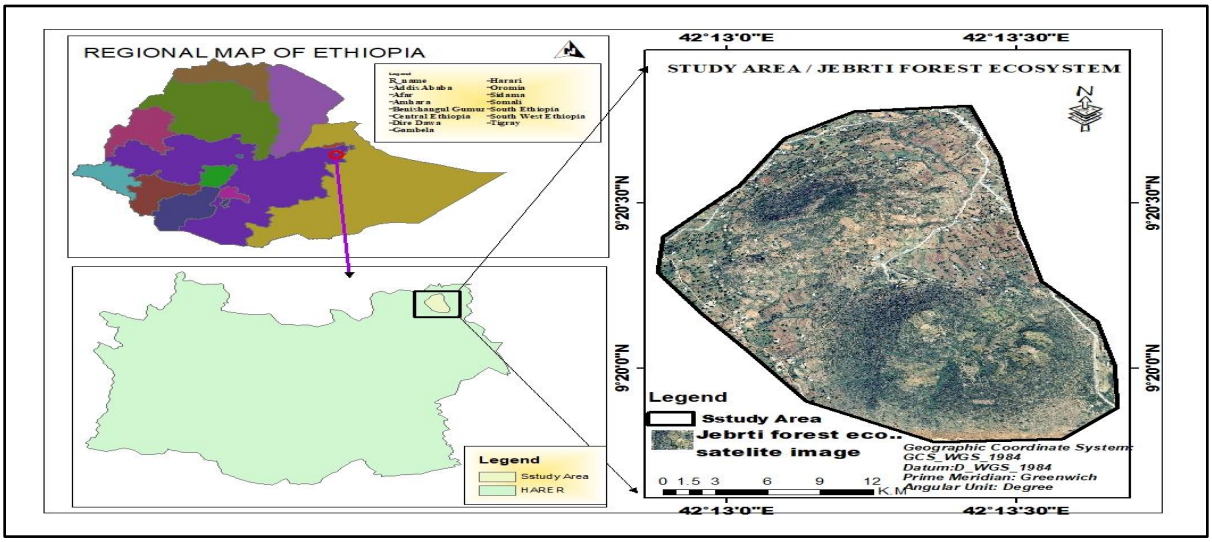
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

ENVIRONMENTAL PROTECTION AUTHORITY

FACT SHEET OF

JEBERTI FOREST ECOSYSTEM HARRI REGION







Prepared By:- State of Environment Data Study and Report Preparation Desk

ADDIS ABABA, 2025

Writers

1. Elshaday Arega (socio-economic and water part)
2. Gedamu Yenesew (RS & GIS Mapping, forest and biodiversity thematic)
3. Birhane Bezabih (Climate and Land thematic)

Coordinated by

1. Tilahun Alemu and
2. Kidest Yehualashet

Table of Contents

LIST of FIGURE ..... **v**

LIST OF TABLES ..... **v**

1. General Background **1**

1.1. Environment for Green Economy Development **1**

1.2.1. The Driver-pressure-state impact response framework 4

1.3. Social and Economic Environment **6**

1.3.1. Social Environment **6**

1.3.2. Economic Environment 14

2. Biophysical Environment **16**

2.1. Land **16**

2.1.1. Land Use- Land Cover Change **17**

2.1.2. State and Trends of LU/LC Change in Jeberti Forest Ecosystem **17**

2.1.3. Driver and Pressures of Jeberti Forest Ecosystem Catchment Land Use/Land Cover Change **18**

2.1.4. Impact of LU/LCC in Jeberti Forest Ecosystem **20**

2.1.5. Response for Jeberti Forest Ecosystem **21**

2.1.6. Outlook **23**

3. Forest **23**

3.1. State and Trend of Flora and Fauna in the Jeberti Forest Ecosystem **23**

3.1.1. Absolute Location & Coordinates 24

3.1.2. Distance from Major Locations 25

3.1.3. The Jeberti Forest Ecosystem (Satellite Image) 25

3.1.4. Land Use Land Cover Change Map (LULCC) in 2005, 2015, and 2025 of Jeberti Forest Ecosystem 25

3.1.4.1. Summary of Trends (2005–2025) 31

3.2. Drivers and Pressures of Degradation in Jeberti Forest Ecosystem **32**

3.3. Impacts of Drivers and Pressures on Jeberti Forest **32**

3.4. Response Taken to Improve the Status of the Jeberti Forest Forest. **33**

3.5. Outlook **33**

3.6. Conclusion and Pathway Forward **35**

4. Biodiversity **37**

4.1. The Biodiversity of Jeberti Forest Ecosystem A Policy and Intervention Analysis 37

4.1.1. **The Driver-Pressure-State-Impact-Response and outlook (DPSIR outlook) Framework** 37
4.1.2. **State (S): Current Condition Of Jeberti Forest Biodiversity** 37
4.1.3. Drivers (D): Underlying Socio-economic and Institutional Forces 45
4.1.4. Pressures for loss of Biodiversity on the Jeberti Forest 46
4.1.5. Impacts for loss of Biodiversity on the Jeberti Forest 46
4.1.6. **Outlook:** 46
5. Climate 48
5.1. State and Trend of Climate Change on Jeberti Wet Land Ecosystem 49
5.1.1. Climate, Climate Change and Forest Ecosystem 49
5.2. Climate Change Drivers and Pressure Forest Ecosystem 61
5.3. Climate Change Impacts 65
5.4. Response to Climate Change 66
5.5. Outlook 68
6. WATER 70
6.1. State and trend of Water availability Jeberti Forest ecosystem 70
6.2. Driver and Pressures of Water Resource Degradation in the Study Area 78
6.3. The main pressures on water in Jeberti Forest ecosystem degradation include: ... 81
6.4. Impact of Water Resource Degradation on the Local Community 83
6.5. Responses to protect water in the Jeberti forest ecosystem 84
6.6. Outlook 84
6.7. Conclusion 85
Reference 86

LIST of FIGURE

Figure 1: Three Dimensions of Sustainability 3
Figure 2 : Transitioning to Green Economy 4
Figure 3: land degradation due to charcoal production in the Jebertiy forest ecosystem 21
Figure 4: Study area map of the Jebri forest ecosystem 24
Figure 5:-Land Use Land Cover Map of Jeberti Forest Ecosystem 26
Figure 6:- LULC Graph of 2005 28
Figure 7:- LULC Graph of 2015 29
Figure 8:- Graph of 2025-LULC 30
Figure 9: Partial view of Jeberti Forest ecosystem 37
Figure 10:- NDVI Jeberti Forest Map 38
Figure 11: Soil Moisture Index (SMI) 44
Figure 12: Average annual minimum temperature 51
Figure 13:- Rainfall variability 52
Figure 14: Jeberti forest ecosystem average rainfall trend in months from the year 2000-2022 53
Figure 15 Jeberti forest ecosystem rainfalls from 2000 to 2022 54
Figure 16 Jeberti Mounthly Average Maximum Temperature 55
Figure 17: Jeberti Annual Average Maximum Temperatures 57
Figure 18:- Jeberti Monthly average minimum temperatures 58
Figure 19:- Jeberti Annual average minimum temperatures 60
Figure 20:- circle of Climate change, Forest Ecosystem and livelihood 62
Figure 21 Charcoal production inside the Jebertiy forest ecosystem 63
Figure 22: Community engage selling fuelwood to the market 64
Figure 23: converting Jeberti forest to farmland 66
Figure 24circle and interlink between climate, forest and livelihoods. 69
Figure 25: Stages of Water Cycle 75
Figure 26: Water cycle 77

LIST OF TABLES

Table 1: Populatin trend of Jeberti Woreda 8
Table 2: student of Jeberti Woreda 8
Table 3:- The health institutions in Jeberti Woreda 10
Table 4: Road in Jeberti Woreda 10
Table 5: - Land use Land cover change in 2005, 2015, and 2025 18
Table 6 : - projective land use land cover change in 2035 22
Table 7:- Land Use Land Cover Map of Jeberti Forest Ecosystem 27
Table 8:- 2005, 2015, 2025 Trend Summary 31

Table 9: Major Flora Composition and Status in Jeberti Forest 40
Table 10: Key Faunal Species of Conservation Concern in Jeberti Forest 41
Table 11: Soil Moisture Change in Jeberti Forest (2019 vs. 2025) 44
Table 12 average monthly rain fall 53
Table 13:- Annual Rain Fall 54
Table 14:- Monthly average Maximum Temperature 55
Table 15:- Annual Maximum Temperature 56
Table 16: Average Min temperature 59

Acronym	Full Meaning
BAU	Business-As-Usual
CSA	Central Statistical Agency
DPSIR	Drivers-Pressures-State-Impacts-Responses
EFAP	Ethiopian Forestry Action Plan
FDRE	Federal Democratic Republic of Ethiopia
FGD:	Focused Group Desiccation GDP: Gross Domestic Product
FGD	Focus Group Discussion
GIS	Geographic Information System
GTP:	Gross and Transformation Plan HDI: Human Development Index
IGAD:	Inter-Governmental Authority for Development KI**:** Key Informant
IUCN	International Union for Conservation of Nature

Acronym	Full Meaning
LC	Least Concern
LULC	Land Use Land Cover
NDVI	Normalized Difference Vegetation Index
NTFP	Non-Timber Forest Product
SMI	Soil Moisture Index
SLM	Sustainable Land Management
UNEP:	United Nation Environmental Program

1. General Background

1.1. Environment for Green Economy Development

Throughout history, human societies driven by diverse interests and values and aiming to utilize natural resources have interacted with the environment, often altering it in the process. Most African economies depend highly on natural resources, aim to achieve industrialization and economic diversification, and face challenges of poverty and unemployment. Therefore, a pathway to a green economy requires action on three fronts: capitalizing on Africa's natural capital, exploiting opportunities for industrial growth and establishing enabling policies and institutions.

First, the economic importance of natural capital in wealth creation, employment, livelihoods, and poverty reduction in Africa needs to be recognized. Africa's natural resources support its social and economic systems. They provide a basis for livelihood to the poor and most vulnerable, which depend primarily on nature for survival. Natural capital assets sustain much of the tourism and associated service industries, which is essential pillars of external trade, foreign exchange revenue generation and employment creation in African countries.

Second, Africa's early stage of industrialization offers avenues for an industrial development supported by the deployment of clean, efficient, and resource-saving technologies. Such technologies would increase energy and resource efficiency in the exploitation of the continent's natural resources, whilst avoiding wasteful consumption, undue economic costs and risks of resource depletion. While the technological and financial requirements of green industrialization are considerable, there are indications that existing opportunities for leapfrogging yield very high potential returns, as can be observed in the African aluminum industry.

Lastly, driving green economic transformation will require a set of enabling policies and institutions that imply a critical role for the State, through public investment, fiscal policies, regulations, government procurement, and market creation at national, regional and international levels, as well as the facilitation of an active participation of non-State act

As development policy has evolved, different approaches have been emphasize at different times that range from promoting more productive agriculture and industrialization to structural adjustment. Global efforts made in the last 50-60 years known to have brought significant advances both in GDP and in Human Development Index (HDI) measures in most countries of the world. Nevertheless, the record of development at the global level is find to be unsatisfactory and criticized for two reasons. First, the benefits of development have been distribute unevenly, i.e. income inequalities remain persistent and sometimes increasing over time; and the global numbers of extremely poor and malnourished people either have remained high or in some areas have increased. Secondly, development-related endeavors have resulted in major negative impacts on the environment (such as depletion of biological resources and pollution) and on the existing social structures.

Growing awareness on the failure of the traditional development thinking to satisfy the needs of the expanding global population, in turn, led to emergence of the idea of sustainable development**.** Sustainable development is development, which meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The concept of sustainable development takes into account the interlinking of the environment, economic and social issues. The idea of development, in this sense, not based on a straight-line progression from traditional to modern mass-consumption society, which results in social inequalities and negative environmental impacts. Instead, the kind of development aspired here is that remedies social inequities and environmental damage while maintaining a sound economic base.

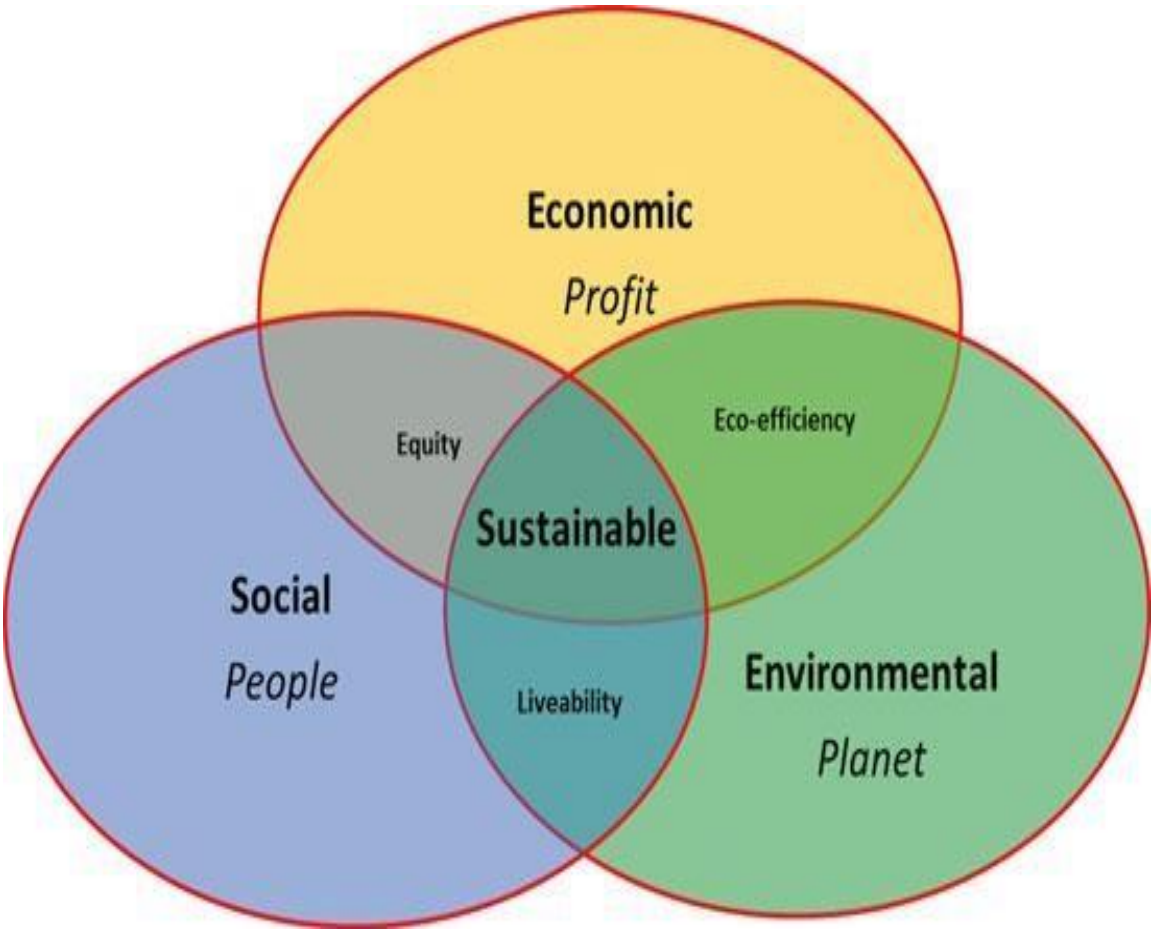


Figure 1: Three Dimensions of Sustainability

Source: Green Growth, Green Economy And Sustainable Development: Terminological and Relational Discourse 2017

The kind of economy developed in this case is green economy that results in improved human-wellbeing and social equity while significantly reducing environmental risks and ecological scarcities.

Green Economy*:* A green economy can be define as one those results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011). It can also define as an economy where economic prosperity can go hand-in-hand with ecological sustainability.

A green economy defined as low carbon, resource efficient and socially inclusive. In a green economy, growth in employment and income driven by public and private investment into such economic activities, infrastructure and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services.

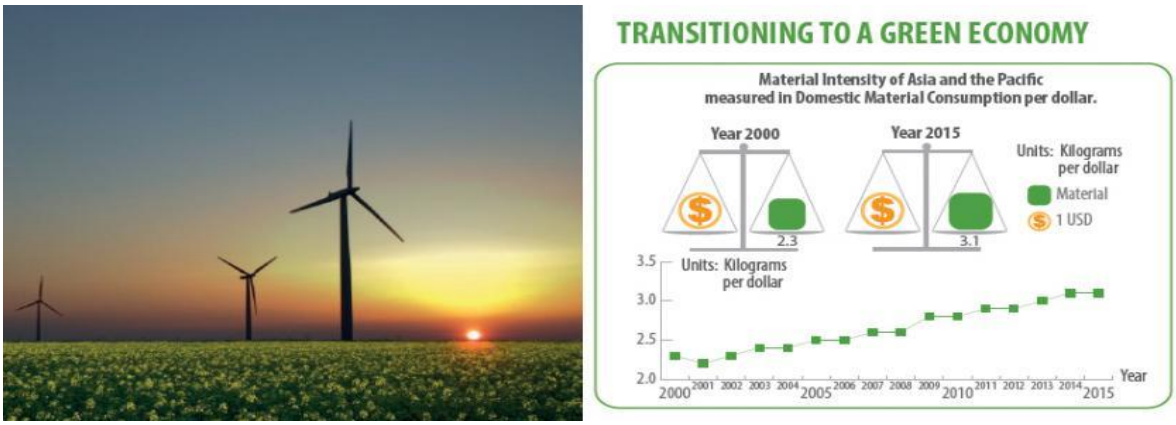


Figure 2 : Transitioning to Green Economy

These green investments need to be enable and supported through targeted public expenditure, policy reforms and changes in taxation and regulation. UN Environment promotes a development path that understands natural capital as a critical economic asset and a source of public benefits, especially for poor people whose livelihoods depend on natural resources. The notion of green economy does not replace sustainable development, but creates a new focus on the economy, investment, capital and infrastructure, employment and skills and positive social and environmental outcomes across Asia and the Pacific.

1.2. Frame works/Approaches

1.2.1. The Driver-pressure-state impact response framework

The current study tried to use DPSIR approaches. The “DPSIR” framework is multi-scalable and indicates generic cause and effect relations withinand 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 influence human wellbeing positively or negatively (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 used for managing society in order to alter the human environment interactions. Drivers, pressures and impacts that can altered by a decision-maker at a given scale are refer to as endogenous factors, while those that cannot referred to as exogenous factors.

1.3. Social and Economic Environment

1.3.1. Social Environment

The social environment refers to the immediate physical and social setting in which people live or in which something happens or develops. It includes the culture that the individual was educated or lives in, and the people and institutions with whom they interact. The interaction may be in person or through communication media, even anonymous or one-way, and may not imply equality of social status.

Harar is the capital city of the Harari Region. The ancient city is located on a hilltop in the eastern part of the country and is about 500 kilometres (310 mi) from the Ethiopian capital Addis Ababa at an elevation of 1,885 metres (6,184 ft).

For centuries, Harar has been a major commercial center, linked by the trade routes with the rest of Ethiopia, the entire Horn of Africa, the Arabian Peninsula, Asia, and through its ports, the outside world. UNESCO listed Harar Jugol,the old walled city, as a world heritage site in 2006. In recognition of its cultural heritage. Because of Harar's long history of involvement during times of trade in the Arabian Peninsula, the Government of Ethiopia has made it a criminal offence to demolish or interfere with any historical sites or fixtures in the city. These include stone homes, museums and items discarded from war. According to UNESCO, it is "considered 'the fourth holiest city' of Islam" with 82 mosques. Harar was later make the new capital of the Adal Sultanate in 1520 by the Sultan Abu Bakr ibn Muhammad. The city saw a political decline during the ensuing Emirate of Harar, only regaining some significance in the Khedivate of Egypt period. During the Ethiopian Empire, the city decayed while maintaining a certain cultural prestige.

The etymology of the name "Harar" remains uncertain; however, archaeologist Timothy Insoll suggests that it may be derive from "Harla," an ancient group that existed in the region prior to the arrival of the Oromo people. Other possible etymologies include ones put forth by British explorer Richard

Francis Burton who states Harar is an extract of the name of a plain located south of the town or a specific tree.

Harar and its residents were, also historically known as Hadharee by outsiders in the region. In the Arabic language, hadhariy serves as both the noun and the adjective that refers to an urban inhabitant and everything associated with a permanent settlement. Jeberti is one of the Woredas in the Harari -Region of Ethiopia.

1.3.1.1. State and trend of social environment

1.3.1.1.1. Population

In world demographics, the **world population** is the total number of humans currently alive. It was estimate by the United Nations to have exceeded eight billion in mid-November 2022. It took around 300,000 years of human prehistory and history for the human population to reach a billion and only 218 more years to reach 8 billion.

The human population has experienced continuous growth following the Great Famine of 1315–1317 and the end of the Black Death in 1350, when it was nearly 370,000,000. The highest global population growth rates, with increases of over 1.8% per year, occurred between 1955 and 1975, peaking at 2.1% between 1965 and 1970. The growth rate declined to 1.1% between 2015 and 2020 and projected to be decline further in the 21st century. The global population is still increasing, but there is significant uncertainty about its long-term trajectory due to changing fertility and mortality rates. The UN Department of Economics and Social Affairs projects between 9 and 10 billion people by 2050 and gives an 80% confidence interval of 10–12 billion by the end of the 21st century, with a growth rate by then of zero. Other demographers predict that the human population will begin to decline in the second half of the 21st century.

The total number of births globally is currently (2015–2020) 140 million/year, which is projected to peak during the period 2040–2045 at 141 million/year and then decline slowly to

126 million/year by 2100. The total number of deaths is currently 57 million/year and is projected to grow steadily to 121 million/year by 2100.

Table 1: Populatin trend of Jeberti Woreda

Year (G. C)	Rural Population		
	MALE	FEMAGE	TOTA L
2021	12429	12360	
2022	12780	12682	
2023	13290	13100	
2024	13305	13105	26410

Source: - Jeberti Woreda (2024)

As the population increases, their economic interest, the demand on infrastructure, food security, energy source, health facilities and necessities as a whole is increased. The consequences which, we saw in the nearby Jeberti Forest Ecosystem due to high population the demand for fuel wood and extra land for agriculture courses the distraction of the forest ecosystem.

1.3.1.1.2. EDUCATION

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. One of the primary goals of FDRE Ministry of Education is promoting primary education in every corner of the country, based on the motto "education for all". Accordingly, regions and City administrations are working in line with this objective.

Table 2: student of Jeberti Woreda

Level of school	Number of school	M	F	Number of student YEAR											
				2012		2013			2014		2015		2016	
				M	F	M	F		M	F	M	F	M	F
Elementary 1-6	9			820	680	1840	996		2167	1490	3513	2291	3466	2389
Primary 7-8	2													
High school 9-12	1			263	197	295	218		329	230	346	238	346	248
Number of teachers		72	95											
Ratio book/students	3.1													

Source Jeberti Woreda education office

Education is the most important factor that plays a leading role in Human development.

According to Jeberti Education office report 9 elementary school,2 primary school, 1 high school, are Available.

1.3.1.1.3. HEALTH

The Health service sector is one of the key sectors of the economy. Adequate health service is one aspect of social service that communities aspire to get from the government. To this end, the Government of Ethiopia is putting the maximum possible effort to set targets towards societal development such as GTP goals and targets, and other policies and strategies. This is exhibited by increasing number of health institutions being established in different regions and city administrations including the rural clinics.

1.3.1.1.4. HEALTH INSTITUTION & HEALTH COVERAGE

Table 3:- The health institutions in Jeberti Woreda

No							
		2020	2021	2022	2023	2024	2225
1	Governmental Health Center	1	1	1	1	1	
1.1	Primary Hospital	o	0	0	0	0	
1.2	Health center	0	0	0			
1.3	Health post	7	7	7	7	7	7
2	Private Health Centers					1	1
2.1	Primary Health clinics	0	0	0	0	0	0
2.2	Number of health professionals						88
	Total						

Source: - Jeberti Woreda Health Report 2025

As indicated on the above tables, the numbers of Governmental Health Institutions in the Jeberti *Woreda* is constant no increment. This shows that there is a shortage of health organization.

1.3.1.1.5. TRANSPORT

The coverage of road in Jeberti Woreda have reached 85%. The main asphalt road of the Woreda is a road that connects Jeberti-Harer which is 22 km. All kebeles have a road network that provides service mainly in winter, but some kebeles doesn't provide service in summer because of improper quality of road.

The length of roads in Jeberti Woreda is 52 km. Among the total, 22 km is asphalt 32 km is gravel/rural roads.

Table 4: Road in Jeberti Woreda

Type of Roads	Flow of Road	Length of road in kilometer	Service of road both in winter and summer	Service of road only Winter
Asphalt Roads	Jeberti –Harare	22	□	
All weathet Roads		20	□	
Dray weather rood		12		x

Source: Jeberti Woreda Road and Transport Sector

1.3.1.1.6. WATER SUPPLY

The water supply source of the Woreda is mainly from both ground and surface water through hand Dug wells and, revers shallow wells and spring development. In 2024 the total coverage of water in Jeberti Woreda is **25 %.** (Office of water and energy development, 2024).

During FGD large number of rural communities, also explained that, there is high scarcity of water for the people, livestock, and agriculture. Drought and population growth are one cause for the scarcity of water in the Woreda.

1.3.1.1.7. ENERGY DEMAND AND COVERAGE

Electricity coverage of Jeberti is **62 %.** The main energy source for cooking was Firewood and Charcoal, which cover 80% from total energy source. Accordant to FDG The main energy source for household light was kerosene lumps, which cover 35. %.

1.3.1.1.8. COMMUNICATION SERVICE

Even though communication services in urban area has an old age, its expansion yet is poor in terms of the stage of development and service per capital. The communication infrastructure that have been rendering service are telecommunication; telephone, fax, and postal services. Jeberti Woreda, has 24 hours telephone services, from total kebeles, but there is problem of networking

system. Total Percentage of Telephone coverage in the Woreda is 8 4 %**.**

1.3.1.2. Drivers and pressure of social environment

Jeberti Forest Ecosystem is one of highly degraded ecosystem in Harare Region. Due to these reason the social environment of the area was changed. The main drivers For the deterioration of the ecosystem are mainly population growth and that leads to overstocking Natural resource which results to degradation. The society use forest for fuel wood and for different household's construction materials as well as Agricultural purpose.

1.3.1.2.1. POPULATION GROWTH

- The driver of environmental change is mainly the results of population growth.
- Increment of population. In the study area result the population density and there need was increased, which result the destruction of natural resource around the area
- Low educational background and less exposure to contraceptive technologies aggravate high birth rates among the rural population
- Even though, currently much attention is give to the provision of primary health care in the households, the provision of family planning services are still low. As a result, there is much more delivery and an increase to the existing population. . In the rural areas, due to high labor demand, the community prefers to have large number of children. Thus, the need for more labor force in the agrarian economy is among others the major cause aggravating pressure on natural resources.

1.3.1.2.2. INCREASING DEMAND FOR FARMING LAND:

- In order to improve their income source most of the local community expand their farm land, during this time the community use different technique such as destruct natural resource especially forest for different purpose like fuel wood .

1.3.1.3. Impacts due to social environment change

Social change refers to the transformation of culture; behavior, social institutions, and social structure over time For example increase diversification of income, local medicine, ekub. Society

is in a natural state of equilibrium. Gradual change is necessary and desirable and typically stems from such things as population growth, technological advances, and interaction with other societies that brings new ways of thinking and acting. However, sudden social change is undesirable because it disrupts this equilibrium. Charles Darwin said that societies evolved just as organisms do, from tiny, simple forms too much larger and more complex structures. When societies are small and simple, there are few roles to perform, and just about, everyone can perform all of these roles. As societies grow and evolve, many new roles develop, and not everyone has the time or skill to perform every role. People thus start to specialize their roles and a division of labor begins. With current high population growth rate of 2.43 percent, there is a very high demand over the available natural resources to satisfy the increasing demand by destructing available natural resources, which exacerbated the condition of environmental degradation. Population growth cause over cultivation, increased the demand of fuel wood and constructional materials, which ultimately resulted in soil nutrient depletion and dwindling proximate environmental resources and, there by resulted in declined food security.

Vulnerability to food crisis referred as people's inability to secure a regular supply of food from their own farmlands of through off-farm incomes. Thus, it is the product of shock or drought and low resilience due to poverty, climatic variability, expansion of air borne diseases, drying of water source, crop failure, scarcity of farmland, lack of off-farm employment opportunity. These are the perceived causes of vulnerability to household livelihood in Jeberti Woreda. Due to deforestation different habitat, fruits, animals and medicinal plant disappear in Jeberti Forest ecosystem,

1.3.1.4. Responses to social Environment Change

There are many potential policy responses to the environmental implications of local population pressure. The population policy of Ethiopia aims at

(i) Closing the gap between high population growth and low economic productivity through planned reduction of population growth;

(ii) Improving the carrying capacity of the environment by taking appropriate environmental protection measures; and

(iii) 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 program in accordance with national priorities as stated below:

- Expansion of population information, education and communication;
- Provision of expanded family planning services;
- Strengthening of training in population; and
- Promotion of the status of women.

To reduce the problem and provide quality education in both primary and secondary school level, schools constructed at village level, teachers trained and placed, and girl's participation was increase in some extent. In recent years as a part of Growth and transformation plan, health service coverage and school enrolment at all levels; improved remarkably, as human capital development also received significant attention from the Ethiopian government.

The government by allocating budget for various sectors, such as agriculture, education, health, and water and road development has shown promising effort in eradicating poverty in the Woreda. As a part of government health, policy document, health professionals in the Woreda are working on maternal and childcare, immunization, control of basic infectious diseases, epidemic and sexually transmitted diseases and specially malaria. In the implementation of the health policy, the involvements of private sectors are also great in the delivery of health services

1.3.2. Economic Environment

1.3.2.1. State and trend of the economic Environment

Ethiopia's economy is highly dependent on Agriculture. At present, the economy of the country is growing at fastest rate. The economy uses natural and environmental resources as essential inputs in the production process. Agriculture is the most important determinant of the Harare Region's economy 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,(specially in chat production) however, agricultural system in the region is at subsistence level and food insecurity problem is

increasing at alarming rate.

- Agriculture Sector 75 percent
- Industry Sector 0 percent
- Service sector 0 Percent

Livestock sector is a source of livelihoods and income, mainly for the rural and per-urban communities. According to key informant and group discussion, the main food crops utilized are maize, sorghum pea and root crops. However, agriculture is the main source of income for the Woreda, community there is low productivity due to low fertility of the soil and shortage of water

1.3.2.2. Drivers and pressures of the economy

- **Population growth**: The driving force lies in the macro-economic objectives. The macro-economic objectives should be environmentally and socially sustainable. There is an interlinked nature of population dynamics and economic environment. As there are high rates of population growth in the study area, the demand to satisfy the increasing new comers increases in over exploitation of the available natural resources.
- **Lack of Awareness about Agricultural Technology:** Due to Lack of Awareness **about** advanced agricultural technology, most of the farmers did not use the land resource intensively and wisely. Instead, they use the land and other resource continuously to satisfy their need and to improve their economic status.

1.3.2.3. Impacts due to the Economic Condition

The nature of economic growth can 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 considered to understand the economic Growth. Thus, the agricultural, service sectors and industrial are used. The first two are to have a higher direct impact on the environment than the third sector.

The rate of deforestation and degradation of forests increased due to agricultural land expansion, firewood and charcoal production, to fulfill their economic demand.

1.3.2.4. Response Measure

There are many potential policy responses to the environmental implications of local population pressure. The population policy of Ethiopia aims at

(i) Closing the gap between high population growth and low economic productivity through planned reduction of population growth;

(ii) Improving the carrying capacity of the environment by taking appropriate environmental protection measures; and

(iii) . Improving the social and economic status of vulnerable groups (women, children and elderly).

1.3.2.5 Outlook for Socio- Economy

If the whole social and economic activities, overpopulation 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, leading to increase loss of biodiversity in Jeberti Forest ecosystem. Then natural environment could not be able to provide the environment service.

1.3.2.6. Options for future Action

The current policies, programs, strategies that are issued by the government are strong instruments for the management of natural resources however they need to be strengthened to cope with the changing situation such climate change and natural resources degradation and depletion. Implementations these policies and strategies should be ensured. Expansion of irrigated agriculture Introduction of drought tolerant crops environmentally friendly resettlement action plan should be in place, Income diversification such as engaged in off-farm activities,

2. Biophysical Environment

2.1. Land

2.1.1. Land Use- Land Cover Change

Land use

Land use refers to a series of operations on land, carried out by humans, intending to obtain products and benefits through using land resources, including soil resources and vegetation resources. In its broader sense, the term "land use" refers to the human utilization of land, encompassing settlements, cultivation, grazing, recreational areas, and industrial zones. Whereas the land cover represents the biophysical cover of the land.

Land cover

The term "land cover" originally referred to the kind and state of vegetation, such as forest or grass cover, but it has broadened in subsequent usage to include other factors, including man-made structures like buildings, soil type, biodiversity, surface, and groundwater (Meyer, 1995).

Land use land cover Changes

Land use and land cover change altered principally by direct human use of agriculture and livestock raising, forest clearing, and urban development. A serious problem the living earth is facing at present is the deterioration of both the natural environment and natural resource. Pparticularly in Ethiopia land is the major natural resource on which economic, social, infrastructure, and other human activities are undertaken. Changes in land use and land cover have always occurred in the past, and present, and are likely to continue in the future.

2.1.2. State and Trends of LU/LC Change in Jeberti Forest Ecosystem

According to our observation and information from the FGD and documented study obtained we understand the status and trend of land use land cover changes of the Forest ecosystem area over the period of 2005, 2015 and 2025 as described the forest ecosystem area was covered dominantly forest vs shrub land coverage changed.

See the map cultivated land, settlement and forestland use vs land cover change in the period from year 2005 to 2025.

From the year 2005 to 2025 the land-use and land cover changes detection matrix show that decresed in the forest and shrub land coverage from 66% to 56 %, cropland was increase by from 7% to 28%. See table; - Jeberti Forest ecosystem land use land cover change.

Table 5: - Land use Land cover change in 2005, 2015, and 2025

ClassName	2005		2015		2025	
	AreaHa	AreaPercen	AreaHa	AreaPercen	Area_Ha	Area_Perce
Perennial crop	13.2	7	38.5	22	50.5	28
Forest	69.7	39	43.3	24	74.4	42
Bare Land	25.6	14	3.0	2	5.6	3
Road	4.6	3	3.8	2	3.6	2
Village	1.4	1	2.6	1	2.6	1
Shrub Land	47.5	27	64.7	36	25.5	14
Cropland	16.7	9	22.7	13	16.3	9
Total	178.6	100	178.6	100	178.6	100

Land use land cover Governance

The Forest land catchment area was governed by the community. Currently, the state involvement in governance is weak or insignificant. The community are full responsible for managing and controlling land holdings family farmlands and communal grazing lands as well as dispute resolution among the neighborhood villages.

2.1.3. Driver and Pressures of Jeberti Forest Ecosystem Catchment Land Use/Land Cover Change

The rapid increase in human population has put great pressure on natural resources mainly on the forest ecosystem for economical needs mainly changing it to farmlands. Land use land cover change is dynamic, widespread and accelerating process, mainly driven by population growth and associated increased economic demand

The Jeberti Forest catchment ecosystem LULC is as constantly changes in response to the dynamic interaction between underlying drivers of human- induced activities and environmental factors causing deterioration the Forest ecosystem. The main drivers behind the land use – land cover changes that had occurred are describe as follow:-

Expansion of agriculture/cash crops

The growing population growth leads many societies to demand more from the land resources mainly expansion of agricultural lands affect the land use land cover changes at an ever-increasing deforestation rate in the Forest

Animal population pressure

The land use land cover change is exacerbated more also by growth of animal population exorable big portion for natural resource degradation and land use-cover changes. See table 2 trends and livestock population growth the Kebelle

This rapid increased animal population has contributed to over grazing causing a large land use land cover change and extinction of indigenous vegetation causing land degradation exposing the area to invasive shrubs and herbs that are not palatable to browsing and grazing animals,

Land use planning problem

In Jeberti Forest ecosystem communities has been considered benefits earned from the farmland and grazing lands are an important socio-economic asset for their livestock are determined. But

this land is governed significantly by the community. The state mainly Agriculture Office involvement and support is insignificant. So the Forest ecosystem and the catchment area has been managed by the traditional way with no scientific imputes.

Tenure insecurity and natural resource degradation

Land tenure insecurity affects how farmers manage and use the resources available to them. If farmers do not feel secure in their control over a particular piece of land, they are less likely to invest time and money into its conservation. This results in land degradation, which leads to reduced soil fertility, loss of biodiversity, and more frequent natural disasters.

2.1.4. Impact of LU/LCC in Jeberti Forest Ecosystem

Land Degradation and Loss of Soil Fertility

Land use land cover changes are perhaps the most prominent form of environmental change phenomenon occurring at spatial and temporal scales in the study area. The changes in land use and land cover aggravate land degradation and soil degradation, Loss of biodiversity, habitat destruction, species transfer and environmental deterioration, negative impact on both the environment and socio-economic settings. As FGD explained that the Soil fertility status of the catchment areas decreased time to time.

As a result the lack of land planning the land use land cover spontaneous changes making it vulnerable to environmental change, fragile natural resources and ecosystems, and a high rate of erosion and land degradation.



Figure 3: land degradation due to charcoal production in the Jebertiy forest ecosystem

Source: field observation

Forest Composition degradation and Biodiversity

As the consequence of Land use Land cover Change, particularly of forest and shrubs degradation vulnerable to invasive species numerous indigenous plant and animal spacious were eliminating in alarming rate.

Loss of productivity

Land use and land cover changes degrade the land's capacity for sustained use and regaining its natural cover. Specifically, changes in land use and land cover have a significant influence on soil resources and biodiversity.

2.1.5. Response for Jeberti Forest Ecosystem

It is a long time the regional state Environmental Protection Authority in collaboration with the Woreda as well as with NGOs has been studying and averting the indigenous forest and shrubs as

well as the grazing biodiversity and land use land cover changes due to invasive shrebs and herbs problem remain aggravated.

The afforestation efforts under way in support of the federal and regional states has established integrated water shade management activity approaches to enhance the area of Jeberti ecosystem soil and water conservations practices.

Even the Wereda Revenue office is not in a position to demand land taxation for the community livelihood is dependent and beneficiary from the LULC. However, the Ethiopian government has been working to implement a land taxation system in connection with land ownership. Projected

As shown in the table from year 2005 to 2025 farmland will increased from 28% to 45 % while the forest-shrubs deforestation rate will be reduce from 45 % to 35%. If this deforestation rate going on with no or little efforts as usual in near future generation it will disappear the forest ecosystem

Table 6 : - projective land use land cover change in 2035

Class Name	2025		2035	
	Area_Ha	Area_Perce	Area_Ha	Area_Perce
Perennial crop	50.5	28	80	45
Forest	74.4	42	62	35
Bare Land	5.6	3	7	4
Road	3.6	2	5	3
Village	2.6	1	4	2
Shrub Land	25.5	14	14	8
Cropland	16.3	9	21	12
Total	178.6	100	178	100

2.1.6. Outlook

If the current rate of deforestation continues with minimal or no intervention, forest ecosystems are likely to disappear in the near future. To counteract this, it is crucial to promote the restoration and enhancement of indigenous tree and shrub species. This effort should involve collaboration among the government, non-governmental organizations (NGOs), and the private sector, leveraging available resources to address the drivers of deforestation and transform these challenges into opportunities for sustainable land use and land cover management.

3. Forest

3.1. State and Trend of Flora and Fauna in the Jeberti Forest Ecosystem

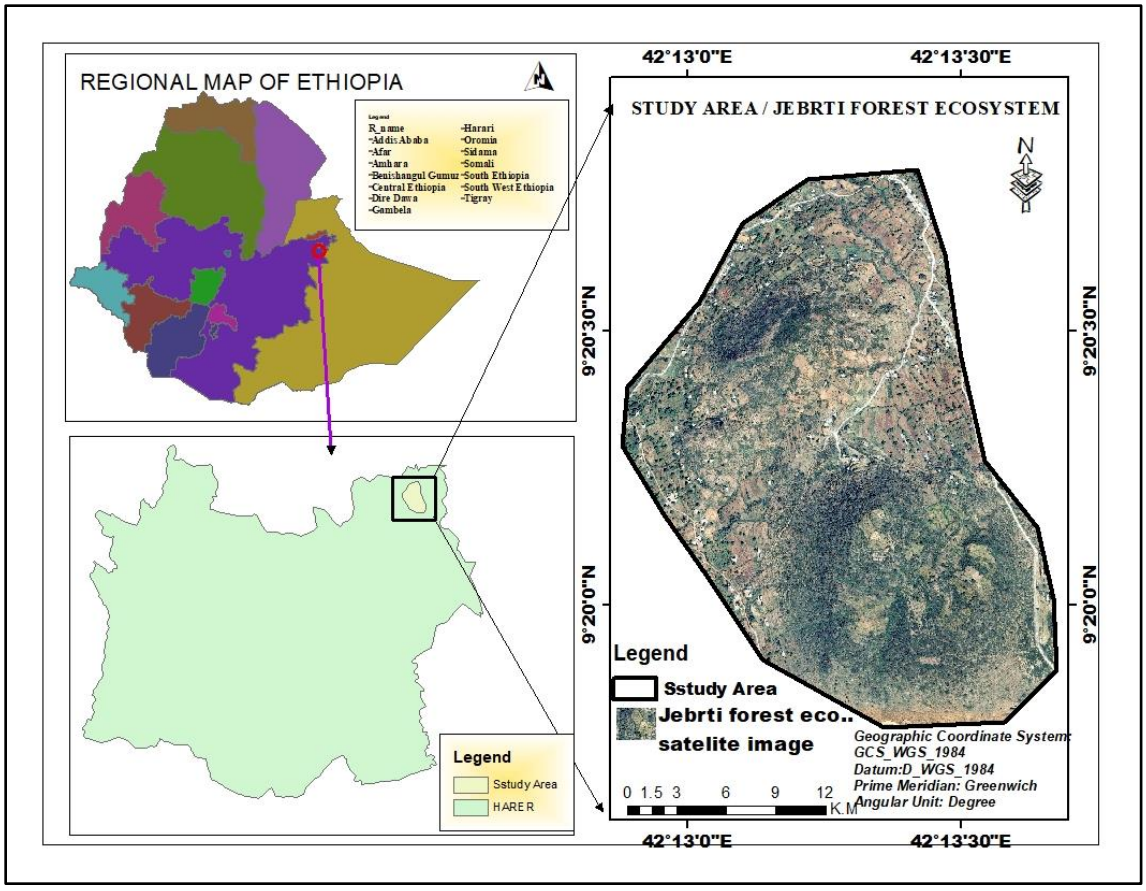


Figure 4: Study area map of the Jebri forest ecosystem

3.1.1. **Absolute Location & Coordinates**

The Jeberti Forest Ecosystem is located in Eastern Ethiopia, specifically within the Harari Regional State. The coordinate system of the study area lies approximately between 9°20'00"N – 9°20'30"N Latitude and 42°13'00"E – 42°13'30"E Longitude. The above Map indicates the "Regional Map of Ethiopia" (top left) highlights a small red circle in the east, which corresponds to the Harari region. The arrow points to a zoomed-in map of the Harari region (bottom left), where the specific "Study Area" is outlined in yellow.

3.1.2. Distance from Major Locations

The Jeberti Forest is located approximately 500 km (310 miles) east of Addis Ababa, a distance clearly illustrated on the map by the long purple arrow extending from the central capital toward the small Harari Region in the east. Within the region itself, the forest lies very close to Harar City. By comparing the map's coordinates (around 42°13'E) with Harar's known position (approximately 42°07'E), the forest is estimated to be only about 10–15 km northeast of the city. This places it on the immediate outskirts of Harar, likely forming part of the nearby upland landscape.

3.1.3.The Jeberti Forest Ecosystem (Satellite Image)

The satellite image on the right presents a high-resolution view of the Jeberti Forest ecosystem, showing a varied terrain with patches of dense vegetation—seen in darker green—interspersed with lighter areas that may indicate grasslands, sparse cover, or human-made clearings. Several paths or open lines appear within the landscape, suggesting possible foot trails or land-use activities. The black polygonal boundary marks the precise limits of the study area as defined in the mapping analysis. The included scale bar demonstrates that the displayed area spans roughly 12 km in width, confirming that the map focuses on a localized but ecologically diverse forest environment.

3.1.4.Land Use Land Cover Change Map (LULCC) in 2005, 2015, and 2025 of Jeberti Forest Ecosystem

The **State** of the Jeberti Forest ecosystem is one of dynamic transition, marked by a significant reversal from degradation to active recovery.

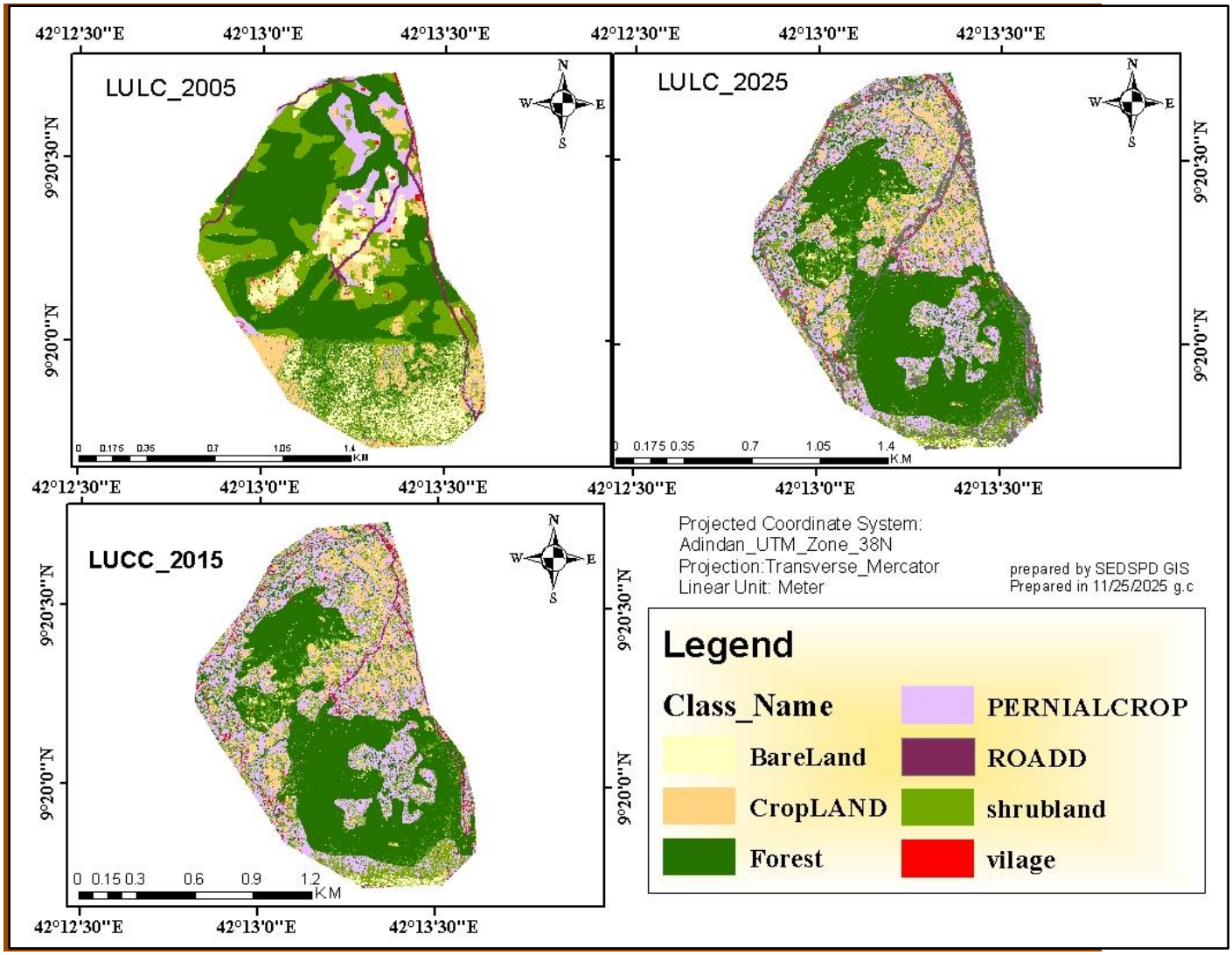


Figure 5:-Land Use Land Cover Map of Jeberti Forest Ecosystem

Table 7:- Land Use Land Cover Map of Jeberti Forest Ecosystem

	2005		2015		2025	
ClassName	Area_Ha	Area Percent	AreaHa	Area Percent	Area_Ha	Area Percent
Perennial crop	13.2	7	38.5	22	50.5	28
Forest	69.7	39	43.3	24	74.4	42
Bare Land	25.6	14	3.0	2	5.6	3
Road	4.6	3	3.8	2	3.6	2
Village	1.4	1	2.6	1	2.6	1
Shrub Land	47.5	27	64.7	36	25.5	14
Cropland	16.7	9	22.7	13	16.3	9
Total	178.6	100	178.6	100	178.6	100

The data reveal a compelling narrative of intense anthropogenic pressure leading to a critical loss of forest cover, followed by a remarkable resurgence driven by concerted conservation efforts.

The expansion of perennial crops demonstrates competing economic land demands, while the dramatic recovery of forest area from 43.3 ha (24%) in 2015 to 74.4 ha (42%) in 2025 underscores the effectiveness of restoration interventions (FAO, 2020). The improvement in soil moisture conditions and the shift in vegetation vigor, as captured by NDVI and SMI analysis, provide further evidence of a changing ecosystem state, though the nature of this recovery requires nuanced interpretation.

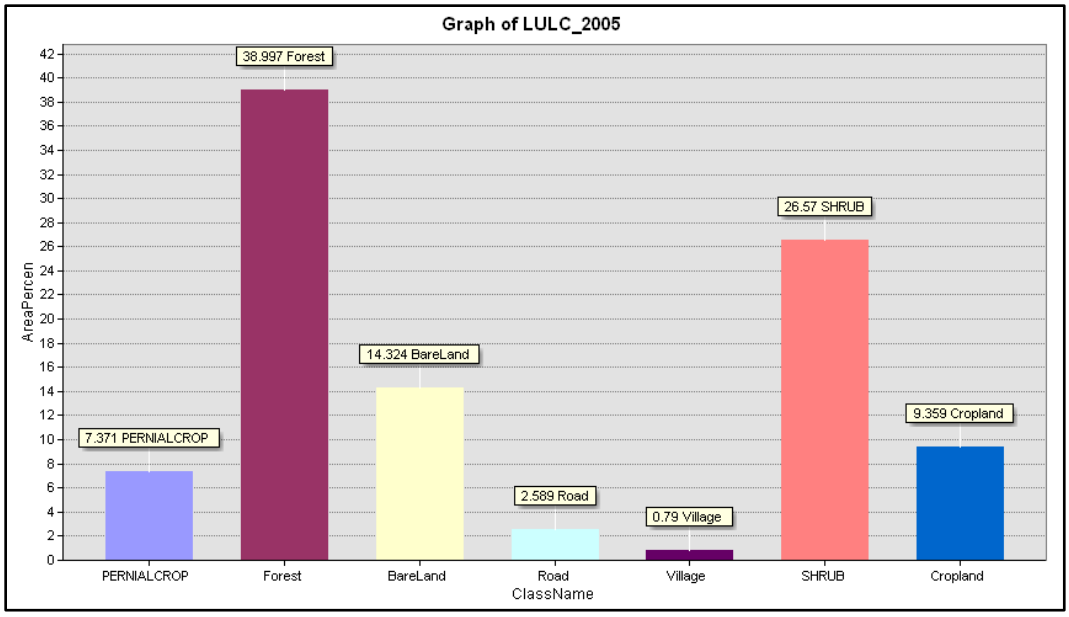


Figure 6:- LULC Graph of 2005

This graph establishes the condition of the ecosystem at the beginning of the study period.

1. Dominant Cover: The area was primarily cover by Forest, accounting for 38.997% of the land.
2. Secondary Cover: shrub land was the second largest category at 26.57%.
3. Bare Land: There was a significant amount of Bare Land (14.324%), indicating areas without significant vegetation cover.
4. Agriculture: Agricultural activity was present but moderate, with Cropland at 9.359% and Perennial Crops at 7.371%.
5. Settlement/Infrastructure: Human settlement was low, with Roads (2.589%) and villages (0.79%) occupying small portions of the landscape.

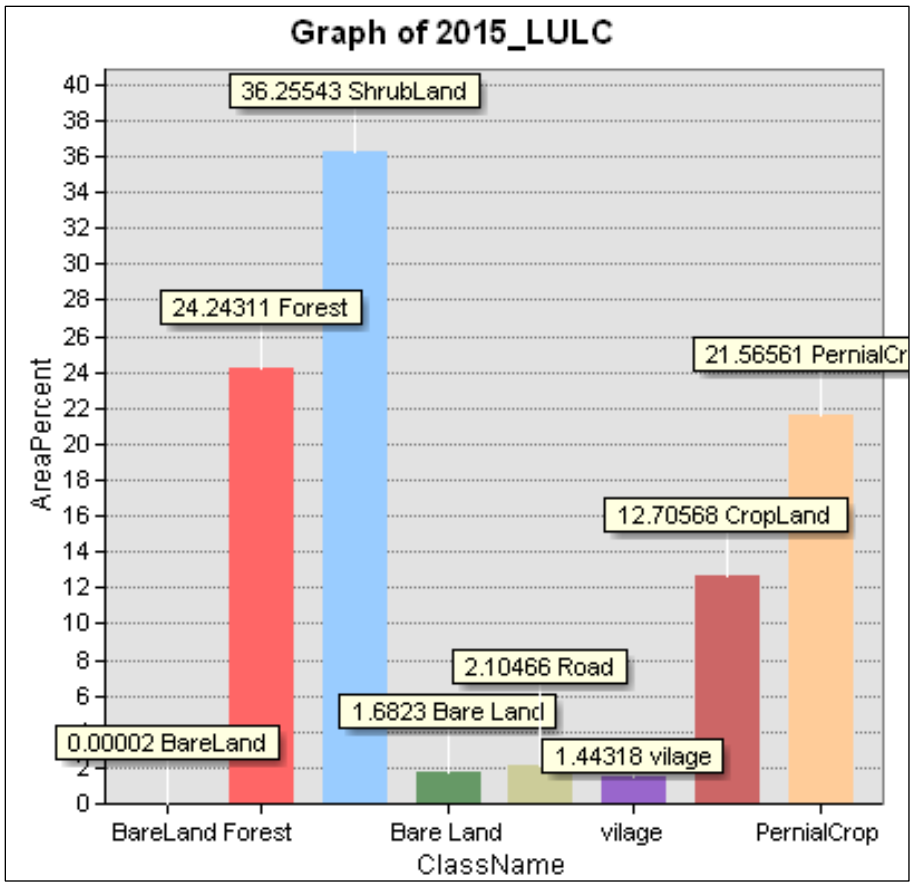


Figure 7:- LULC Graph of 2015

Ten years later, the landscape underwent a drastic transformation, characterized by a reduction in forest cover and a rise in shrub land and specific agricultural types.

1) Dominant Cover Shift: shrub land overtook Forest as the dominant land cover, rising significantly to 36.25543%.
2) Forest Decline: Forest cover dropped to 24.24311%, suggesting deforestation or degradation of the forest into shrub land during this decade.
3) Agricultural Expansion: There was a massive increase in Perennial Crops, which jumped to 21.56561% (nearly triple the 2005 figure). Cropland also saw a slight increase to 12.70568%.

4) Reduction in Bare Land: Bare Land decreased drastically to just 1.6823%, implying that previously unused land was converted into agricultural fields or shrub land.
5) Settlement Growth: The Village area nearly doubled to 1.44318%, reflecting population or settlement expansion.

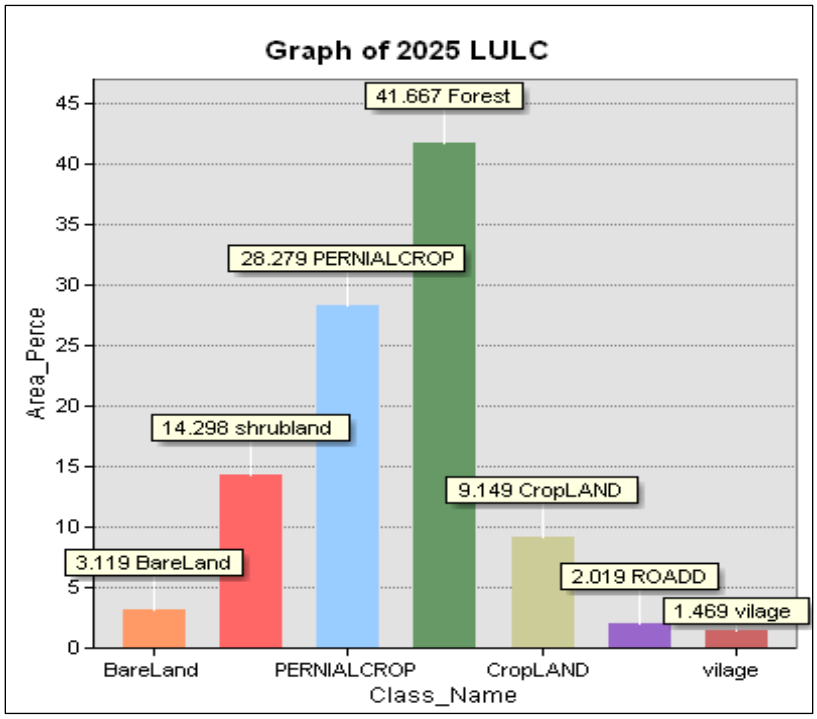


Figure 8:- Graph of 2025-LULC

The 2025 graph appears to represent successful restoration period, showing a strong recovery of the forest.

i. Forest Resurgence: Forest cover rebound significantly to 41.667%, becoming the dominant class again and exceeding the 2005 baseline.
ii. Agricultural Consolidation: Perennial Crops continue to rise, reaching 28.279%, indicating a long-term shift toward this type of agriculture. Conversely, Cropland drops back down to 9.149%.

iii. Shrub land Reduction: Shrub land drops sharply to 14.298% (its lowest point in the timeline), suggesting that much of the shrub land has likely been restored to forest or converted to perennial crops.

iv. Infrastructure: Road coverage remains stable at roughly 2.019%, and Village size stabilizes around 1.469%.

3.1.4.1. Summary of Trends (2005–2025)

Table 8:- 2005, 2015, 2025 Trend Summary

Land Class	2005 Trend	2015 Trend	2025 Trend	Interpretation
Forest	High (39%)	Low (24%)	Highest (42%)	Deforestation followed by successful Reforestation/Recovery.
Shrubland	Medium (27%)	High (36%)	Low (14%)	Expanded as forests degraded, then reduced as forests recovered.
Perennial Crop	Low (7%)	Medium (21%)	High (28%)	Consistent, rapid expansion across all two decades.
Bare Land	High (14%)	Low (1.6%)	Low (3%)	Mostly converted to vegetation or agriculture early on.

Generally, the Jeberti ecosystem shows a "U-shaped" recovery pattern for forests. Between 2005 and 2015, the area suffered forest loss and degradation into shrubland. However, by 2025, the data suggests a successful intervention where forests recover fully, likely alongside a strategic shift toward perennial crop farming.

The Jeberti Forest Ecosystem in the Harari Region has undergone profound land use and land cover changes between 2005 and 2025, driven by complex socio-economic and environmental factors. The DPSIR (Drivers, Pressures, State, Impact, and Response) framework provides a structured framework for analyzing these changes and their implications for sustainability and future management.

3.2. Drivers and Pressures of Degradation in Jeberti Forest Ecosystem

Drivers are fundamental socioeconomic and biophysical forces that cause changes in the ecosystem. In Jeberti, population growth and settlement expansion are key drivers, as shown by the increase in village area from 1.4 ha in 2005 to 2.6 ha in 2015 and 2025 (CSA, 2007; 2019). A main economic driver is the rapid growth of commercial agriculture, notably the fourfold increase in perennial crop land from 13.2 ha (7%) in 2005 to 50.5 ha (28%) in 2025, indicating a regional shift toward high-value crops like khat and fruits driven by market forces (Gebrehiwot & Hundera, 2014). Infrastructure development, though showing a slight net decrease in total road area, has involved upgrading and widening, which enhances access to the forest and facilitates resource extraction and land conversion. Conversely, a significant positive driver has been the implementation of national and regional environmental policies, such as the Green Legacy Initiative, which have mobilized resources for large-scale afforestation and conservation.

3.3. Impacts of Drivers and Pressures on Jeberti Forest

The **Impacts** of these changes are multifaceted, affecting both the ecological and socioeconomic dimensions of the region. The period of forest loss and degradation led to negative impacts such as biodiversity decline, soil erosion, and potential disruption of local water cycles (Moges, Zewide, & Mekonnen, 2021). The NDVI analysis reveals a severe impact on habitat quality, with high and very high vigor vegetation critical for specialist species collapsing from 62% of the area in 2019 to just 3% in 2025 (Pettorelli et al., 2005). Socioeconomically, this degradation reduced the availability of fuelwood, medicinal plants, and other non-timber forest products, increasing livelihood insecurity for local communities. However, the recent recovery phase has initiated

positive impacts. The regrowing forest contributes to carbon sequestration, and the significant increase in moderate soil moisture area (from 0.78 ha to 11.28 ha) indicates improved water retention and a healthier, more resilient ecosystem (Ilstedt et al., 2016).

3.4. Response Taken to Improve the Status of the Jeberti Forest Forest.

Government and Community Responses (2005–2025)

Responses to the societal and institutional actions to mitigate negative impacts have been pivotal in altering the trajectory of the Jeberti Forest. The most impactful response has been the implementation of large-scale reforestation and afforestation campaigns, notably the national Green Legacy Initiative, which directly explains the forest recovery post-2015 (FDRE, 2019). The establishment of enclosures to allow natural regeneration has been highly effective, facilitating the transition of shrub land back to forest. Community-based forest management, involving local communities in protection and management, has fostered a sense of ownership and improved compliance with conservation bylaws (Mekuria et al., 2018). Government enforcement against illegal logging and the promotion of soil and water conservation practices have further supported the ecosystem's recovery. The positive trends in forest cover and soil moisture are the clearest indicators of the effectiveness of these combined responses.

3.5. Outlook

The trajectory of the Jeberti Forest Ecosystem is at a critical inflection point. The period from 2005 to 2025 demonstrates a dramatic "U-shaped" recovery, but this positive trend is not yet guaranteed. The future state of the forest will be determined by whether the forces of conservation or the pressures of economic expansion prevail. Based on the LULCC trends, the following scenarios outline plausible futures for the ecosystem.

Scenario 1: The Pessimistic Scenario (Business-as-Usual Continues)

If the current drivers and pressures continue without a significant strengthening of conservation responses, the initial recovery seen by 2025 will be short-lived. The "business-as-usual" path assumes that the expansion of perennial crops continues at its historical rate, eventually overwhelming the capacity for forest regeneration.

What will happen by 2035 and beyond?

1) **Forest Cover Re-decline:** The relentless conversion of land for perennial crops, which grew from 7% to 28% in 20 years, will not stop at the forest boundary. By 2035, forest cover would begin to decline again, falling back below 30% as protected areas and enclosures were encroached upon for new agricultural land.
2) **Shrubland as a Permanent State:** The sharp reduction in shrub land by 2025 will reverse. Shrubland will expand once more, not as a transitional state to forest, but as a degraded, permanent landscape resulting from the fragmentation and degradation of the recovered forest patches.
3) **Loss of Recovery Gains:** The significant improvements in soil moisture retention, evidenced by the growth of moderate SMI areas, will be lost. The landscape will become drier and more susceptible to erosion, undermining agricultural productivity itself.
4) **Biodiversity Collapse:** The NDVI analysis, which already shows a collapse in high-vigor vegetation, would confirm that the complex, mature forest habitat fails to re-establish. Specialist species will be locally extirpate, and the ecosystem will become dominated by generalist and invasive species.
5) **Socio-Economic Strain:** The loss of forest services will lead to renewed scarcity of fuelwood and water, increasing the burden on local communities and potentially leading to conflict over dwindling resources.

In essence, the "U-shaped" recovery becomes a small peak on a long-term downward trend, representing a missed opportunity where initial success not consolidated.

Scenario 2: The Optimistic Scenario (Sustained and Enhanced Intervention)

This scenario assumes that the lessons from the successful 2015-2025 recovery phase are learned and that conservation efforts are not only maintained but also intelligently enhanced. It involves a proactive, integrated approach to land management.

What will happen by 2035 and beyond?

1. **Forest Maturation and Dominance:** Forest cover stabilizes and then slowly expands beyond 45%, but more importantly, the forest *matures*. The NDVI values for high and very high vegetation vigor recover significantly as the tree stands develop into a complex, multi-layered ecosystem. Shrubland continues its decline, primarily transitioning into stable forest.
2. **Sustainable Agricultural Mosaic:** The expansion of perennial crops managed through land-use planning, reaching a sustainable equilibrium. Agroforestry practices are widely adopted, integrating tree cover into agricultural systems, which blurs the hard line between "forest" and "crop" and creates a more resilient landscape mosaic.
3. **Enhanced Ecosystem Services:** The improvements in soil moisture and water retention accelerate. Local microclimates become more regulated, benefiting both agriculture and human settlements. The forest becomes a robust carbon sink and a stable refuge for biodiversity.
4. **Community Prosperity:** Community-based forest management evolves into a source of sustainable income through carbon credits, non-timber forest products, and ecotourism. The forest viewed not as an obstacle to development, but as its foundation, ensuring long-term community buy-in for its protection.

In this future, the 2015-2025 period is seen as the turning point that set the ecosystem on a permanent path to ecological and socio-economic health.

3.6. **Conclusion and Pathway Forward**

The data from Jeberti provides a clear warning and a powerful promise. The Pessimistic Scenario is the path of least resistance, where powerful economic drivers eventually resurface and overwhelm a one-off restoration effort. The Optimistic Scenario is the path of sustained

commitment, requiring intelligent, adaptive management that values long-term stability over short-term gain.

The critical variable is not ecological, but socio-political. The outlook for Jeberti hinges entirely on the continued and enhanced implementation of the DPSIR Responses:

i. Strengthening, not complacently maintaining, conservation policies.
ii. Deepening community involvement and benefits.
iii. Integrating forestry and agriculture through sustainable practices.

The Jeberti Forest Ecosystem has proven it can recover. The future will determine whether we allow it to.

In conclusion, the Jeberti Forest Ecosystem exemplifies a system at a crossroads, having experienced a severe degradation phase but now demonstrating a strong capacity for recovery. While the expansion of perennial agriculture remains a persistent challenge, the data confirms that targeted policy interventions, community engagement, and sustained political will can effectively reverse negative trends. The recovery, however, is still young; the NDVI data suggests the new forest stands have not yet achieved the structural complexity and biomass of the original ecosystem. Therefore, sustaining this positive trajectory requires continued commitment to sustainable land management policies, the diversification of local livelihoods to reduce pressure on the forest, and long-term protection of the regenerating areas. Ensuring the ecological and socioeconomic sustainability of the Jeberti Forest will depend on integrating these strategies into a cohesive, adaptive management plan.

4. Biodiversity

4.1. The Biodiversity of Jeberti Forest Ecosystem A Policy and Intervention Analysis

4.1.1. The Driver-Pressure-State-Impact-Response and outlook (DPSIR outlook) Framework

The DPSIR framework applied for systematically analyze the interlinked socio-economic and ecological factors affecting the Jeberti Forest's biodiversity, forming the basis for a targeted strategic intervention plan.

4.1.2. State (S): Current Condition Of Jeberti Forest Biodiversity

The ecological state of the Jeberti Forest reflects an ecosystem in a critical phase of transition. After a period of significant degradation, strong restoration responses have initiated a recovery trajectory. However, the biodiversity value of this recovering system is fundamentally different from its historical state, characterized by young, regenerating stands with lower structural complexity.



Figure 9: Partial view of Jeberti Forest ecosystem

4.1.2.1. NDVI JEBERTI FOREST ANALYSIS

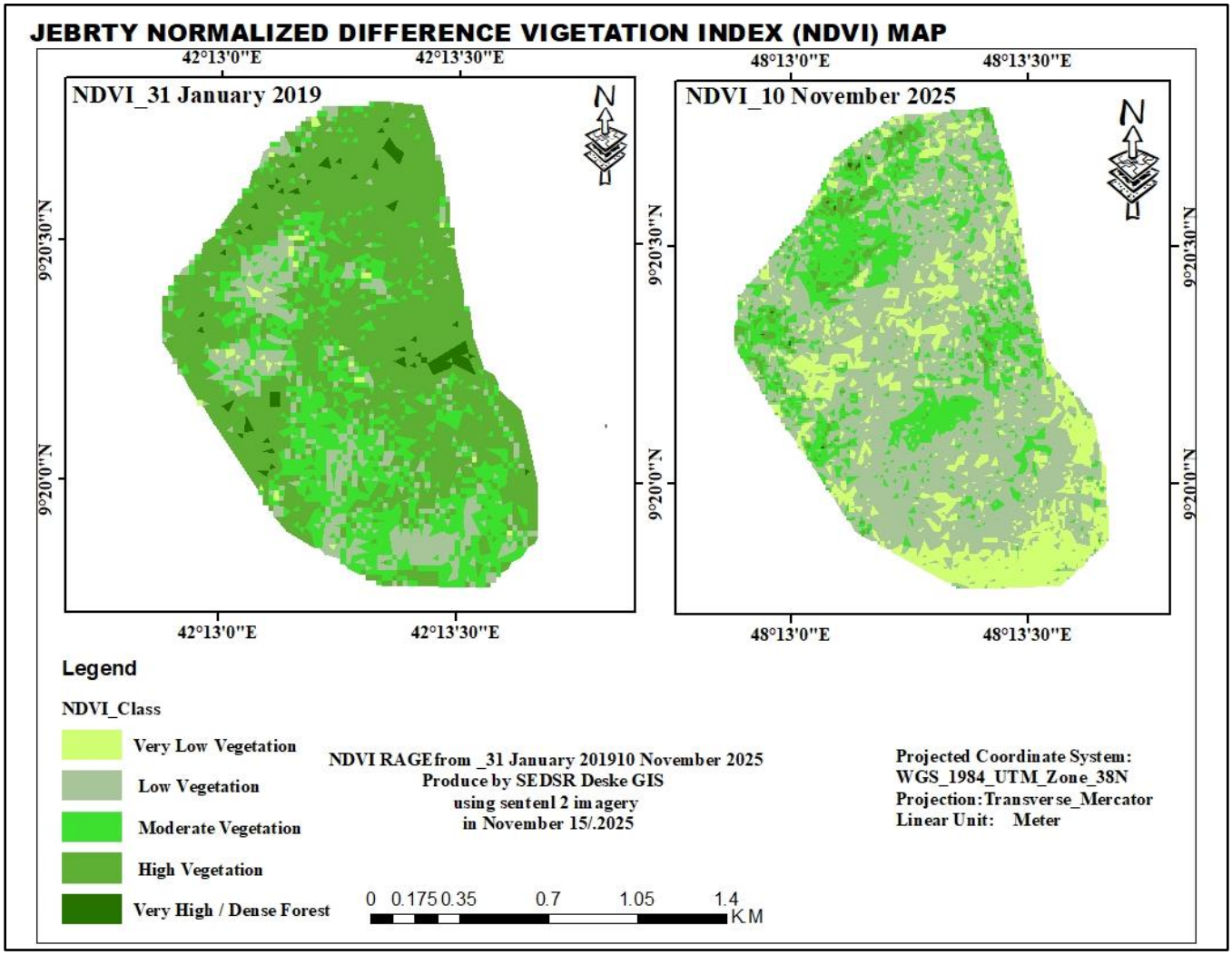


Figure 10:- NDVI Jeberti Forest Map

Interpretation, Explanation, and Analysis of the NDVI Data

The NDVI data for the Jeberti Forest from January 2019 and November 2025 reveals a dramatic and ecologically significant shift in vegetation vigor and structure.

Table 1: NDVI Change in Jeberti Forest (2019 vs. 2025)

NDVI Class	Vegetation Description	2019 Area (ha)	2019 Area (%)	2025 Area (ha)	2025 Area (%)	Net Change (ha)	Implication for Biodiversity
Very Low	Bare soil, sparse grass	1.6	1%	35.4	20%	33.8	Major increase in degraded land; habitat loss.
Low	Poor rangeland, stressed vegetation	25.2	14%	100.4	56%	75.2	Dominance of low-quality, homogenous habitat.
Moderate	Grassland, mixed shrubs	42	24%	36.4	20%	-5.6	Slight reduction in medium-quality habitat.
High	Healthy cropland, shrub land, and woodland	105.9	60%	6.2	3%	-99.7	Catastrophic loss of high-biomass, complex habitat.
Very High / Dense Forest	Dense forest, vigorous vegetation	3.2	2%	0.2	0%	-3.0	Near-total loss of climax forest habitat.

4.1.2.2. **The Main Observations**

a) **Collapse of High-Quality Habitat:** The most critical finding is the near-complete collapse of "High" and "Very High" NDVI areas, which fell from 62% of the landscape in 2019 to just 3% in 2025. These classes represent the most complex and productive habitats mature woodlands and forests that support the highest diversity of flora and fauna (Pettorelli et al., 2005).

b) **Dominance of Low-Vigor Vegetation:** The landscape in 2025 overwhelmingly dominated by "Low" and "Very Low" vigor vegetation (76% combined, up from 15% in 2019). This indicates a shift towards homogenous, early-successional habitats that primarily support generalist, disturbance-tolerant species.

c) **Reconciliation with LULC Data:** This NDVI trend appears to contradict the LULC data showing forest recovery. This discrepancy best explained by the nature of the recovery: the new forest areas mapped in 2025 are composed of young, regenerating, or less dense stands that have not yet achieved the high biomass and canopy closure of the former mature forest. The NDVI thus provides a qualitative insight into the poor structural condition of the recovering forest, indicating it is in an early successional stage.

4.1.2.3.**Flora State (Ecosystem Transition)**

The vegetation structure is undergoing a forced succession, shifting from a mature, complex forest to a landscape dominated by young trees, shrubs, and perennial crops.

1. **State of Forest Regeneration:** The core forest area is in a state of recovery. The increase in forest cover from 43.3 ha (2015) to 74.4 ha (2025) is a positive trend, but these are largely young plantations and naturally regenerated saplings that lack the structural diversity (e.g., canopy layers, deadwood) of an old-growth forest.
2. **Loss of Native Understory:** The dramatic decline in shrub land from 64.7 ha (2015) to 25.5 ha (2025), as shown in the LULC data, indicates a loss of this critical transitional and diverse habitat layer, likely converted to forest or cropland.
3. **Dominance of Perennial Crops:** The four-fold expansion of perennial crops (13.2 ha to 50.5 ha) creates a monoculture landscape that fragments habitats and supports low native biodiversity.

Table 9: Major Flora Composition and Status in Jeberti Forest

Category	Dominant Species	Status/Remarks
Regenerating Forest	Plantations of native species (e.g., *Acacia*, *Podocarpus*)	Young, low-structural diversity provides cover but limited habitat complexity.

Category	Dominant Species	Status/Remarks
Invasive Species	Potential incursions of *Lantana camara, Parthenium*	Opportunistic invaders taking advantage of canopy openings; requires monitoring.
Native Trees/Shrubs	*Acacia abyssinica*, *Ficus vasta*, *Olea europaea*	Persisting in core forest patches but marginalized in regenerating and edge areas.
Perennial Crops	*Catha edulis* (Khat), *Coffea arabica* (Coffee)	Forms dense monocultures with very low biodiversity value; fragments forest habita ts.

4.1.2.4. Fauna State (Vulnerability of Forest-Dependent Species)

The faunal community is likely experiencing a shift, with forest-specialist species declining while generalist and edge-adapted species may persist or increase.

Table 10: Key Faunal Species of Conservation Concern in Jeberti Forest

Category	Species (Common / Scientific)	Conservation Status (IUCN)	Ecological Status in Jeberti
Mammals	Grivet Monkey (*Chlorocebus aethiops*)	LC	Population fragmented; dependent on

Category	Species (Common / Scientific)	Conservation Status (IUCN)	Ecological Status in Jeberti
			remaining mature forest patches for food and shelter.
	Civet (*Civettictis civetta*)	LC	Nocturnal; threatened by habitat fragmentation and reduced prey availability.
	Various Forest Rodents & Bats	Mixed	Diversity is linked to forest structural complexity; likely declining.
Birds	Silvery-cheeked Hornbill (*Bycanistes brevis*)	LC	Flagship species; requires large trees for nesting; highly vulnerable to forest degradation.
	Abyssinian Woodpecker (*Dendropicos abyssinus*)	LC	Dependent on mature trees; indicator of forest health.
	Various Forest Warblers & Sunbirds	Mixed	Insectivorous and nectar-feeding birds sensitive to canopy cover changes.

Category	Species (Common / Scientific)	Conservation Status (IUCN)	Ecological Status in Jeberti
Amphibians/Reptiles	Forest-floor frogs and lizards	Data Deficient	Highly susceptible to microclimate changes (drying) from canopy loss.

4.1.2.5. **Soil Moisture State (Ecosystem Function)**

The Soil Moisture Index (SMI) provides a positive indicator of improving ecosystem function, which is crucial for supporting biodiversity.

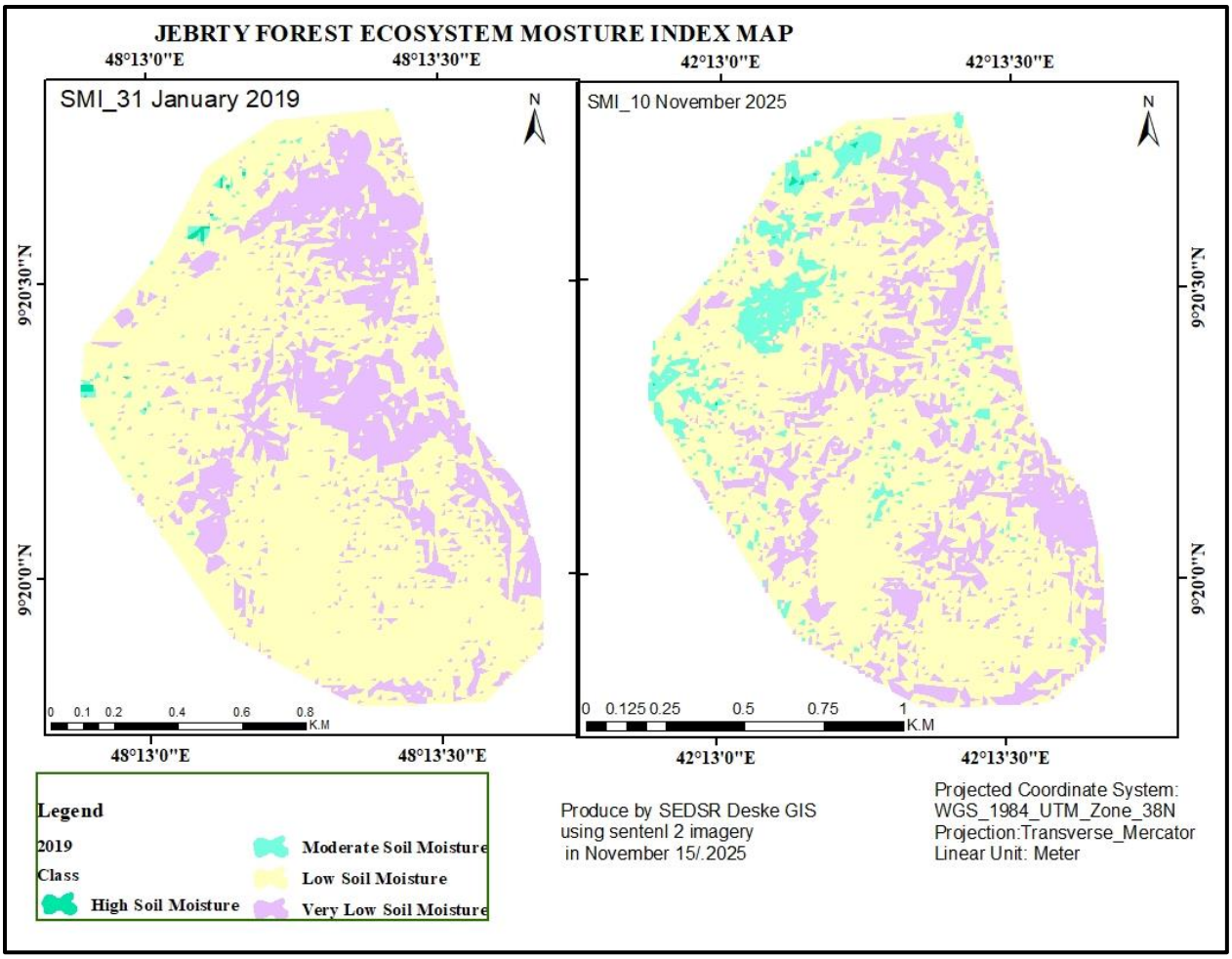


Figure 11: Soil Moisture Index (SMI)

Table 11: Soil Moisture Change in Jeberti Forest (2019 vs. 2025)

SMI Class	Moisture Condition	2019 Area (ha)	2019 Area (%)	2025 Area (ha)	2025 Area (%)	Net Change (ha)	Implication for Biodiversity
Very Low	Severely dry soil	48.2	27.02%	42.7	23.94%	-5.5	Reduction in severely stressed areas.
Low	Dry soil	129.12	72.37%	124.23	69.67%	-4.89	Slight improvement in dry areas.

SMI Class	Moisture Condition	2019 Area (ha)	2019 Area (%)	2025 Area (ha)	2025 Area (%)	Net Change (ha)	Implication for Biodiversity
Moderate	Medium soil water	0.78	0.44%	11.28	6.33%	10.5	Significant creation of areas with sufficient water for healthy plant growth.
High	Wet soil	0.3	0.17%	0.11	0.06%	-0.19	Negligible change.

The 14-fold increase in areas with moderate soil moisture results directly from increased forest cover and less bare land. This improved hydrological system promotes healthier plant growth, boosts drought resilience for plants and animals, and creates better conditions for seed germination and soil organisms, supporting the overall recovery of the ecosystem.

4.1.2.5.1. Overall Trend

The system is shifting toward a younger, simpler forest structure with improved underlying hydrological function. While the recovery of forest area is a major conservation success, the biodiversity value of this new state currently low compared to a mature forest. The trajectory looks positive for ecosystem function, but the full recovery of complex, high-diversity habitats will take decades. Without ongoing protection, the young forest remains vulnerable to reconversion.

4.1.3. Drivers (D): Underlying Socio-economic and Institutional Forces

A. Agricultural Commercialization: The primary driver of habitat loss is the economic shift towards perennial cash crops, particularly khat (*Catha edulis*), which offers higher and faster returns than subsistence farming or forest conservation (Gebrehiwot & Hundera, 2014).
B. Population Growth and Settlement Expansion: The doubling of village area within the forest landscape (1.4 ha to 2.6 ha) indicates increasing human pressure for housing and infrastructure, resulting in habitat fragmentation.

C. Policy-Driven Restoration: A powerful positive driver has been the implementation of national reforestation campaigns, such as the Green Legacy Initiative, which mobilized political and community resources for large-scale tree planting (FDRE, 2019).

4.1.4. Pressures for loss of Biodiversity on the Jeberti Forest

1) Land Conversion for Agriculture: The direct conversion of forest and shrub land to perennial crop fields is the most significant pressure on native biodiversity.
2) Forest Fragmentation: The expansion of settlements and roads creates isolated forest patches, inhibiting wildlife movement and gene flow.
3) Resource Extraction: Ongoing, albeit reduced, pressure from fuelwood collection and selective logging of remaining large trees limits the forest's ability to develop old-growth characteristics.

4.1.5.Impacts for loss of Biodiversity on the Jeberti Forest

The replacement of complex forests with simple habitats has led to a likely decline in forest-specialist species (e.g., hornbills, woodpeckers) and an increase in generalist species (e.g., certain rodents, opportunistic birds). This represents a significant loss of regional biodiversity.

4.1.5.1. **Ecological Impact: Reduction in Habitat Complexity**

The young age and uniform structure of the regenerating forest provide fewer ecological niches (e.g., tree hollows, diverse canopy layers, decaying wood) than a mature forest, leading to a less varied ecosystem overall.

4.1.5.2. **STRATEGIC RESPONSE FRAMEWORK (R)**

4.1.6. **Outlook:**

4.1.6.1. **Business-as-Usual (BAU) Scenario**

Without enhanced measures, perennial crop expansion may continue to encroach on the regenerating forest. The forest may remain in a young, low-diversity state indefinitely due to pressures, failing to recover its full biodiversity potential.

4.1.6.2. **Optimistic Scenario (2035 Vision)**

The Jeberti Forest becomes a model of sustainable forest management, characterized by:

1. Structural Recovery: The regenerating forest matures, developing a multi-layered canopy and increasing its "High" NDVI signature, thereby supporting a returning community of forest-specialist species.
2. Sustainable Livelihoods: Communities benefit from a diversified income, including sustainable NTFP harvesting and potential eco-tourism, reducing pressure on the forest.
3. Connected Landscape: The forest core protected and connected via ecological corridors, allowing for viable wildlife populations.

4.1.6.3. **Theory of Change and Intervention Strategy**

Goal: To accelerate the recovery of structurally complex and biodiverse forest ecosystems in Jeberti by 2035.

Core Logic: If the maturing forest is protected from re-conversion and actively managed for diversity, and if community benefits are linked to forest health, then the state of forest biodiversity will significantly improve, securing critical habitat for specialist species.

4.1.6.4. **Response Pillar 1: Active Biodiversity-Sensitive Forest Management**

i. Enrichment Planting: Go beyond monoculture plantations by enriching regenerating areas with a diversity of native tree and shrub species to accelerate structural and compositional recovery.

ii. Habitat Creation: Actively create habitat features such as artificial nesting boxes for birds and bats, and retain deadwood to boost faunal diversity.

iii. Invasive Species Control: Implement early detection and rapid response programs for invasive plant species to prevent them from colonizing recovering areas.

4.1.6.5.**Response Pillar 2: Sustainable Livelihoods and Zoning**

i. Agroforestry Promotion: Promote the integration of native trees into farmland to create buffers and connectivity, reducing the isolation of the forest core.

ii. Strict Zoning: Formalize and enforce land-use zones distinguishing a Core Biodiversity Zone (minimal extraction), a Sustainable Use Zone (for NTFPs), and a Settlement/Agriculture Zone.
iii. NTFP Value Chains: Develop community-based enterprises for the sustainable harvest and marketing of medicinal plants and wild honey, directly linking economic benefit to forest conservation.

4.1.6.6.**Response Pillar 3: Long-term Monitoring and Governance**

Biodiversity Monitoring: Establish a long-term program to monitor key indicator species (e.g., Silvery-cheeked Hornbill, forest butterflies) to track the effectiveness of interventions.
ii. Strengthen Governance: Integrate community-based forest management groups into the formal governance structure of the forest, providing them with legal authority and support.
iii. Carbon Finance Exploration: Explore opportunities for carbon credit financing through programs like REDD+ to generate sustainable funding for continued forest protection and management.

5. Climate

5.1. State and Trend of Climate Change on Jeberti Wet Land Ecosystem

5.1.1. Climate, Climate Change and Forest Ecosystem

5.1.1.1. Climate

The wind blow from Atlantic Ocean across Equatorial Africa have a marked seasonal effect on much of Ethiopia climate and weather. These inter tropical convergence zone has great influence on Ethiopian Kiremt seasons which is one of the main long rainy seasons. Such weather pattern provides the highlands with most of its rainfall during a period mid-June to mid-September. In addition, short rain gains from March to May Monsoon windblown from Indian Ocean winds.

According to the Ethiopian National Meteorological Service Agency (NMSA) Ethiopia Climate is characterized of having has three seasons of Kiremt, Bega and Belg.

Kiremt (summer) it is starting from mid-June up to mid-September during this seasons long and heavy rainfall occurs.

Bega (winter) is the dry season that occurs during the month of October up to January and little cooler season

Belg seasons on the month of February, March, April and May were short or moderate rainfall occurs.

5.1.1.2. Climate Change

Climate Change is any significant change in climate (such as temperature or precipitation) lasting for an extended period (typically three decades). United Nations Framework Convention on Climate Change (UNFCCC) defines Climate Change as ‘a change of climate which is attributed directly or indirectly to human activity due the composition of the global atmosphere’. Mainly increasing Green House Gas’s in the atmosphere

According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2014), the global surface temperature projected to increase by more than 1.5°C relative to the 1850-1900 period by the end of the 21st century under most scenarios, with many scenarios predicting an increase exceeding 2.0°C. Additionally, climate conditions vary with elevation, with the average temperature decreasing by approximately 0.6°C for every 100-meter increase in altitude.

5.1.1.3. **Baseline State and Trends of Climate of Central EthiopiaRegion (1960 1990)**

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 1960 -1990 taking weather parameters of temperature and rainfall variability and historical events.

A. ***Temperature variability and trend***

The country has experienced both warm and cool years over the last 30 years, however, the later years are the warmest compared to the early years. The Figure clearly reveals that there has been a warming trend in the annual minimum temperature over the past 30 years.

- Years like
    - 1957, 1958, 1973, 1987 and 1995 were very warm while
    - 1964, 1967, 1968, 1975, 1977 and 1989 were very cool.

The average annual minimum temperature over the country has been increasing by about 0.25^0C every ten years while average annual maximum temperature has been increasing by about 0.1^0C. It is interesting to note that the average annual minimum temperature is increasing faster than the average annual maximum temperature.

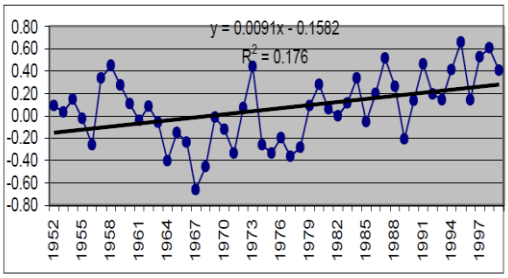


Figure 5.5: Year to Year Annual Mean Maximum Temperature Variability and Trend over Ethiopia

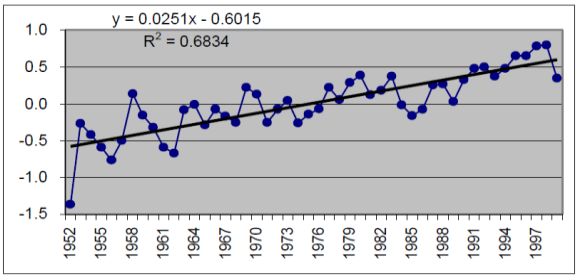


Figure 5.6: Year to Year Annual Mean Minimum Temperature Variability and Trend over Ethiopia

Figure 12: Average annual minimum temperature

For the past four decades, the average annual temperature has been increasing by 0.37ºC every ten years, which is slightly lower than the ***average global temperature rise***. (Global is 0.7 - 1 degree certificate titrate) At country, level the temperature rise more pronounced in the dry and hot spots located in the northern, northeastern, and eastern parts. The mean annual temperature varies from less than $10C^0$ over the central high lands to more than $35C^0$ over Northeastern and Southeastern low lands.

B. ***Rainfall variability and trend****:*

This baseline climate study developed using historical data of precipitation from 1960- 1990 from selected stations. Figure below shows the year-to-year variation of rainfall over the country expressed in terms of normalized rainfall anomaly averaged. As it can be seen from the figures, the country has experienced both dry and wet years over the last fifty 30 years.

- Years like 1952, 1959, 1965, 1972, 1973, 1978, 1984, 1991, 1994, 1999 and 2002 were **dry** while
- Years like 1958, 1961, 1964, 1967, 1968, 1977, 1993, 1996, 1998 and 2006 were **wet**

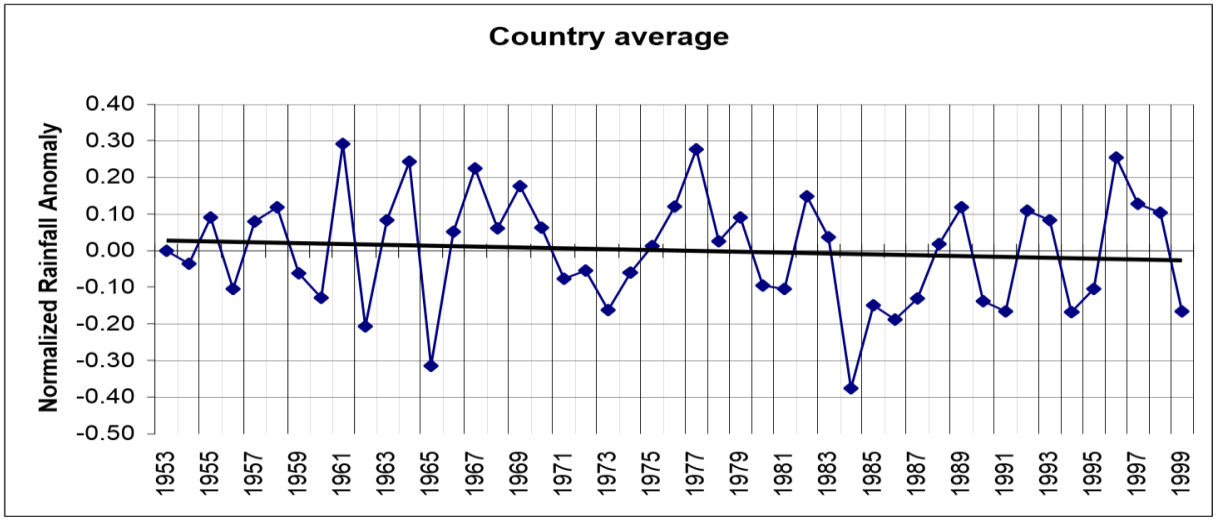


Figure 13:- Rainfall variability

Trend analysis of annual rainfall shows that rainfall in the region is increasing, while a declining trend has been observed over the lowlands and in the highland the rainfall has increased but in the case of the study areas of Central the rainfall has increased.

5.1.2. State and Trends of Climate of Jeberti Wet Land Ecosystem (1990 – 2020)

RainFall

The eastern part of the country experience a bimodal rainfall pattern, receiving the majority of their rainfall from the Atlantic and some derives from the Indian Ocean. The main rains from July to October come mainly from the Atlantic, while the light spring rains between March to May come from the Indian Ocean.

Monthly

According to the national Meteorology agency (NMA) rainfall grid data obtained for the past 23 years (2000 – 2022) , Jeberti forest ecosystem gets the longer from July to

September and the shorter rain from March to May. The data's are analyzed and described as follow

Table 12 average monthly rain fall

Month	Am RF
January	20.84
feburary	13.3
Martch	38.68
April	35.37
May	26.2
June	15.17
July	118.33
August	123.31
September	44.75
October	21.33
November	21.27
December	12.61
Sum	**491.15**

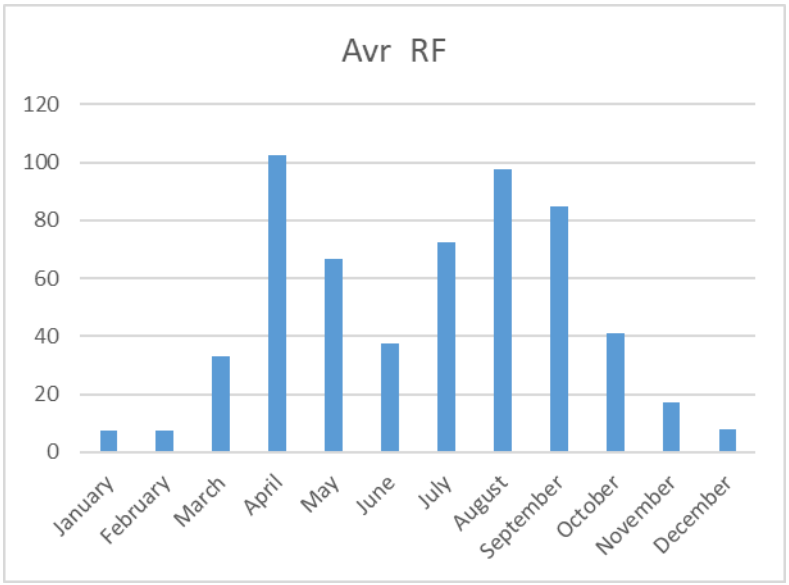


Figure 14: Jeberti forest ecosystem average rainfall trend in months from the year 2000-2022

Yearly

In Jeberti forest Ecosystem the maximum rainfall was recorded in 2006 around 819.63 mm. comparatively minimum rainfall was recorded around 425.72 mm in 2022. One can observe the variation and erratic nature of the rainfall. The rainfall trends shows it is highly variable.

Table 13:- Annual Rain Fall

Year	Annual RF
2000	592.449
2001	594.815
2002	393.381
2003	595.192
2004	633.024
2005	565.67
2006	819.625
2007	705.947
2008	513.53
2009	398.245
2010	509.43
2011	445.326
2012	447.388
2013	719.299
2014	626.63
2015	311.803
2016	719.757
2017	522.04
2018	748.986
2019	615.446
2020	670.325
2021	659.328
2022	425.718
Avr/Year	575.3632

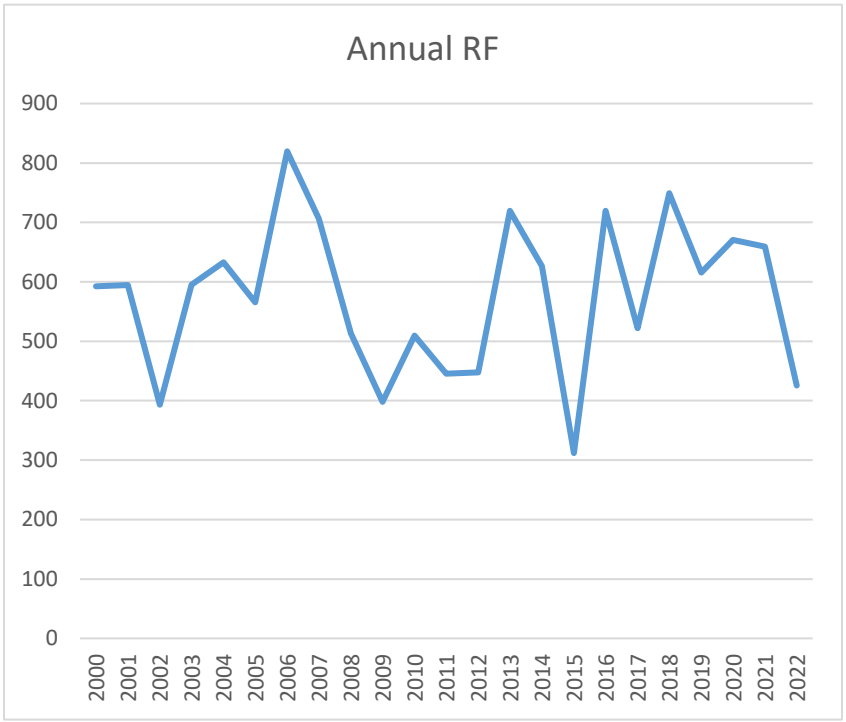


Figure 15 Jeberti forest ecosystem rainfalls from 2000 to 2022

A. **Temperature**

Maximum Temperature - Month

Jeberti forest ecosystem has been experienced a warm pattern from February to May and and relatively cooler July to August.

The hottest month from the 2000 - 2022 period was the months of March with an average maximum temperature of 30.24 °C, relatively cool month was the months of July with a maximum temperature of 26.59 °C while the normal reference is 28.3 °C.

Table 14:- Monthly average Maximum Temperature

Mounth	**Avr T Max**
January	28.25093
February	29.82949
March	30.24459
April	28.88089
May	28.72391
June	27.82667
July	26.58578
August	26.77748
September	27.22766
October	28.74992
November	28.64104
December	27.81187
Avr T Max	**28.29585**

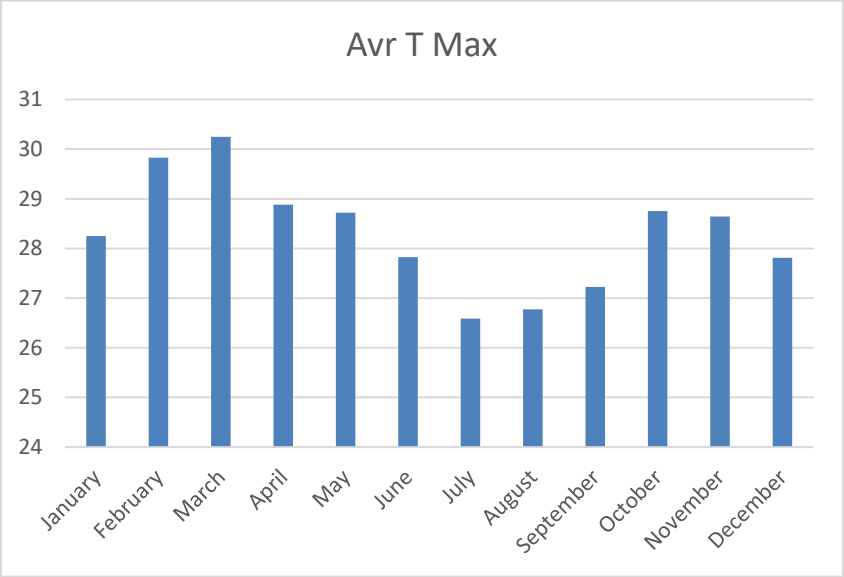


Figure 16 Jeberti Mounthly Average Maximum Temperature

Maximum Temperature - Year

Considering the reference normal of 28.3 °C the average annual maximum temperature recorded

- Highest recorded was 30.15 °C in 2011 with anomaly +1.85 . While
- Lowest recorded was 26.48 °C in 1994 with anomaly of -1.82 °C.

From the data one can observe the Maximum Temperature is range or variance is increasing and getting erratic in recent years.

Table 15:- Annual Maximum Temperature

Year	T Max
2000	27.71497
2001	27.62938
2002	27.47005
2003	28.54343
2004	28.48176
2005	29.08787
2006	28.41626
2007	28.00875
2008	28.34999
2009	28.37802
2010	27.35514
2011	28.51251
2012	28.52984
2013	27.69537
2014	27.70551
2015	28.06642
2016	28.33402
2017	29.15269
2018	26.48
2019	28.43935

2020	29.41232
2021	30.14552
2022	28.89542
Avr	**28.29585**

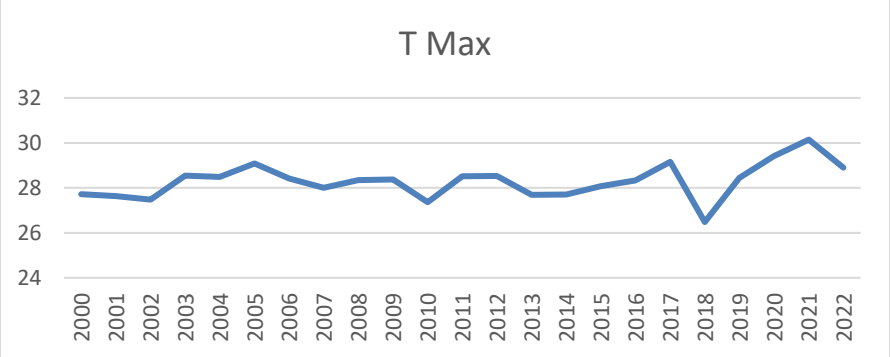


Figure 17: Jeberti Annual Average Maximum Temperatures

Minimum Temperature - Month

Jeberti forest ecosystem has been experienced a warm pattern from April and June and relatively cooler January and February.

The cool month for the 2000 - 2022 period was the months of January with coolest temperature of 12.55 °C, and relatively June is warmer temperature of 15.22 °C while the normal reference of 14.06 °C

Month	Avr T Min
January	12.55253
February	13.49094
March	14.37409
April	15.20022
May	15.03361
June	15.21885
July	14.83701
August	14.76544
September	14.52099
October	13.65786
November	12.80511
December	12.20347
Ann Avr T Min	**14.05501**

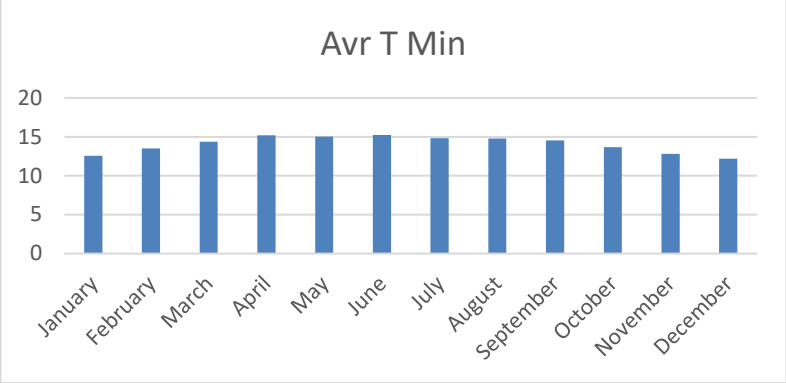


Figure 18:- Jeberti Monthly average minimum temperatures

Minimum Temperature – Year

Considering the reference normal of 14.05 °C the average annual **minimum** temperature recorded

- Coolest temperature recorded was 12.2 °C in 2021 with anomaly - 1.85 . While
- Relatively warmer recorded was 14.75 °C in 2011 with anomaly +.7 . While

From the data one can observe the Minimum Temperature is range or variance is increasing and getting erratic.

Table 16: Average Min temperature

Year	Avr T. Min
2000	13.286294
2001	13.831788
2002	14.146135
2003	13.720222
2004	13.516311
2005	14.188928
2006	14.454523
2007	14.548147
2008	14.26721
2009	14.449259
2010	14.429736
2011	14.752385
2012	13.996034
2013	14.399444
2014	14.822786
2015	14.499538
2016	14.453439
2017	13.17824
2018	14.130919
2019	14.242433
2020	14.215753
2021	12.203077
2022	13.532643
Avr T Min	**14.05501**

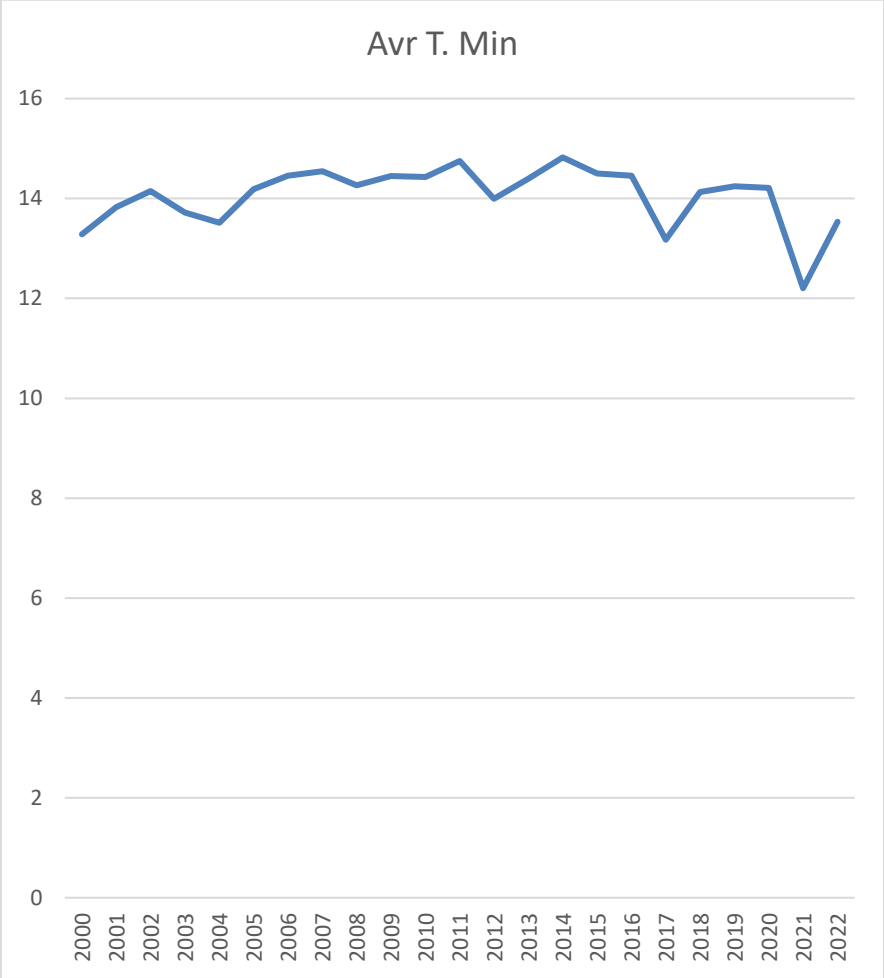


Figure 19:- Jeberti Annual average minimum temperatures

B. Climate variability and anomalies observation from FGD

The focus group discussion was carried with selected indigenous elder peoples having well know the forest ecosystem and the climate for the past 3-5 decades. According to their life experiences of sensationalizing the climate change and it's adverse impacts on the forest and livelihoods, they stated and explanations experience is summarized as follow:-

Drought effects /moisture stress

- Jeberti Forest Ecosystem and vicinity areas rainfall is decreasing as compared to the increasing rainfall of the central region. As a result of this the forest area and nearby mountains they are exposed to drought,
- Loss of crop production and productivity. As a result cereals productivity was reduced
- Rainfall is highly erratic and typically falls in the form of intensive convective storms such variability cause shifting of crops seasons

Temperature effects

- Species have shifted their geographic range Lllantana Camara & preatrium, Yeberea Chew invasive herbs and shrub envisage the area
- Location (i.e. elevation and altitude)
    - certain crops like, wheat, maize, sarcoma etc were reduced production
- Animal disease Aba Senga spread recorded since the last 10 -15 years ago
- Currently temperature fluctuation was very high and exposed to diseases cold/Beerd.

5.2. Climate Change Drivers and Pressure Forest Ecosystem

Visuals 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 (caring capacity) to human and other creatures. The degradation and deforestation of forest ecosystems, which serve as carbon sinks and biodiversity reservoirs, release the sequestered carbon into the atmosphere and result in the loss of shade-dependent, understory biodiversity.

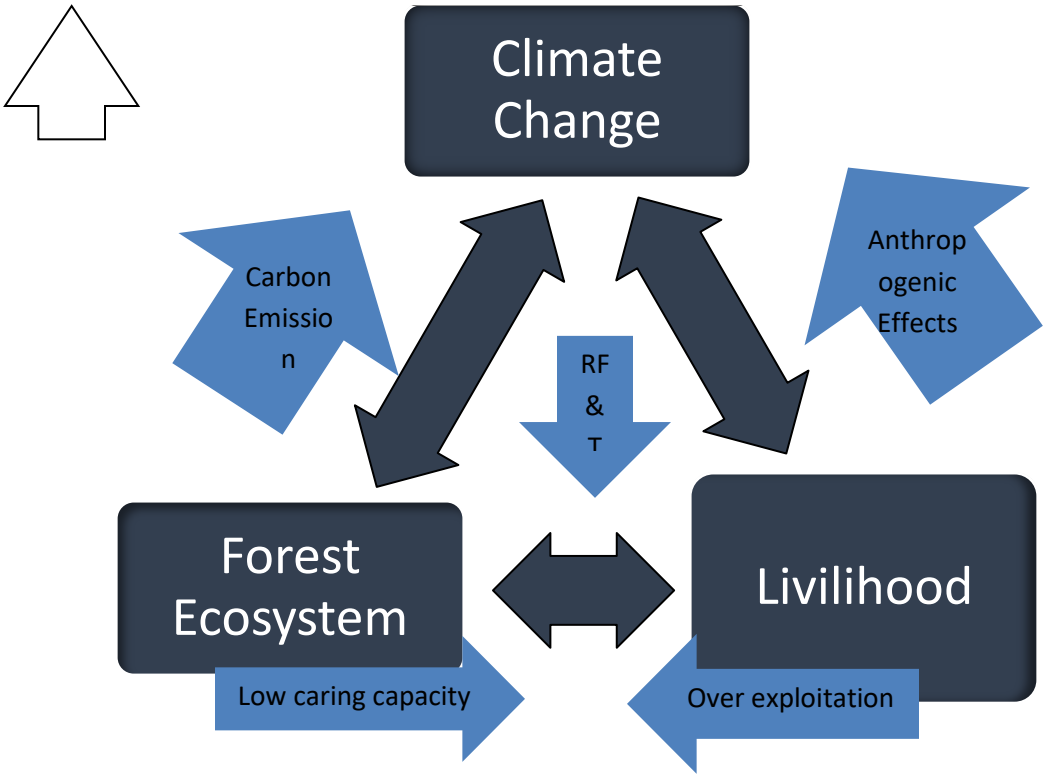


Figure 20:- circle of Climate change, Forest Ecosystem and livelihood

1. Climate change rainfall and temperature variability affects forest ecosystem and livelihoods

a) Livelihoods crises

Frequency and length of the **drought** increase with time in the lowlands due to rise of temperature a

b) Forest Ecosystem degradation and deforestation

Loss of **biodiversity** due to the upper canopy shade deforestation and forest degradation mainly herbs a d shrubs

c) Converting forests lands to agricultural/grazing to annual crops.

2. Forest ecosystem degradation and deforestation affects climate change and livelihoods

Climate change emission

During field observations, it was noted that local communities engage in deforestation to produce charcoal. This practice not only leads to the loss of forest cover but also releases smoke and greenhouse gases into the atmosphere, contributing to air pollution, carbon emissions and environmental degradation.



Figure 21 Charcoal production inside the Jebertiy forest ecosystem

Deforestation and forest degradation as well as biomass energy uses like Fuel wood

Field observations reveal that local communities engage in deforestation for the purpose of harvesting and selling fuelwood. This practice accelerates the depletion of Jeberti forest cover, leading to increased carbon emissions from biomass burning and soil degradation due to the loss of root structures that stabilize the soil. Moreover, the depletion of forest ecosystems disrupts vital ecosystem services, including carbon sequestration, water regulation, and biodiversity preservation, thereby exacerbating environmental degradation and contributing to climate change.



Figure 22: Community engage selling fuelwood to the market

Land Degradation and Invasive spp

As the result of the catchment area degradation and favorable environment created for the invasive species mainly the Prosodies Julifelerea make the indigenous and native trees and shrubs as well as wild animals are extinction or endanger condition. The composition of the forest and the ecosystem is changing

3. **Livelihoods crises affect Forest ecosystem degradation and deforestation and aggravate anthropogenic effects of climate change**

Forest Ecosystem degradation and deforestation

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.

Animal Population

Grazing and browsing animal population growth and animals coming from near nearby Wereda/Tribes cause over grazing and natural vegetation degradation creating favorable condition to invasive species pioneering the degraded environment.

4. **Aggravate Climate change due anthropogenic effects**

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.

As a consequence, the intervention of livelihoods of interest compensation income by converting forests to agricultural lands (crops/grazing) the shade tree and cutting for lumber sales the unearth shade tolerate species has extinct

5.3. Climate Change Impacts

Climate change emission

Deforestation and forest degradation as well as biomass energy uses like Fuel wood use emits carbon due to backward three stone stove which is not energy saving and wasteful.

Frequency and length of the drought increase with time in the lowlands due to rise of temperature

Forest Ecosystem degradation and deforestation

Loss of biodiversity due to the upper canopy shade deforestation and forest degradation mainly herbs a d shrubs

Forest Ecosystem degradation and deforestation

Livelihoods:

Converting forests lands to agricultural/grazing to annual crops.

Illegal timber cuttings in the last remaining high forests which one can blame a number of wood traders

The intervention of livelihoods of interest compensation income by converting forests to agricultural lands (crops/grazing) the shade tree and cutting for lumber sales the unearth shade tolerate species has extinct



Figure 23: converting Jeberti forest to farmland

Source: field observation

5.4. Response to Climate Change

Stakeholders Response

There is no any state or non-state intervention in rehabilitating the Forest Ecosystem starting from its declaring closure there is no any significant interventions

- from NGO and
- State

Actors to help the forest ecosystem conservation efforts

The only efforts are response measures or practices by community in

- Soil and water conservation
- Afforestation and plantation activities

I. Climate Change Projection

Rainfall Projection

IPCC (report 2008) forecast on the level of precipitation shows a long-term increase in rainfall in Ethiopia despite the short- and medium-term observation of frequent dry periods with extreme rainfall levels. The average change in rainfall is projected to be in the range of 1.4 to 4.5 percent, 3.1 to 8.4 percent, and 5.1 to 13.8 percent over 20, 30, and 50 years, respectively, compared to the 1961 to 1990 normal .

Temperature Projection

Future temperature projections under the IPCC's mid-range scenario indicate that the mean annual temperature in Ethiopia will rise by 0.9 to 1.1ºC by 2030, 1.7 to 2.1ºC by 2050, and 2.7 to 3.4ºC by 2080, relative to the 1961-1990 baseline. This trend poses a sustained threat to the country's economy.

5.5. Outlook

Accordingly based on the available meteorological data in Jeberti forest area temperature was increased. If this condition continuous without any strong mitigation, and adaptation measures in the coming 22 years temperature will increased, it will lead to increase climate-related hazards on the society and as well as on the Forest Ecosystem.

Unless, the vicious triangle of climate, livelihood ad Forest Ecosystem linkage is broken through the climate change mitigation ad adaptation efforts of livelihood improvement, reduce deforestation and degradation through enhancing participatory forest management practices of : -

- use alternative cooking stoves technology,
- rehabilitee of forests through afforestation, reforestation,

In the coming climate state and trend of forest ecosystem can be conserved the existing status and enhanced in quality and quantity benefiting the ecosystem and livelihood. Therefore, the forest ecosystem will face more challenges in accelerating sustainable growth in the face of future climate 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 Forest Ecosystem neighboring vulnerable people.

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

II. Recommendation

To assure sustainable development and rehabilitate Jeberti Forest Ecosystem it needs to break the vicious 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 ad the Forest Ecosystem.

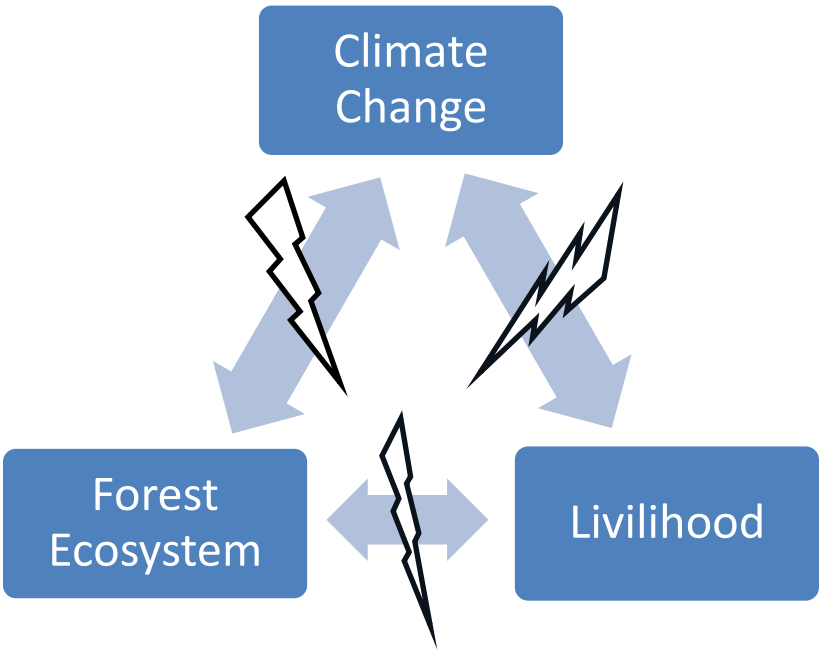


Figure 24circle and interlink between climate, forest and livelihoods.

Sustainable development among climate, forest ad livelihoods:-

- **Climate Change**
  - Reduce carbon emission from deforestation ad forest degradation
- Forest Ecosystem
  - Promote adaptation strategies of PFM
  - Rehabilitee forest ecosystem through afforestation, reforestation,
  - Strengthening participatory forest management practices in coloration with the government, the society and by NGO.

- 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
  - 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 and 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
  - 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.

6. WATER

6.1. State and trend of Water availability Jeberti Forest ecosystem

Water universally recognized as essential for sustaining life on Earth. It would not be an overemphasis to say that without effective water resource management, the world's social and economic development will be severely constrained or even threatened in the future. Both developed and developing countries need to implement more effective water management policies and practices for better water quality and ensure the availability of water in nature (UNEP, 2010). Water is one among the foremost, important, and most precious natural resources. Without it, there would be no life on earth. It is essential to the survival of civilization. However, the majority of people in the globe, mostly in Africa and Asia, do not have access to better water supplies or sanitation services (WHO/UNICEF, 2017). Sub-Saharan African countries are at the front of the

water scarcity problem, one among which is Ethiopia, despite the fact that the country has abundant groundwater, major lakes, and large volumes of rainfall (WHO and UNICEF, 2019)

Water is an inorganic compound with the chemical formula H_2O. It is a transparent, tasteless, odorless, and nearly colorless chemical substance. It is the main constituent of Earth's hydrosphere and the fluids of all known living organisms, in which it acts as a solvent. Water, being a polar molecule, undergoes strong intermolecular hydrogen bonding which is a large contributor to its physical and chemical properties. It is vital for all known forms of life, despite not providing food energy or being an organic micronutrient. Due to its presence in all organisms, its chemical stability, its worldwide abundance, and its strong polarity relative to its small molecular size, water often referred to as the "universal solvent".

Because Earth's environment is relatively close to water's triple point, water exists on Earth as a solid, a liquid, and a gas. It forms precipitation in the form of rain and aerosols in the form of fog. Clouds consist of suspended droplets of water and ice, its solid state. When finely divided, crystalline ice may precipitate in the form of snow. The gaseous state of water is steam or water vapor.

Water covers about 71.0% of the Earth's surface, with seas and oceans making up most of the water volume (about 96.5%). Small portions of water occur as groundwater (1.7%), in the glaciers and the ice caps of Antarctica and Greenland (1.7%), and in the air as vapor, clouds (consisting of ice and liquid water suspended in air), and precipitation (0.001%).[24][25] Water moves continually through the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

Water plays an important role in the world economy. Approximately 70% of the fresh water used by humans goes to agriculture.[26] Fishing in salt and fresh water bodies has been, and continues to be, a major source of food for many parts of the world, providing 6.5% of global protein. Much of the long-distance trade of commodities (such as oil, natural gas, and manufactured products) transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam used for cooling and heating in industry and homes. Water is an excellent solvent for a wide variety of substances, both mineral and organic; as such, it is widely used in industrial processes

and in cooking and washing. Water, ice, and snow are also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, diving, ice skating, snowboarding, and skiing.

Etymology

The word water comes from Old English **water** from Proto-Germanic watar (source also of Old Saxon watar, Old Frisian wetir, Dutch water, Old High German wazzar, German Wasser, vatn, Gothic (wato)), from Proto-Indo-European wod-or, suffixed form of root wed- ('water'; 'wet').[28] Also cognate, through the Indo-European root, with Greek ὑδωρ (ýdor; from Ancient Greek ὕδωρ (hýdōr), whence English 'hydro-'), Russian вода́ (vodá), Irish uisce, and Albanian ujë.

According to Prasifka (1994), water covers about three-quarters of the earth's surface. However, it is worth noting that freshwater is unevenly distribute across the world. To illustrate, only the Amazon River carries one-fifth of the water discharged by all the world's rivers. The Amazon is theoretically enough to supply twice the worlds freshwater needs. The great river of China, Yangtze Kiang, has enough water to supply every person on the planet with about 500 liters of water in a day. As water is nowadays a limiting factor for the socio-economic development of any country, international, regional, and local conflicts overutilization of water are increasing significantly. In addition to the impact of global change on water resources in the world due to increasing demand, excessive water extraction from underground aquifers and rapid population growth are among these problems.

Although the growing demand for water in agricultural production has received considerable global attention in recent years, water requirements for energy production have largely been overlooked by water professionals and development practitioners.Sustainable development and advanced economic growth, sanitation, wastewater treatment, and water supply cannot achieved without adequate energy resources, especially in developing countries. Similarly, it is not possible to produce electricity on a large scale without large quantities of water (Asit, 2008).

According to WWAP (2012), water management is not only a technical term but also encompasses various scientific disciplines and activities. It requires a combination of practices and

measures, including policies, regulations, principles, prices, and other incentives, and changes in physical infrastructure and facilities. Integrated Water Resources Management (IWRM), which is intensively voice nowadays, focuses on the necessary integration of water management between sectors, policies, and institutions. These divided into three categories: Management of resources, Management of water services, and Management the necessary balance between supply and demand. Management of water resources refers to the management of rivers, lakes, and groundwater. It includes water allocation, assessment and protection from pollution, natural and man-made infrastructure, and groundwater discharge to maintain, distribute and store water-related ecosystems and water quality. Water service management extends from the water supplier to the end user's demand. Management of balancing supply and demand also involves a wide range of socio-economic interests, administrative activities related to allocation, authorization, and agreements (Tortajada and Biswas, 2009).

The Ethiopian Rift characterized by a chain of lakes that vary in size, as well as in their hydrological and hydrogeological settings. Some of the lakes and tributary rivers used for irrigation, soda abstraction, commercial fish farming and recreation; and they support a wide variety of endemic birds and wild animals. Few lakes shrunk due to excessive abstraction of water; others expanded due to increase in surface runoff and groundwater flux from percolated irrigation water. Excessive land degradation, deforestation and over-irrigation resulted in sedimentation in lakes and increase in soil salinity. Water is essential to sustain life, and a satisfactory (adequate, safe, and accessible) supply of drinking water should be available to all (Okorafor et al., 2012, Mboto et al., 2019). Improving access to safe drinking water may result in tangible benefits to health. So that, every effort should be made to achieve drinking water that is as safe as practicable (WHO, 2017). The availability and accessibility of good water quality is crucial for both social and economic growth, as well as for ensuring public health, environmental protection, and sustainable development (WHO, 2008).

Lack of safe water remains one of the world’s most urgent health issues. People in developing countries have no access to safe and adequate drinking water despite access to safe drinking water

is a global priority agenda. In 2015, it was estimated that approximately 56% of the global population relied on unsafe water sources.

Ethiopia has the lowest water supply and sanitation coverage (WHO and UNICEF, 2019). Ethiopia is one of the developing countries in Sub-Saharan Africa, facing most of the common challenges in providing water services to its citizens. According to data from WHO and UNICEF estimated in 2015, only 11% of the total population had access to improved water supply, 59% had access to unimproved sanitation (WHO/UNICEF, 2017). Safely managed drinking water services refer to improved water sources that are located on premises, available when needed, and free from fecal and priority chemical contamination (WHO and UNICEF, 2019). According to the Central Statistical Agency of Ethiopia (2017), 13% of the national population had access to safely managed water services. Limited access to drinking water services continues to be a major public health problem in Ethiopia.

In Ethiopia, provision of safe, accessible, and reliable water is very critical. In rural areas of Ethiopia during 2016, 4% have safely managed services, 30% have basic services, and 26% have limited services. This leaves 40% of the country's rural population with unimproved water services. According to the Ministry of Water, Irrigation and Electricity (MoWIE), rural water supply coverage reached 63% by mid-2016, while the Ethiopian Demographic and Health Survey (EDHS) 2016 reported a coverage of 57%. Strengthening source-based water safety measures and preventing cross-contamination at the point of use are critical strategies for improving water quality and reducing associated health risks. Source-based interventions include designing and construction of improved source that have the potential to protect water from contamination and deliver safe water; community-driven sanitation to protect pollution of the catchment area from human, animal, and agricultural wastes; and source-based water treatment.

The Harari Water Supply & Sewerage Authority stands as a cornerstone of modern infrastructure within the historic embrace of Harar, Ethiopia. This organization is dedicate to ensuring the vital flow of clean, safe water and the efficient management of sewerage systems for the city's residents. It represents a blend of tradition and progress, merging the needs of a growing urban population with sustainable practices that honor the city's rich heritage. Through its commitment to service

and environmental stewardship, the Authority plays a crucial role in maintaining the health and well-being of the Harari community, while safeguarding the natural resources that have sustained this ancient city for centuries.

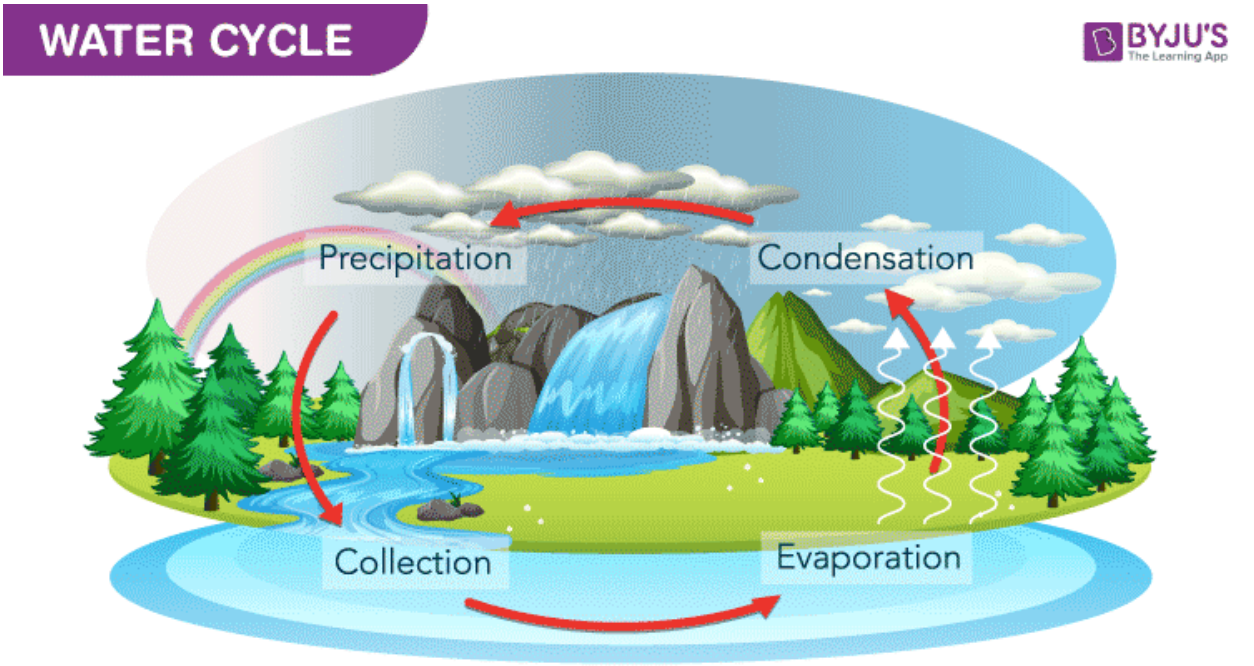


Figure 25: Stages of Water Cycle

Stages of Water Cycle

The complete water cycle is carry into four stages, which are as follows: Evaporation, Condensation, Precipitation and Collection.

Evaporation

This is the initial stage of the water cycle.

The process by which water from its liquid state changes to vapor, a gaseous state, is termed as evaporation. During the water cycle, water in the water bodies get heat up and evaporates in the form of vapor, mixes with the air and disappears.

Condensation

When the evaporated water vapor loses its thermal energy, it becomes liquid through the process of condensation. Formation of clouds are examples of condensation.

Precipitation

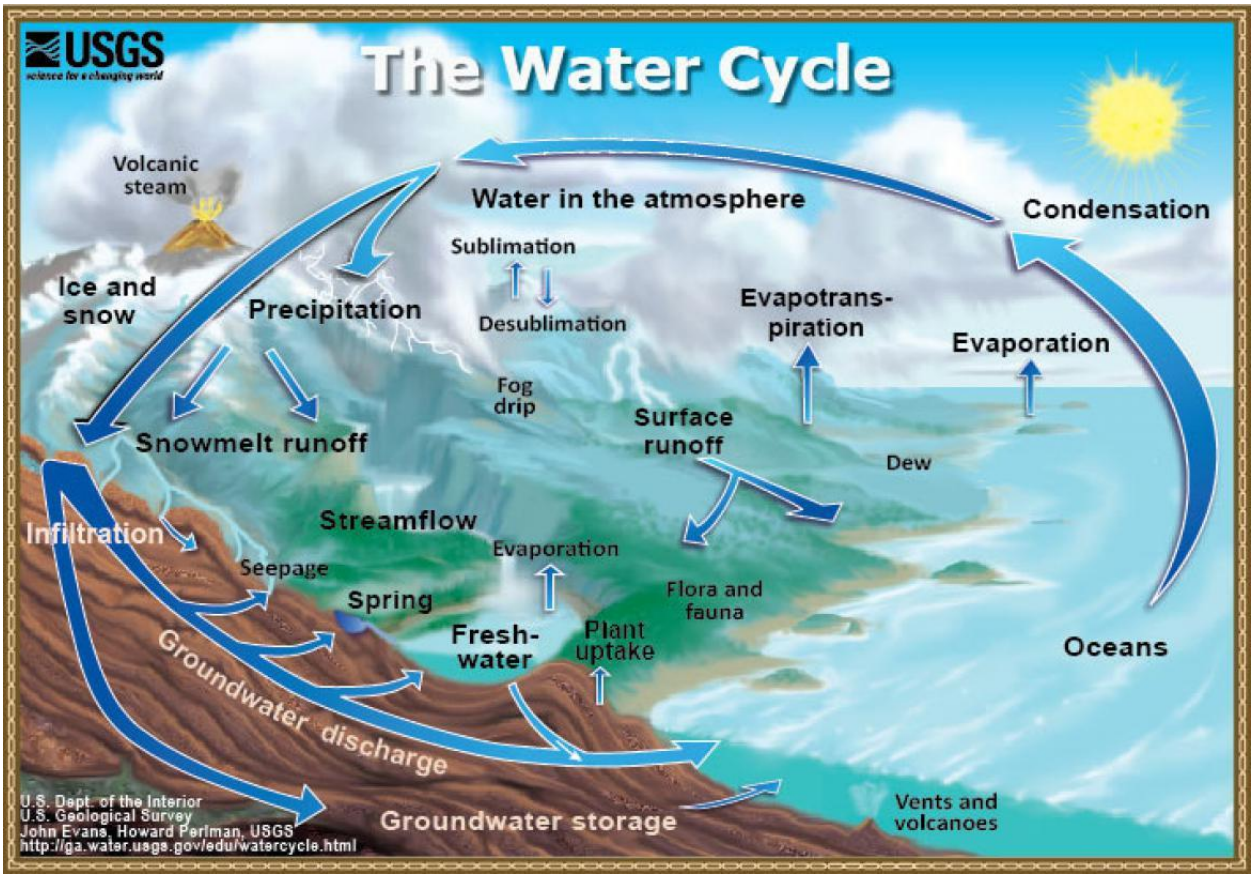
Rain, snow, sleet, or hail are all examples of Precipitation. After the condensation, atmospheric water vapor forms sufficiently large water droplets and falls back to the earth with the help of gravity.

Deposition or Collection

This is the final stage of the water cycle. Deposition occurs when evaporated water vapour falls back to earth as precipitation. This water may fall back into the different water bodies, including oceans, rivers, ponds, lakes and even end up on the land, which in turn becomes a part of the groundwater.

Overall, the water cycle process describes how water is balance in the atmosphere. It also plays an important role in ensuring the availability of water for all living organisms and it has a great impact on our environment.

For more information about Water Cycle, its steps, facts and other related topics, visit us at BYJU'S Biology



.

Figure 26: Water cycle

Earth's water is always in movement, and the natural water cycle, also known as the hydrologic cycle, describes the continuous movement of water on, above, and below the surface of the Earth. Water is always changing states between liquid, vapor, and ice, with these processes happening in the blink of an eye and over millions of years.

The study conducted in Harare regen Jeberti forest ecosystem. The regional state has been striving to provide equal access to safe and affordable drinking water supply for all inhabitants. the regional pure water access coverage in urban is 25% The major sources of potable water supply for rural and urban community are spring ,hand dug well, River and under gowned water .

According to the Woreda water and energy, office people are suffering with water shortage so they travel long distance to fetch water. Due to this reason, rural women's are more vulnerable to water shortage.

6.2. Driver and Pressures of Water Resource Degradation in the Study Area

Overexploitation of fresh water resources jeopardizes human wellbeing and the environment. Wetlands, critical ecosystems for biodiversity, water purification and flood control, are increasingly under threat from a complex interplay of socio-economic and environmental hazards. The multi-hazard context of wetland loss and degradation involves a combination of natural and anthropogenic factors that exacerbate their vulnerability.

Human activities are a primary driver of wetland loss, in particular land use change and agriculture. Agricultural expansion results in direct habitat loss and fragmentation. Agricultural practices represent a significant driver of wetland loss, primarily through conversion for agricultural land, water extraction and pollution. The expansion of agricultural land often necessitates the drainage and infilling of wetlands, disrupting their natural hydrology and ecological functions. Furthermore, agricultural activities can lead to increased nutrient pollution, sedimentation and habitat fragmentation, further degrading wetland ecosystems. These impacts can have severe consequences for biodiversity, water quality and the provision of ecosystem services (Convention on Wetlands, 2022).

Climate change also contributes to wetland loss, manifesting through rising temperatures, altered precipitation patterns and increased frequency of extreme weather events such as storms and droughts. These climatic shifts disrupt hydrological regimes, leading to either prolonged inundation or excessive drying, both detrimental to wetland health. For instance, intensified storms can cause physical damage and increase sedimentation rates, while droughts can reduce water availability, impacting the flora and fauna dependent on wetland habitats (Humpenöder et al., 2020; Gitay et al., 2011).

Moreover, socio-economic factors such as poverty and inadequate environmental governance can exacerbate wetland degradation. In many regions, wetlands exploited for their resources-such as timber, fish and water-without sustainable management practices, leading to over-extraction and habitat destruction (Ghosh et al., 2023).

Wetland loss/degradation is a negative trend in wetland condition, caused by physical or direct/indirect human-induced processes, expressed as a long-term reduction or loss of at least one of the following: biological productivity, ecological role or value to humans (Olsson et al., 2019). Wetlands are defined as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Convention on Wetlands, 1971: Article 1.1). Wetlands may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands (Convention on Wetlands, 1971: Article 2.1).

1. **Population Growth**

According to Jeberti Woreda water mineral and energy office, the amount of wastewater generated from urban area is residences and other households waste increasing from time to time.

2. Overexploitation of Resources

Overexploitation of resources is a significant driver of water degradation in ecosystems through several key mechanisms:

Excessive Water Withdrawal-over-extraction of groundwater for agricultural, industrial, or domestic use can lower water tables, reducing the flow into rivers, lakes, and wetlands. Excessive withdrawal from surface water sources can lead to reduced stream flow, affecting aquatic habitats and ecosystems that rely on consistent water levels.

Habitat Destruction- resource extraction such as mining, logging, and land conversion for agriculture can lead to habitat loss, disrupting the natural water cycle and diminishing water quality.

3 Altered Landscapes: Clearing land for resource extraction can lead to increased erosion and sedimentation in nearby water bodies, degrading water quality and aquatic habitats..

Destructive forest practices can harm the physical environment, leading to further degradation of water quality and habitats.

4. Infrastructure Development -urban development creates impervious surfaces (like roads and buildings) that increase runoff, leading to higher sediment loads and pollutants entering water bodies. Construction activities often disturb soil, leading to increased erosion and sedimentation in nearby rivers and lakes, which can degrade water quality and aquatic habitats. Construction sites can introduce oils, heavy metals, and other pollutants into nearby waterways through storm water runoff.

Disruption of Ecosystems: Infrastructure such as roads and urban areas can fragment habitats, limiting wildlife movement and disrupting ecological processes, which can impact water quality and availability.

New infrastructure can facilitate the movement of invasive species, which can out compete native species and disrupt local ecosystems, negatively impacting water quality.

Expanding urban areas typically increase water demand for domestic, industrial, and recreational use, potentially leading to over-extraction of local water resources and degradation of nearby ecosystems.

Infrastructure development often leads to the destruction of wetlands, which play crucial roles in filtering pollutants, absorbing floodwaters, and maintaining water quality.

Loss of vegetation around water bodies reduces the natural filtration capacity, increasing runoff and pollution.

Infrastructure that does not properly manage wastewater can lead to the contamination of local water sources, posing risks to public health and ecosystem integrity

5. Invasive Species

Invasive alien species (IAS) are non-native organisms that, when introduced to a new environment, can cause significant ecological disruption. They are a major driver of water degradation in ecosystems through several key mechanisms:

Invasive species can introduce new diseases or pests to native populations, further stressing ecosystems and potentially leading to declines in biodiversity and ecosystem health. Invasive species can introduce new predators or competitors that disrupt existing food webs. This can lead to declines in native species that play critical roles in ecosystem functioning, further degrading water quality and habitat integrity. Invasive species often out compete native flora and fauna for resources such as light, nutrients, and space, leading to declines in native populations. This competition can disrupt local ecosystems and alter community structures.

Some invasive aquatic plants can create dense mats that obstruct water flow, affect sedimentation patterns, and reduce light penetration. This can alter aquatic ecosystems, negatively impacting water quality and the organisms that depend on it. Many invasive plants can change the physical environment, such as modifying soil chemistry or water availability. This can lead to changes in hydrology and affect water quality, impacting both aquatic and terrestrial species.

6. Climate Change temperature and precipitation changes altered weather patterns can affect hydrology and biodiversity.

6.3. The main pressures on water in Jeberti Forest ecosystem degradation include:

Water quality degradation is mostly a result of diffuse-source contaminants and the spatial and temporal variability associated with these sources. Diffuse pollution is far more difficult to identify and control than point-source pollution, as highlighted in the conference on diffuse pollution we hosted, DipCon 2011.

How pollution spreads out over time downstream of point sources also presents challenges to those managing water resources. This programme aims to fill the gaps in the scientific understanding of the high-level issues, such as cumulative and multiple-stressor effects and ecosystem tipping points, and will be followed by catchment and local scale water quality modelling.

1. Hydrological Alterations

Water Diversion: Changing natural water flow for agricultural or urban use can lead to reduced water levels, affecting wetland habitats.

2. Pollution

Nutrient Loading: Runoff from agriculture, urban areas, and industrial sites introduces excess nutrients, leading to eutrophication and harmful algal blooms.

Chemical Contaminants: Pesticides, heavy metals, and pharmaceuticals can contaminate water, harming aquatic life and reducing biodiversity.

3. Sedimentation

Soil Erosion: Land use changes, such as deforestation and agriculture, can increase sediment runoff into wetlands, smothering aquatic plants and degrading habitats.

Urban Runoff: Increased impervious surfaces lead to higher sediment loads in storm water runoff, affecting water quality.

4. Climate Change

Changing Precipitation Patterns: Altered rainfall can lead to periods of flooding or drought, stressing wetland ecosystems.

5. Invasive Species

Competition for Resources: Invasive plants and animals can out compete native species for water and nutrients, degrading habitat quality.

Altered Ecosystem Dynamics: Invasive species can change the structure and function of wetland ecosystems, impacting water retention and quality.

6. Overexploitation

Unsustainable Water Use: Excessive withdrawal for agriculture, industry, or urban development can deplete water resources, stressing wetland ecosystems.

Resource Harvesting: Overfishing and unsustainable harvesting of wetland resources can lead to declines in species and overall ecosystem health.

7. Infrastructure Development

Roads and Canals: These can fragment wetlands, alter hydrology, and disrupt natural water flows, affecting the ecological balance.

Urban Expansion: The encroachment of urban areas can increase pressure on water resources and lead to habitat destruction.

8. Recreational Pressure

Pollution from Activities: Increased human activities such as boating, fishing, and hiking can lead to littering and pollution, degrading water quality.

Habitat Disturbance: Recreational activities can disturb wildlife and damage sensitive wetland areas.

6.4. Impact of Water Resource Degradation on the Local Community

Though the region contains a number of perennial rivers of high surface water potential, uneven spatial and temporal distribution of the available water resources either demand huge investment to develop and extend to the water scarce areas or constrained the utility at required time and place. This is again due to the fact that most perennial springs and streams exist only in the highlands, whereas there is hardly any surface runoff and perennial springs and streams in areas below 1500 meters above sea level (m.a.sl) that comprise the majority of the region. Even the ground water, which distributed in the lowlands of the region could not be appropriately developed and utilized because of financial and available technology problems. Such failures in developing and utilizing the region water resources and mismanagement to the sparsely available water have already been reflected as a root cause for overall environmental degradation.

Due to the degradation of Jeberti forest ecosystems can have significant and far-reaching impacts. Here are some key effects:

1. Water quality decline and reduced source of clean water availability -. Poor water quality can lead to health issues for communities relying on surface water sources, increasing healthcare costs.

2. Loss of Biodiversity

Habitat Loss: Forest provide critical habitats for many species, including, birds, and amphibians. Their degradation leads to population declines and potential extinction of sensitive species and, shortage of drinking clean water for the locale community.

3. Climate Change Effects

Increased Vulnerability: Loss of forest Couse the impacts of climate change, making the area more susceptible to flooding and extreme weather events or draughts.

4. Exposed for water borne diseases: Due to the loss of water quality by different activities the focus group discussion and key informants told that they were expose to diseases like cholera, diarrhea, bilharzia and other water borne diseases through time. Specifically, women's, children's and animals are going too far distances to fetch water.

6.5. Responses to protect water in the Jeberti forest ecosystem

In response to water degradation, local communities and Woreda implement some measures aimed at mitigating impacts and restoring water quality. From those measures water shade management (soil and water conservation practices), Lake buffer zone demarcation and development, Community awareness and education programs are often introduce to inform residents about the importance of water conservation and the consequences of degradation.

6.6. Outlook

The outlook for water degradation in Jeberti Woreda is increasingly concerning due to rapid population growth, deforestation, water demand for agriculture, and drinking, urbanization, and climate change. Water bodies are under significant stress from pollution, over extraction, and habitat destruction, leading to decreased, threated water quality and biodiversity loss. Climate change further complicates the situation with altered rainfall patterns and prolonged droughts, impacting water availability and ecosystem health. Rural communities, dependent on these

resources, face increased vulnerability, as they are expose to significant health risks and suffer from reduced agricultural productivity. Despite these challenges, there is potential for positive change through heightened awareness, community-led conservation, and government initiatives focused on sustainable water management. Strengthening policies and infrastructure, along with fostering community engagement, is vital for reversing degradation trends and enhancing resilience in Ethiopia's water ecosystems.

6.7. Conclusion

The degradation of water bods has profound implications for water quality, biodiversity, climate resilience, and human livelihoods. Protecting and restoring water bodes is essential for maintaining healthy water systems and sustainable ecosystems. Addressing the overexploitation of resources through sustainable management practices is crucial for protecting water quality and ensuring the health of ecosystems. Implementing conservation strategies, improving resource efficiency, and restoring degraded areas can help mitigate these impacts. Addressing these pressures is crucial for the conservation and restoration of wetland ecosystems. Sustainable management practices and policies can help mitigate these impacts and promote the resilience of these vital habitats.

Reference

Albert, S.et al., 2017 heading for the hills: climate driving community relocations in the Solomon Islands and Alaska proved insightfora1.5cfuture. Regional environment changes 1-12, do: 10.1007/s10113_017-1256-8.

Central Statistical Agency (CSA). (2007). The 2007 Population and Housing Census of Ethiopia. CSA.

Central Statistical Agency (CSA). (2019). The 2019 Population and Housing Census of Ethiopia. CSA.

Characterization and Classification of Soils of Aba-Midan Sub Watershed in Bambasi Wereda, West Ethiopia Daniel Adhanom*, Tefera Toshome** *Department of Natural Resource Management, Assosa University **Department of Plant Sciences Assosa University

Climate Variability and Household Adaptation Strategies in Southern Ethiopia Wassie Berhanu 1,* and Fekadu Beyene , 2015)

Dereje Mosissa1*, Ashafi Mohammed2 and Yemiru Tesfaye2. World Journal of Agriculture and Soil Science, June 26, 2019. 1- Ethiopian Biodiversity Institute Assosa Biodiversity Center, Assosa, Ethiopia. 2- Hawassa University, Wondo Genet Collage of Forestry and Natural Resources, Ethiopia..

FAO. (2020). Global Forest Resources Assessment 2020. Food and Agriculture Organization of the United Nations.

FDRE. (2019). National Green Legacy Initiative Guideline. Federal Democratic Republic of Ethiopia.

FDRE. (2019). National Green Legacy Initiative Guideline. Federal Democratic Republic of Ethiopia.

Fourth Assessment Report (AR4) Climate Change 2007: Synthesis Report. September 2007. Working Group Report ... AR4 Climate Change 2007: Impacts, Adaptation, and Vulnerability.

Gebrehiwot, K., & Hundera, K. (2014). Area and production of chat in Ethiopia. Journal of Biology, Agriculture and Healthcare, 4(11), 1-5.

Gebrehiwot, K., & Hundera, K. (2014). Area and production of chat in Ethiopia. Journal of Biology, Agriculture and Healthcare, 4(11), 1-5.

Geist, H. J., & Lambin, E. F. (2002). Proximate causes and underlying driving forces of tropical deforestation. BioScience, 52(2), 143–150.

Global Environment Outlook (Geo-6) Healthy Planet, Healthy People (2019).

https://www.epa.gov> ghgemissions>).

https://www.researchgate.net/publication/258049236_Biodiversity_Status_in_Ethiopia_and_Challenges [accessed Dec 11 2018]. © ResearchGate 2018.

IGAD /Biodiversity management programme/ Issue No.2, December 9, 2015

Ilstedt, U., Bargués Tobella, A., Bazié, H. R., Bayala, J., Verbeeten, E., Nyberg, G., ... & Malmer, A. (2016). Intermediate tree cover can maximize groundwater recharge in the seasonally dry tropics. Scientific Reports, 6(1), 21930.

International Journal of Fauna and Biological Studies 2017; 4(5): 67-75, Isolation, identification and antimicrobial susceptibility of Pasteurella multocida from cattle with hemorrhagic septicemia in Assosa and Bambasi districts, Benishangul Gumuz Regional state, Ethiopia.

International Journal of Scientific and Research Publications, Volume 6, Issue 6, June 2016 390 ISSN 2250-3153 www.ijsrp.org

Mekuria, W., Gebregziabher, G., Langan, S., & Veldkamp, E. (2018). Effectiveness of exclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. Journal of Arid Environments, 153, 1-10.

Millennium Ecosystem Assessment Ecosystems and Human Well-being: Biodiversity Synthesis (2005)

Mishra, Husen, A., , V.K., Semwal, K. and Kumar, D. 2012. Biodiversity Status in Ethiopia and Challenges. Gonder, Ethiopia : s.n., 2012. (ISBN 978-93-5056-149-2)..

Moges, Y., Zewide, I., & Mekonnen, M. (2021). Deforestation and forest degradation in Ethiopia: A review. Journal of Forestry Research, 32(2), 1-12.

Mr. Musba Kedir (2019), Greener Journal of Agricultural Sciences,Vol. 9(2), pp. 119-137, 2019,, ISSN: 2276-7770.

Ola et al., G.H.leeks, G.J.I. pack man, J, C., Smith,B,P.G., Lewis.s,. Hiwitt, E., J.2006 river flow and assisted transport of sediments and Solute through highly urbanized catchments, Bradford, west yorksimire, science of the total environment 360:98-108.

Peter T. et al. 2015. What is the Diffrence between weather and climate? s.l. : U.S. Department of Agriculture, 2015. MF3197.

Pettorelli, N., Vik, J. O., Mysterud, A., Gaillard, J. M., Tucker, C. J., & Stenseth, N. C. (2005). Using the satellite-derived NDVI to assess ecological responses to environmental change. Trends in Ecology & Evolution, 20(9), 503-510.

Pettorelli, N., Vik, J. O., Mysterud, A., Gaillard, J. M., Tucker, C. J., & Stenseth, N. C. (2005). Using the satellite-derived NDVI to assess ecological responses to environmental change. Trends in Ecology & Evolution, 20(9), 503-510.

UNFCCC. 2007. Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries. 2007, pp. 17, 28, 51 and 54 .