba mountains, Etisa mountains, Gola mountains, at ulanula and at hawayie jebertii, qimataro mountains, Marko mountains in waldiya in dodota and few private farmers are planted among them the model farmer forester known by the name as shame yonis is one of the person .

The negative signs spoken now against the forest development at erer qimataro dodota cattle let into forest land and now the forest is being ruined unless sound measures is taken and kept well as other forest lands with guarders installed destruction is inevitable in qamataro mount forest

The participants in FGD around Etisa forest ecosystem explained that there is a great problem of drinking water in the surrounding area of Etisa Forest Ecosystem, about 80% of the residents

was prawn to water shortage. The participants also explained that the water source of the area is spring water.

3.3.2. Driver and Pressures of deterioration of water bodies in Etisa Forest Ecosystem

The participants in the FGD explained that the cause of water shortage in the study area was drought and shortage of rainfall.

The main drivers of and pressures of water resource degradation in Etisa Forest Ecosystem was mentioned as follows.

- **Population Growth**

An increase in population also leads to an increase in the consumption of other resources, which in turn affects the economic development of a country. Groundwater can be considered as an urban self-supply system when it is appropriately managed and supported by strong policy in response to population growth and accelerated urbanization, developing cities are becoming increasingly dependent on groundwater for their water supply needs. According to the participants in FGD, the population of Erer district increased from time to time, due to this the community excessively extract the forest and water resources highly in order to achieve their needs.

- **Urban and Industrial Expanisition**
- **Poor waste water management system**

The Harar City industrial and commercial wastewater management practice is very poor, which affects/pollutes the environment, particularly the water source in the surrounding, as there are a lot of privately constructed wells in the town for private consumption and downstream community ground water sources. It is reported by the consultant hired for 2nd Urban Water and Sanitation that almost all of the industries, hotels, and institutions do not have their own safe waste water disposal mechanism or system and there is a high suspect of illegal connection to the drainage system or may developed unsafe means which again is dangerous for the environment as a whole, particularly for the ground water in the town and at downstream.

The hardness or minerals concentration related issues at both water sources of DD (with high Calcite/Bicarbonate Concentration) and Errer (with Iron/Fe concentration) still unresolved with the understanding that the health impact is not as such proven or no observed serious health

problem related report appeared. In view of this facts, and since Harar is still under serious water access/shortage problem, water quality issues are not as such considered a serious issue, other than the effort made on decalcification treatment plant installation for DD water source that was failed due to high operational cost against the level of loss due to long and fully uncontrolled distribution system we have.

- **Increasing water demand and Accessibility**

Currently, the Utility is producing water from all the three groundwater sources estimated to be 8,000 – 9,500 m3 /day out of it Harar town may get 5,300 m3 /day (58 l/s) and average consumption of Harar was 3,000 m3 /day (~35 l/s). The Current demand for all the users is estimated to be more than 22,700 m3 /day (323 l/s) in 2020, as per old design by BECEOM (EGIS) in association with Ethiopian Water Works Design and Supervision Enterprise and forecasted for the year 2021 as 29,095 m3 /day (336.52 l/s). Harar town demand is estimated to be more than 22,727 m3 /day (263 l/s) in the year 2020, and 23,500 m3 /day (272 l/s) in 2021 The gap between the existing production and water demand as per old design is as follows: for Harar 23,584.83 – 5,300 m3 /day = 18,284.83 m3 /day. Generally, Harar and all neighboring towns the existing production and water demand asper old design is as follows 29,095 – 9,500 m3 /day = 19,595 m3 /day If HWSSA has improved and rehabilitate all water wells and pumping station efficiently and assuming there is no power interruption/failure, HWSSA may produce additional water of 8,000- 10,000 m3 /day (93 - 115 l/s) from all the source.

- **Climate Change and Extreme Climatic Events**

It is well known that water is one of the sector affected by the climate change impacts in many ways be it directly or indirectly, particularly the case in Harar, as the water system comes/after being conveyed a long distance under different terrain condition that can be easily affected by flood, in addition to the direct impact for any temperature increment create a pressure on the scarcely available water resource as demand increase and, as well as, evaporation and evapotranspiration increase that directly affect the availability of water at any form (surface or underground). The impact of temperature increment has also negative impact on water quality as most micro-organism and minerals are sensitive to this change and as a result of that reaction might accelerate abnormally that possibly affect the water quality.

3.3.3. Impacts of Water Resource Deterioration on the local Community

The current water supply is not sustainable in technical, climate and financial terms. The current aquifer is rapidly depleting. Moreover, production and distribution costs are extremely high due to high energy costs (4 kWh per m3). Besides the loss at the main and distribution system is very high, frequent power/Electric interruption due to the intermittent Power/Electric interruption, as the system immediately release the water to back flow with high pressure, which usually causes great water loss with total estimated Non-Revenue Water to be 35-40% in average, with the possibility of this figure to be escalated dramatically.

Similarly, the Rural part of Harari Region is characterized by limited natural water resources and rapid growing rural population. Despite a rainfall of 600-800 mm/ year, the natural recharge to groundwater is limited and perennial rivers are absent. Larger volumes of groundwater is only available in seasonal river (wadi) beds, in inland alluvial valleys and locally in deeper sand stone and limestone deposits. During the dry season a serious water scarcity is experienced in large part of the area. The rural drinking water supply is organized through some 198 community based schemes with boreholes, shallow wells and rain water harvesting schemes. At the start of the HWSA project, it was estimated that – due to water scarcity and high failure rate of current systems - only 66% with non-functionality rate of 21 %. of the population has access to safe water in acceptable quantities, leaving about 40,000 rural inhabitants poorly served.

Deterioration of water bodies are many impacts on the local community as well as the country as a whole. According to the FGD and Key informant interview declining of water bodies' cause to women travel long distance to fetch water. Young girls often stay at home to help their mothers with household tasks, including collecting water. Some even get up early to collect water, and then arrive at school completely exhausted. Clean water closer to home totally changes this. It means young girls can spend more time in school, rested and ready to learn.

Female participants in the FGD explained that:

Our children are students and so they only come and help with getting water when they don't have school. Otherwise, we are responsible for all the work. Sometimes, when we get so tired, we can't collect water, and as a result, our children miss their school.

The participants also explained that due shortage of water the local community prawn too many diseases like Att and Malaria.

3.2.4. Response

Rehabilitate & maximize the Existing Water Supply System

Erer Water Supply System - rehabilitate and replace the low yielding wells, to connect the newly developed wells. Solve the outstanding social problems with the Babile woreda and local administration, local elders local PA admins, drill and develop the whole water system connect to the existing water supply system.

Reduction of Loss: - As one of the areas to be focused is to reduce the loss in the whole distribution line, which contribute the most part, in this regards different approaches and strategies started before need to be strengthened like Telemetry system to monitor the whole process at remotely and developing ground water monitoring system is also required as that safeguard the pump to be burnt and take alternative options before serious problem happens. Along with the stated efforts strengthening the administration of the water system and improving the overall administration system.

3.2.5. Outlook

High increase in water demand has been noted in water scarce basins like Awash River Basin due to rapid urbanization and industrialization. The increase in domestic and industrial water demands will intensify the pressure on the available limited freshwater resources. It is important to note that Ethiopia's water resources management policy gives priority to meeting domestic and industrial water demands. The water share of the agricultural sector, however, will decrease with time to meet the competing domestic and industrial demands.

3.4. State and Trend of Climate Change for Etisa Forest Ecosystem

Baseline State and Trends of Climate of Hararri Region (1960-1990)

Baseline Climate

The world's climate has already changed and will change dramatically. Under the no emission scenario, the average global surface temperature is predicted to increase by 2.8ºC during this

century (IPCC, 2007). Such global warming would alter the natural climate, leading to increased frequency of extreme weather events (such as droughts, storms, and flooding), rising sea levels, reversal of ocean currents, and changes in precipitation patterns.

The Ethiopia climate patterns mainly rainfall and temperature are modulated by altitude and latitudinal differences. For this baseline study the state of the climate is considering the 30-year climate trend before 1990.

According to the Ethiopian agroclimatic classifications, Harari Region dominantly experiences temperate (80 % 'Woina Dega') climate which is defined by an altitude range of 1500-2300 m a.s.l. the remaining small span 20% of area fall in Kola climate which is represented by an altitude range of 500-1500 m.a.s.l.

A. Rainfall variability and trend

The mean annual rainfall for Harar weather stations from 1967 to 2000 is 724.4 mm and the mean annual rainfall varies from about 650 to 1000 mm. However, 65% of the Rainfall occurs during the two rainy seasons, the first in April-May and the second in July-Sept. The remaining 35% is distributed in the 7 months long dry season.

B. Temperature variability and trend

The average annual maximum and minimum temperatures from 1967 to 2000 were 25.49 ^{0}C and 13.42 ^{0}C respectively.

3.4.1. State and Trends of Climate for Etisa Forest Ecosystem (1993– 2023)

State and Trend of Rainfall for Etisa Forest Ecosystem

Rainfall

Etisa forest ecosystem have has been experienced a bio-modal rainfall pattern classified as the long rainy season (June –October) and short rains (March-May) locally referred as *Kiiremt* and *Belg* rains respectively.

Table 7 Average monthly rainfall

MONTHLY	RF
January	13.65
February	14.48
March	47.92
April	113.79
May	83.40
June	42.75
July	90.35
August	110.05
September	91.53
October	50.77
November	20.51
December	9.31
Avr Sum RF	**688.52**

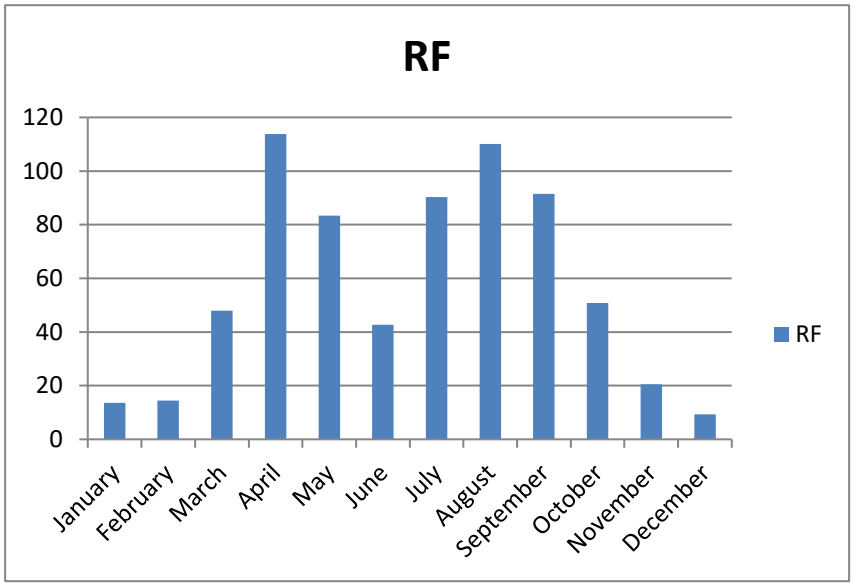


Figure 9 **Average Monthly** rainfall from 1988-2018 (Source : National Metrology Institution)

One can observe that the peak average monthly sum of rainfall was recorded during August, it reached around 110 mm. The positive rainfall anomaly was recorded in April to May and July up to September months. The positive sign was an implication that the monthly averages were higher than the 30-year normal. On the other hand, all the other seven months have a negative anomaly which means the monthly average rainfall was recorded lower than the 30-year average normal.

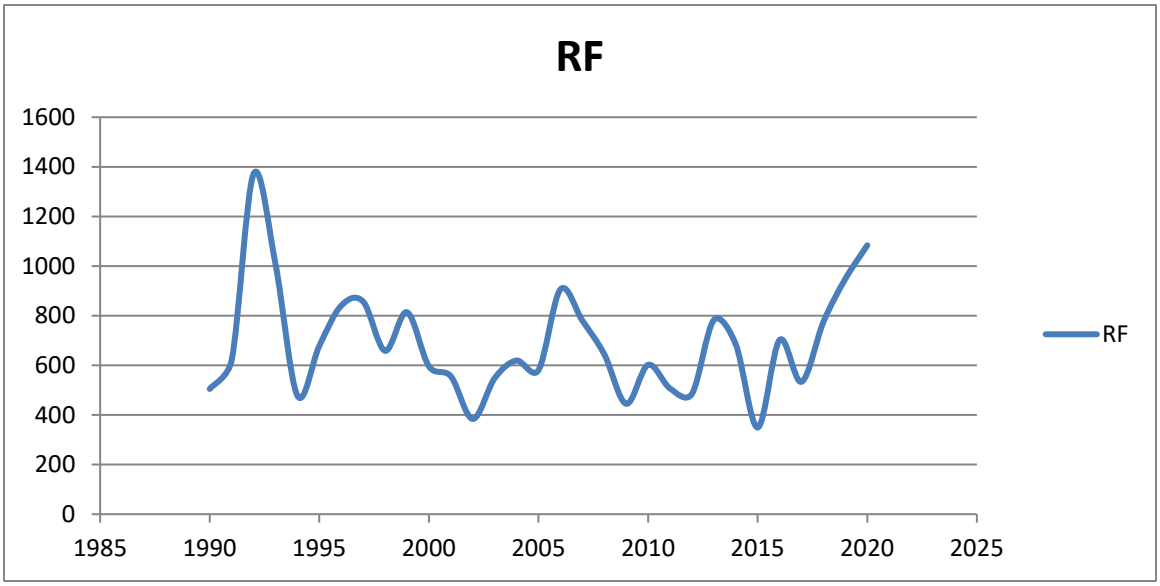


Figure 10: Etisa annual Rainfall from 1990- 2020

Source: National Metrology Institution

The amount of annual sum of rainfall was highly variable from year to year. The highest Rainfall was recorded around 1371 mm in 1992 and the lowest rainfall was recorded in 2009 which was 445 mm. From the available data annual average rainfall was 689 mm rainfall were recorded.

The highest negative anomaly was **-244** mm in **2009** which indicate that in these years the average rainfall received was far below the reference normal. On the other hand, the highest positive rainfall anomaly was recorded in **1992** which is **+ 682** mm above the reference normal as illustrated above.

Temperature

Etisa forest ecosystem has been experienced a warm pattern classified as the long warm season (February – May) and cool (June – September) locally referred as belge and Meher respectively.

Table 8: Monthly Maximum Temperature

MONTHLY	Max Temp

January	27.25
February	28.39
March	28.84
April	27.76
May	27.68
June	27.10
July	25.62
August	25.96
September	26.56
October	27.34
November	27.31
December	26.84
Ann Avr	**27.22**

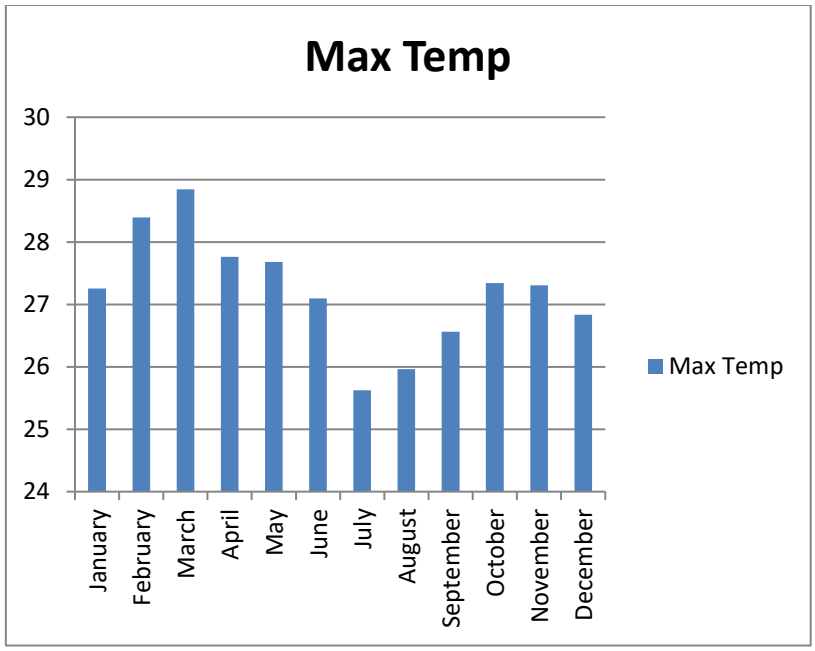


Figure 11 Etisa Average Monthly Maximum Temperature from 1990-2020 Source : National Metrology Institution

MONTHLY	Mi
January	12.12
February	12.73
March	13.84
April	14.32
May	14.22
June	14.45
July	14.12
August	14.11
September	13.77
October	13.19
November	12.28
December	11.75
Ann Avr	**13.41**

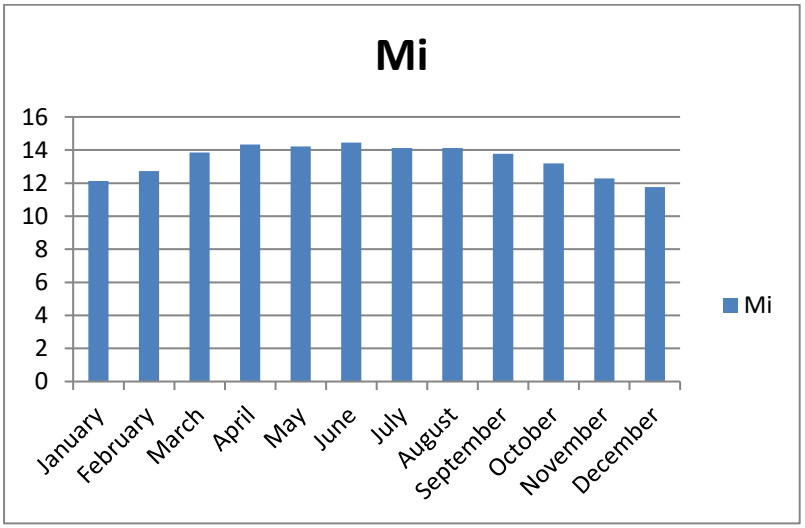


Figure 12: Etisa Average Monthly Mi Temperature from 1988-2018

Source : National Metrology Institution

The hottest month for the 1988 - 2018 period was the months of March with an average maximum temperature of 28.84454 °C against the normal reference of 27.22274 °C an increase of 1.62°C while the coldest month was the months of December with a maximum average of

26.83621 °C against the normal reference of 27.22274 °C decreases of - 0.3865 °C as well. The overall total average anomaly for the 1988 - 2018periods was 2.001 °C.{ Range }

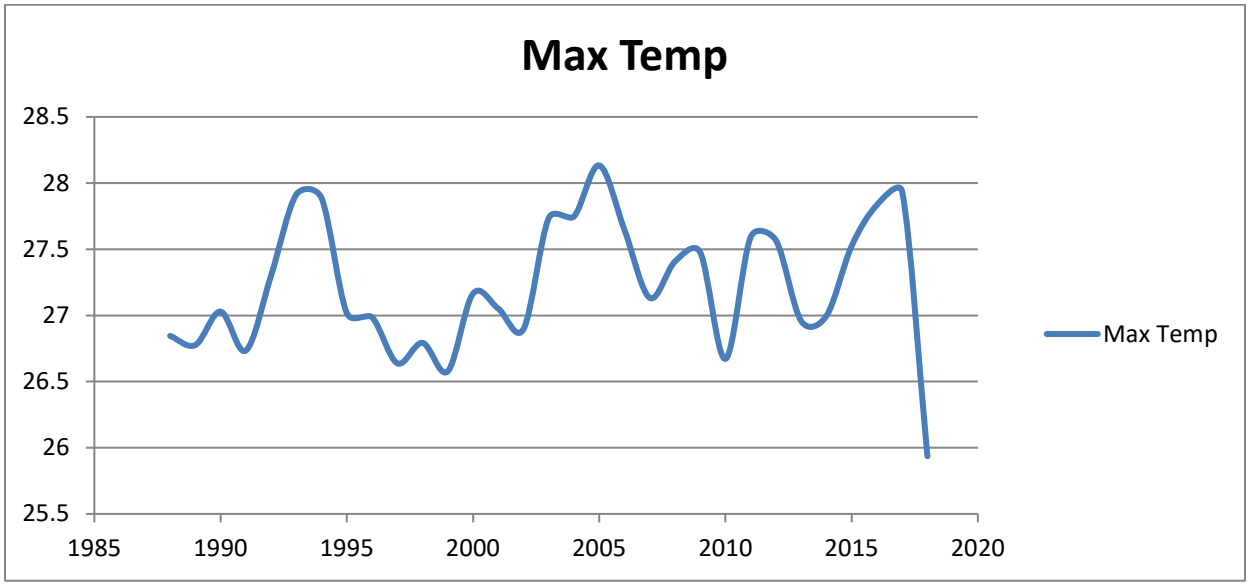


Figure 13: Etisa Average Annual Maximum Temperature from 1990-2020

Source : National Metrology Institution

Within the period of between 1988 - 2018, the considering the reference normal of 27.22 °C average annual **maximum** temperature recorded

- Highest recorded was 27.89 °C in 2017 with the highest anomaly +.711 °C of. While
- Lowest average annual maximum temperature was 25.94 °C in 2018 with an anomaly of - 1. 29 °C

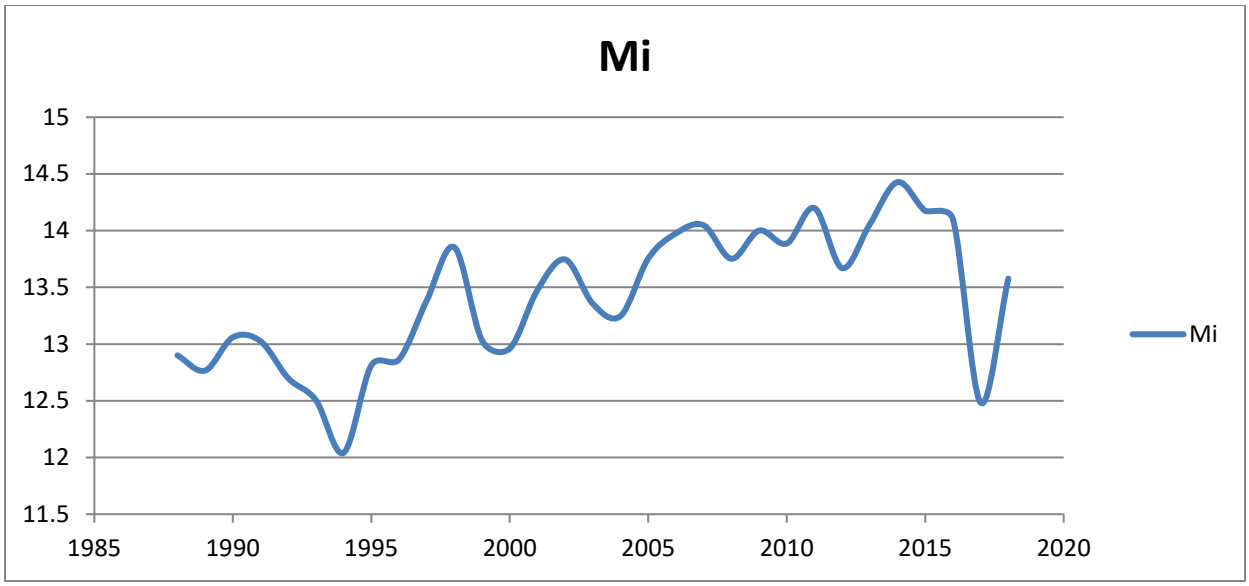


Figure 14: Etisa Average Annual Maximum Temperature from 1990-2020

Source : National Metrology Institution

Within the period of between 1988 - 2018, the considering the reference normal of 13.41 °C average annual **minimum** recorded

- Highest recorded was 14.43 °C in 2014 with the highest anomaly +1.02 °C of. While
- Lowest recorded was 12.48 °C in 2017 with an anomaly of - 0. 93 °C

Climate variability and anomalies observation from FGD

The focus group discussion was carried with selected indigenous elder peoples having well know the forest ecosystem & the climate for the past 3-5 decades. According to their life experiences of sensationalizing the climate change and its adverse impacts on the forest and livelihoods; the participants' explanation is summarized as follow:-

- Rainfall is highly erratic and typically falls in the form of intensive convective storms such variability causes
    - Severe flooding effects to the downstream areas of the nearby forest villages. The name Etisa is derived as junction of rivers.
    - increases the number of extreme events
- Shift of crop season

- rainfall starts in may but now it is changed its pattern earlier or later

- Pests and Disease
  - Plant disease: - Sorghum warm pest.
  - Animal Disease :- Livestock foot swelling
- Droughts affecting agricultural productivity and livestock feed
- Drying of former springs
- Species have shifted their geographic range envisage the area
  - Invasive species " Bekertea and Yeferenje Biskut' occurrence and spread in the locality
- Extinct plant species from the Forest Ecosystem
  - Tree and Shrubs species : - Jejeba, Diressa, Bakka, Hamessa, Hagamssa and prosopis (Prosopis juliflora)
  - Herb species: - invading Harari region are parthenium weed (Parthenium hysterophorus), and lantana weed (Lantana camera).

3.4.2. DRIVER AND PRESSURE

Vicious Circle

Vicious circle of Climate change, Forest Ecosystem and livelihood is inter liked affects each other The climate variability's of rainfall and temperature affects the forest ecosystem and life supporting capacity to human and other creatures. The degradation and deforestation of the Forest Ecosystem as carbon and biodiversity reserve emit the sequestered carbon and lost the lower canopy shade tolerate biodiversity species. Livelihood crises will also aggravate deforestation and degradation for extensive agriculture and fuel wood demands aggravate anthropogenic effects on the climate change.

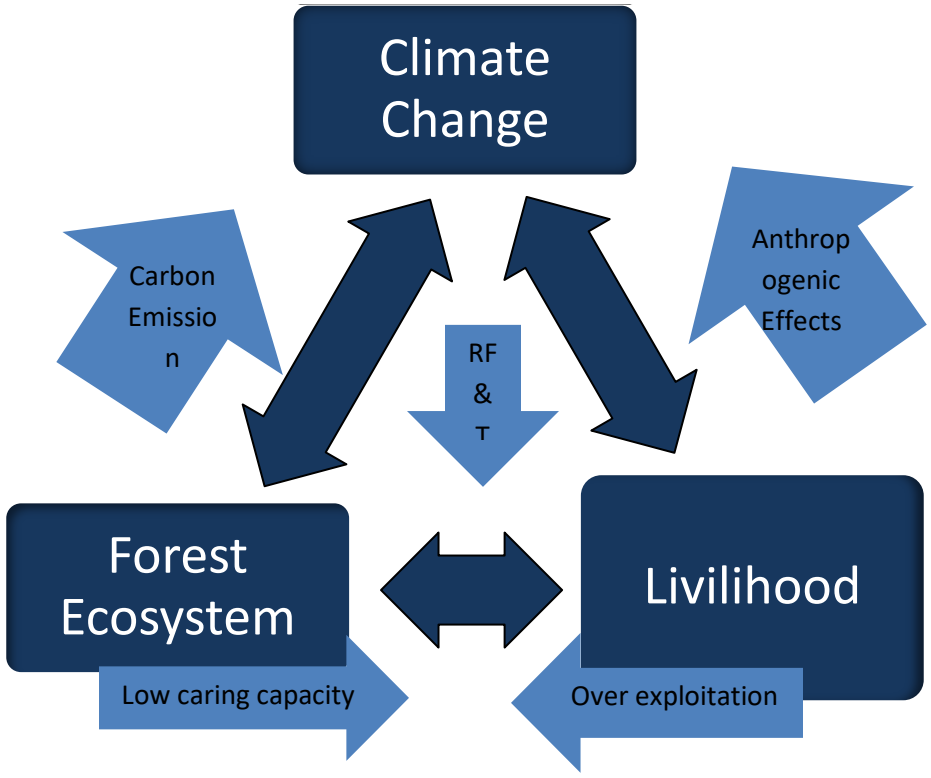


Figure 15 Vicious circle of Climate, Forest and Livelihoods

Global Drivers and Pressures

Drivers: - The Western Materialistic Philosophy

According to the Western philosophical believes of Christians nature is given for human beings them to own and use right GIVEN by GOD. The Holy Bible states that:-

- "Be fruitful, and multiply, and replenish the earth, and subdue it; and domination over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth. (Genesis 1: 28)

The Bible gives human beings to exploit nature as a gift. Accordingly their way of life HAPPINESS is an accumulation of wealth and owning matter. This enable them to exploit the natural resources and develop veracious apatite of exploitation the natural resources unsustainable and generate wastes beyond the recycling capacity of the earth.

Whereas the Eastern world believes human beings are as **part of nature**. And developed living with nature in harmony and keeping the natural equilibrium as way of life happiness.

Western materialism is expanding globally. Now Eastern nations are also influenced by the love of matter. Countries which are the modeled of Eastern philosophy of living with nature like China and India (half of the global population) were one of influenced countries. So the development of the materialism thoughts is main driver of challenge to global climate changes by emitting greenhouse gases and producing wastes beyond the recycling capacity of the Earth.

Pressures: - GHG Emission

Anthropogenic factors are thought to be the main drivers of global warming. Human activities have led to changes in the chemical composition of the atmosphere by adding more greenhouse gases (GhGs) to it. Between 1970 and 2004, global GhG emissions increasedby 70 percent (IPCC 2007). The energy sector was the largest contributorof global GhG emissions, increasing by about 145 percent. Over the same period, direct emissions from transport grew by 120 percent; industry 65 percent; and land use, land use change and forestry 40 percent (IPCC 2007). Trends in the concentrations of the main GhGs—carbon dioxide (CO2), methane (Ch4) and nitrous oxide (N2O)—are increasing.

The unprecedented increase in global energy uses of fossil has given rise greenhouse gas emission. The main natural GHGs are **carbon dioxide (CO_2)** , **methane (CH_4) , nitrous oxide (N_2O) , water vapor (H_2O) , and ozone (O_3)** in the troposphere and stratosphere. Further human activities in recent decades add new **halocarbons** (HFCs) as GHG.. On the whole if the rise of GHG's takes place in the current rate the overall rise of each pollutant gases that contribute the greenhouse effect will be somewhat in fair higher side with **doubling point sometimes in 2030**. Thus the corresponding temperature changes from 1850 to 2050 at the magnitude of 0.25^0C to 3.5^0C.. Thus it is **very urgent** to restrict the current rate of GHGs emission.

Most scientists agree that if the pollution continues at present rates, the result will be irreversible damage to the ecological cycles which all life depends. They **warn that fundamental, and perhaps drastic, changes in human behavior is** required to avert the ecological crisis and assure sustainable development.

National and Local Drives and Pressures

Ethiopia's current contribution to the global increase in GHG emissions since the industrial revolution has been practically negligible. Even after years of rapid economic expansion, today's per capita emissions of less than 2 t CO2e are modest compared with the more than 10 t per capita on average in the EU and more than 20 t per capita in the US and Australia. Overall, Ethiopia's total emissions of around 150 Mt CO2e represent less than 0.3% of global emissions. Of the 150 Mt CO2e in 2010, more than 85% of GHG emissions came from the agricultural and forestry sectors. They are followed by power, transport, industry and buildings, which contributed 3% each.

Ethiopia's greenhouse gas emissions were about 150 megatons CO_2 equivalent in 2010. Under a business-as-usual development strategy, these emissions are projected to more than double to 400 megatons CO_2 equivalent by 2030.

The impacts of human activities on forests contribute significantly to Ethiopia's emissions. Forest-related emissions amounted to almost 55 megatons CO_2 equivalent in 2010, driven by deforestation for agricultural land (50% of all forestry-related emissions) and forest degradation due to firewood consumption (46%) as well as formal and informal logging (4%). These are among the main direct drivers of deforestation and forest degradation.

The mainly pressures of GHG emission are:-

A. Population growth and anthropogenic effects

According to CSA (2013), the population would have reached above 90 million in 2015, which makes Ethiopia the most populous nations in Eastern Africa and the second-most populous in Africa after Nigeria (CRGE 2011). With the current annual population growth of over 2 percent, Ethiopia will have more than 120 million people by 2030. Over the past 50 years poor rural families have not got sufficient social security support and turned therefore to various other kinds of social security net surrogates. These surrogates have been, for instance, ***large families***, which provided sufficient household labor for family livelihood. Secondly, the families in villages and town communities have to support each other during the difficult times. The third social security net surrogate has been exploitable forests, which could provide many goods and services free of charge

such as wood energy, construction wood, food and fodder, new farm and housing land and drinking water.

For instance, rural populations depend most fundamentally on forests in terms of subsistence, health and income. The most prevalent activities' are grazing and fuel-wood collection. The pressure is therefore, very high not only for forest products but also for conversion of forest land to agriculture.

B. Over-grazing

Overgrazing results in decreased soil cover, increased erosion, decreased quality and productivity of range resources, reduction or elimination of the natural regeneration of woody species and preferred forage species, bush encroachment in some areas and loss of biodiversity. Root causes include demographic growth, the breakdown in traditional management systems, land tenure and de facto, lack of incentives for sustainable use and lack of range management models in some areas.

C. Land tenure

As long as there is no real responsibility among the local population for the common forest resources and forest laws and regulations are not enforced, it is impossible to stop another person from exploiting forests. The worst kinds are the illegal timber cuttings in the last remaining high forests which one can blame a number of wood traders.

D. Encroachment and illegal logging

In the region illegal logging or forest clearing is spread widely, they chop down the trees because they want to use the land for cultivation and cattle ranching. The cut wood might be an additional incentive but is not the main source and force for forest clearing. In economic terms illegal logging results in lost revenues and other foregone benefits. In environmental terms illegal logging is associated with deforestation, climate change and a loss of biodiversity. In social terms illegal logging can be linked to conflicts over land and resources, the disempowerment of local and indigenous communities, corruption and armed conflicts. Illegal activities also undermine the efforts of responsible operators by making available cheaper but illegal timber and timber products in the market place.

Illegal logging has a huge impact on the loss of forests that account for the vast majority of deforestation.

E. Land use changes

Conversion of natural forests ecosystems to other land use is the greatest single threat to ecosystem and biodiversity. Conversion results in the loss of nearly all species of fauna and flora on the site and leads to increasing fragmentation of the remaining ecosystems. Root causes of clearing for agriculture include population growth, low productivity of agriculture, unsustainable agricultural systems (soil erosion and inability to maintain soil fertility), tenure systems that allow the conversion of common lands to farmland and lack of enforcement – even some of natural mountainous area around Erer and Sofi woreda have been heavily encroached by farmers.

F. Charcoal and fuel wood production:

Charcoal and fuel wood production is cause of forest degradation as a result it hinders the carbon sequestration potential of the forest ecosystem. Wood fuel accounts for more than 80% of household energy supply in Ethiopia and is particularly important in rural areas. According to Harari region bureau of agriculture animal and fishery development 2021 data, there are more than 16500 donkeys' out of which most of them are in Erer district with their main functions is loading wood to cities for fire consumptions.

3.4.3. Impact of Climate Change

Global and National Impacts

The WMO Greenhouse Gas Bulletin showed that globally averaged concentrations of carbon dioxide (CO2) reached 407. 8 parts per million in 2018, up from 405. 5 parts per million (ppm) in 2017. Globally increasing GHG that causes global warming affects

- Forest distraction,
- Worldwide loss of habitat and biodiversity,
- Soil erosion,
- Air and water pollution,

- Shrinking fossil fuel supplies, and
- Accommodation of toxic wastes
- Human Health major tropical diseases spread with changing climate
    - Malaria (vector Mosquito) ,
    - Schistomiasis (vector Water snail),
    - Filariasis (vector Mosquito),
    - Onchocerciasis/river blindness (vector Black fly),
    - African trpanosomiasis / sleeping sickness (vector Tsetse fly),
    - Dengue Fever (vector Mosquito), and
    - Yellow Fever (vector Mosquito).

Local Impacts

A. Drought

Harari Region is frequently affected by climate change and variability related hazards like recurrent drought, erratic rainfall and flood. The trends of temperature is increasing from time to time where as rainfall variability is increasing in space and time in addition amount of rainfall have a decreasing trends. Because of this and other factors climate related hazards mainly recurrent drought is happened several times and has put pressure on rural households livelihood mainly agriculture and food security

B. Feed Scarcity

Natural pasture and bush/shrub is the major feed sources for the pastoralists and agro-pastoralist households in the Administration. The main source of animal feed resources in the region is natural pastures herbaceous vegetation composed mainly of grasses and forbs and browses (shrubs, tree leaves and pods) are reducing from time to time. As a result, the pastoralists are always forced to migrate seasonally from place to place in search of feed and water. Feed shortage is the primary reason for migration. The pastoralists migrate on average for 78 days away from the residential areas they relatively consider as their permanent address. Generally, pastoralists and agro-pastoralists believe that shortage of feed has resulted in long calving period, weak physical condition and less yields (milk, meat, lower market values) and reduced reproductive capacity.

C. Deforestation

In Harari region charcoal production and fuel wood are two of the greatest drivers for deforestation mainly in the areas of Erer woreda. Although the tree cover for the area is rather sparse, charcoal and fire wood could be seen sold in large quantities all along the route towards in urban commercial centres. Charcoal production is illegal, but its prevalence along the roadside showed that enforcement was lacking. Deforestation also occurs on land that is being cleared by increasing populations for agriculture. Additionally, with use rights being codified only for agricultural lands, forests may be cleared so agricultural use rights can be officially bestowed.

D. Loss of biodiversity

In the last 2-3 decades Harari region was known to one of the potential area for the production of agricultural products including high economic value fruits. The vegetation of the region composed of various species such as ground nuts, mango, and coffee which had high economic value for the region and indigenous forest trees. It was also a place for crop species with genetic diversity. There were also various wild plants that are used by communities for various purposes including medicinal use.

E. Invasive spp

- Prosopis julifiora
    - locally called Yeferenje Biscut – is an alien invasive species – a species so aggressive and dominant that it has displaced almost all desirable indigenous plants or grasses because they could not withstand the aggressive competition with Prosopis julifiora for light nutrient and moisture.
- Parthenium weed (Partheniumhysterophorus)
    - in all weredas of Harar city or rural part of most places and farm and border of rivers and so on is invaded with parthenium,
- lantana weed (Lantana camera)
    - Their high seed production capacity and spread, adaptation to wide climatic and soil conditions, spread by animal movement and their association with pastoralists

way of life and overgrazing are challenges to their management in Ethiopia and Harari region in particular.

- Striga weed
    - locally known Anamalie spread in the city and rural road sides and villages and
- Darsa weed
    - In recent times it is posing threats in low land areas of Sofi and Erer Wordas.

F. Flood

In Harari region floods seen to occur and damage notably to Erer Waldiya, Dodota, and Hawayie peasant association from 2015 to 2021. The flood occurs from end May to end of August and damages farmers crops. Erer River once over flown its inundation areas widen to be up to 1.5 ha. Each year it goes damaging newer farmer's farms around the river known as Erer River. For example in 2021 in Erer district the flood takes away farm property belonging to 1992 householders. About 8000 eucalyptus trees, 3, 54 ha lemon, 2 hectares papaya, 5 hectares of mango. 11 ha of khat, 27 ha of elephant grass of forage 12.5 ha of pepper, 2.7 ha of tomato, 18 ha banana, and 145 ha of sugarcane 20 ha sorghum and 65 ha of maize have been uprooted and taken away with floods.

3.4.4. The Current Response Measures or Practices for Climate Change /Variability

Global Response

Efforts of COP 1 -28

The **United Nations Framework Convention on Climate Change** (**UNFCCC**) is the UN process for negotiating an agreement to limit dangerous climate change. It is an international treaty among countries to combat "dangerous human interference with the climate system. The main way to do this is limiting the increase in greenhouse gases in the atmosphere. It was signed in 1992 by 154 states known as the Summit. The convention's main objective is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system and to allow ecosystems to adapt to climate change.

The **United Nations Climate Change Conferences** are yearly conferences held in the framework of the United Nations Framework Convention on Climate Change (UNFCCC). They serve as the formal meeting of the UNFCCC parties – the Conference of the Parties (COP) – to assess progress in dealing with climate change, and establish legally binding obligations for developed countries to reduce their greenhouse gas emissions.

National Response Climate Change

Ethiopia's green economy offers GHG abatement potential of 250 Mt to the global community:-

Ethiopia is the pioneer and frontline country presenting the continent Africa in the global climate change negotiations in UNEP Conference of Parties (COP). Ethiopia is playing a leading role and submitted a 25 year green strategic plan "Climate Resilience Green Economy (CRGE)" in **COP 16** in Johannesburg, South Africa, as a model to the world.

The priority initiatives that form the foundation of the green economy concept could help to curb the increase in the global emissions projected in the business as usual scenario. While contributing to reaching economic and social development targets, we have the domestic potential to contribute to the global effort by abating around 250 Mt CO2e in 2030 as compared to conventional development practices – this equals a decrease in GHG emissions of up to 64% compared to BAU in 2030.

The impacts of human activities on forests contribute significantly to Ethiopia's emissions. Forest-related emissions amounted to almost 55 megatons CO_2 equivalent in 2010, driven by deforestation for agricultural land (50% of all forestry-related emissions) and forest degradation due to firewood consumption (46%) as well as formal and informal logging (4%). These are among the main direct drivers of deforestation and forest degradation.

To avoid these negative consequences, the CRGE Strategy prioritizes several initiatives to develop more sustainable forestry and agricultural practices.

- Improving crop and livestock production practices for higher food security and farmer income while reducing emissions

- Intensification of agriculture through use of improved inputs and better management of crop and animal residues, resulting in a decreased requirement for additional agricultural land that would be taken primarily from forests.
- Expand agricultural activities on degraded lands through increased irrigation.

- Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks
  - Reduce demand for wood fuel through dissemination of more efficient wood and/or alternative-fuel stoves.
  - Promote afforestation, reforestation and improved forest management activities to increase carbon sequestration in forests and woodlands.
- Expanding electricity generation from renewable sources of energy for domestic and regional markets
- Leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings.

Local Response Climate Change

The City State of Dire Dawa Administration is carrying out different project interventions to alleviate the climate change impacts on the Forest Ecosystems. Among the significant program based interventions carried out are: -

- Conserve and Protect Soil Resources
- Alleviate the Problems of Forest Management and Utilization
- Improve the Management and Utilization of Rangelands and Livestock
- Ameliorate the Pressure on the Environment Resulting from Mining Activities
- Tackle the Problems Associated with Energy Resources Development and Utilization
- Safety net projects in assuring food security

3.4.5. Outlook

Regional Rainfall Projection

Spatial patterns and quantities of projected future rainfall reductions and temperature increases are projected in figure 3, by extending the rate of observed 1960–2009 changes for each season, through 2010–2039, based on an assumed persistence of the observed trends. For the Belg rains, rainfall declines range from -100 to -50 mm across the region, and will be associated with lower Belg harvests and poorer during the summer and early fall. This may be particularly disruptive for agriculturalist and agro-forestry living in Harari regions that currently rely upon Belg rains for their livelihoods. For the Kiremt rains, rainfall declines range from -100 to -50 mm across the region. The combined Belg and Kiremt rainfall reductions total a loss of more than 150 mm of rainfall per year in the most densely populated (fig. 2) long cycle crop growing area of the country.

Regional Temperature Projection

If recent warming trends continue, most of the region will experience more than a 1.0° Celsius (°C) increase in air temperature, with the warming tendency projected to be greatest in the Eastern part of the region. This warming will intensify the impacts of droughts, and could particularly reduce the amount of productive crop land for coffee, since coffee plants typically prefer temperatures cooler than 22°C.

According to the National Meteorological Agency of Ethiopia (NMA, 2010), drought occur when the negative anomaly from the mean seasonal rainfall is 19% or more. Further droughts are classified as moderate and sever if the seasonal rainfall deficiency is between 21% to 25%, and more than 25%, respectively. Based on that criterion of NMA, the area has experienced a number of drought years in the period between 1989 and 2012.

Local Climate Projection

Business us Usual Scenario

Accordingly based on the available meteorological data for Etisa Forest Ecosystem temperature was increased and rainfall is decreasing causing frequent drought. If this condition continuous without any strong mitigation, and adaptation measures in the coming 30 years the forest

ecosystem will severely degraded or even perish. The droughts will also more frequently happen that lead to increase climate-related hazards on the society.

CRGE Scenario

Unless, the Vicious circle of climate, livelihood ad Forest Ecosystem linkage is broken through the climate change mitigation and adaptation efforts of livelihood improvement, reduce deforestation and degradation through enhancing the existing project interventions of adaptation and mitigation efforts of :-

- Improving livestock feeding
- Improving the livelihoods/food security efforts
- use alternative cooking stoves technology,
- rehabilitee of forests through afforestation, reforestation,

In the coming 30 years (2020 – 2050) climate state and trend of forest ecosystem can be conserved the existing status and enhanced in quality and quantity

Climate change has already created costs of increasing frequency, and some unprecedented heavy rains leading to over-flooding. The community in nearby the forest ecosystem livilhood is dependent on rain-fed agriculture and less adaptive to climate change will create a great pressure on the Forest Ecosystem for compensating the loss income. Therefore the forest ecosystem will face more challenges in accelerating sustainable growth in the face of future climate changes for three reasons

- **First**, agriculture is by far the dominant producer, employer, and main source of income
- **Second**, the agriculture is highly susceptible to the causalities of climate change.
- **Third**, the agricultural population constitutes the significant majority of the Legoda Merga Forest Ecosystem neighboring Kebelles are poor and highly vulnerable people.

All these factors will create great pressure and impact on the Forest Ecosystem.

3.4.6. Recommendation

National Recommendation

Ethiopia, like the rest of the world, is experiencing adverse impacts of climate change and variability. These have exacerbated environmental degradation, reduced agricultural production and food security, increased incidences of flooding, droughts and diseases

While the trajectories of future climate change and variability impacts in Ethiopia are uncertain, there is need to institute robust strategies to prepare for the uncertain future rather than using uncertainty as a reason for inaction. In addition to formulating a national climate change policy and enacting a climate change law, there is need to implement the following recommendations:

- **Establish specialized institutions and centres of excellence** that will enable Ethiopia to enunciate the science-policy nexus, and allocate funds to adequately research feasible mitigation and adaptation mechanisms.
- **Develop early warning systems** and link climate change and disaster risk reduction at all levels.
- **Enhance communication of climate change adaptation and mitigation programme s**at the national, county and community levels in order to upscale monitoring and reporting.
- **Use a number of policy and financial instruments to encourage use of alternative, cleaner sources of energy that are gentler on the world's climate systems.** These could consist of command and control legal provisions, taxes that are predicated on the 'polluter pays' principle, green budgeting and a range of fiscal incentives.

Local Recommendation

To assure sustainable development and rehabilitate Legoda Merga Forest Ecosystem it needs to ***break*** the visas circle and establish friend interlink between climate, forest and livelihoods. Therefore the following measures have to be taken in assuring suitability among the climate, livelihood and the Forest Ecosystem.

Sustainable development among climate, forest ad livelihoods:-

- **Climate Change**
  - Reduce carbon emission from deforestation and forest degradation
  - Promote climate change mitigation efforts
  - Addressing the issue of ground water and flood hazard is the issue of alpha and omega to the Dire Dawa Administration
    - Flood hazard and ground water depletion many hamper all development endeavors in the Administration and of course its adverse impact will be catastrophic.
  - So to reverse the would be expected evil consequence of flooding and ground water depletion due attention should be given to the above mentioned emerging issues to ensure sustainable development and of course the very existence of the city of Dire Dawa at large

- **Forest Ecosystem**
  - Promote adaptation strategies of Participatory Forest Management
  - Enhance area enclosures to protect ecological degradation and loss of biodiversity.
    - Rehabilitee forest ecosystem through afforestation, reforestation,
  - Strengthening participatory forest management practices in coloration with the government, the society and by NGO.
  - Developing forest ownership/tenure law which is fair, stable and unambiguous with clear rights and duties (state, common, private).
    - Legalizing or recognizing customary rights of communities over forests and woodlands and enhance the capacity of informal institutions to the extent possible.
    - Developing perceptive legal instruments (policy, law and regulation) that consider Participatory Forest Management as the main "pull" of forest management in the country and to develop or amend the forest law.
- **Livelihoods**
  - Promote adaptation strategies of wood and non-wood products utilization
    - Substitute house construction material by others instead use forest for construction.

- Use alternative cooking stoves technology and improve electricity accessibility and bio-full gas instead use forest for fuel wood.
- Enhance drought and extreme event of RF ad T resistance improved crop.
- The factors that drive the local people to overexploit the forest should be identified and appropriate mitigation measures should be taken to halt the problem
- Provide land for private and community woodlots and local households, while closing the natural forests from humans and livestock. The organized land tenure situation has impacted favorably on deforestation and degradation
    - With land registration individual households get their rights overland and they can defend them from other households and outsiders coming to an area to cut trees
- Campaign and awareness on the need of sustainable development assurance through advocacy, law enforcement ad establish system
- Livelihood comprises capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from the stress and shocks and maintain or enhance its capacities and assets both now and in the future without undermining the natural resource base.

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Countries world-wide adopted the so-called 2030 Agenda for Sustainable Development

Erer woreda Agriculture and natural resource office

Erer woreda education office

Erer woreda health office

Erer woreda water office

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