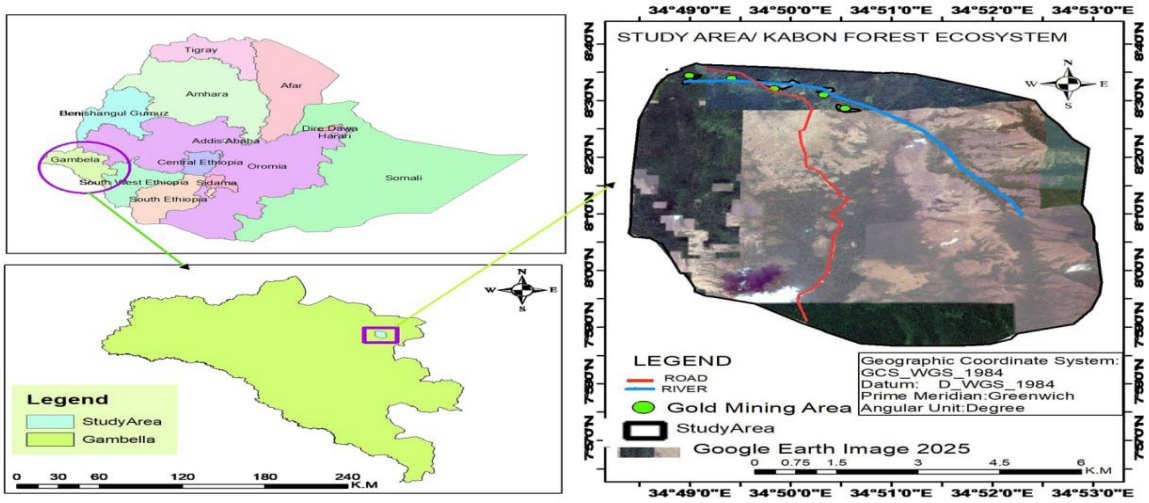
The Federal Democratic Republic of Ethiopia

Environmental protection Authority

FACT–SHEET OF

KABON FOREST ECOSYSTEM IN GAMBELA ETHIOPIA





State of Environment Data Study and Report Preparation Desk

March, 2025

Table of Contents

List of Figure ..... **iii**
List of Table ..... **iii**
Abbreviations ..... **iii**
Writer ..... **iv**
Facilitator ..... **iv**
1. General Back ground **1**
1.1 Environment for Green Economy Development **1**
1.2. Frame works/Approaches **12**
1.2.1. The Driver-pressure-state impact response framework 12
2. Social and Economic Environment **14**
2.1. Social Environment **14**
2.1.1. State and trend of social environment 16
2.1.2. Drivers and pressure of social environment 23
2.1.3. Impacts due to social environment change 23
2.1.4. Responses to social Environment Change 24
2.1.5. Outlook for Socio Environment **26**
2.2. Economic Environment **26**
2.2.1. State and trend of the economic Environment 26
2.2.2. Drivers and pressures of the economy 27
2.2.3. Impacts due to the Economic Condition 27
2.2.4. Response Measure 27
2.2.5. Outlook for Economy 29
2.2.6. Options for future Action 29
3. Biophysical Environment **30**
3.1. Land **30**
3.1.1. State and trends of Land for Kabon forest in Gambella 30
3.1.2. Drivers and pressure for Kabon Land degeradation 33
3.1.3. Impact of land degeradation 34
3.1.4. Response 34
3.1.5. Out look 35
3.2. Forest **35**
3.2.1. State and Trend of Flora and Founa in the Kabon Forest Ecosystem 35

3.2.2. Drivers and Pressures Of Degradation In Kabon Forest and Wood Land Ecosystem 43
3.2.3. Impacts of Drivers and Pressures on Kabon Forest and Wood Land Ecosystem Degradation 46
3.2.4. Response Taken to Improve the Status of the Kabon Forest Ecosystem..... 51
3.2.5. Conclusion 51
3.2.6. Outlook 51
3.3. Atomospher 51
3.3.1. State and Trend of Climate Change on the Kabon Forest Ecosystem 51
3.3.2. Driver and pressure 52
3.3.3. Impact of climate change 53
3.3.4. Outlook 53
3.3.5. Recommendation 54
3.4. Water 55
3.4.1. State and trend of Water in the Gambela worda ecosystem 55
3.4.2. Driver and Pressures of Water Resource Degradation in the Study Area 58
3.4.3. Impact of Water Resource Degradation on the Local Community..... 60
2.4.4. Responses to protect Kabon forest ecosystem 61
2.4.5. Out look 61
2.4.6. Conclusion 61
References 62

List of Figure

Figure 1. Environmental functions supporting economic growth. 5
Figure 2. The link between economic growth and environment. 9
Figure 3. Environment Kuznets Curve. 11
Figure 4.FGD on the issue of flora and fauna degradation 46

List of Table

Table 1. Population Gambela woreda (2020-2024). 17
Table 2. Students, teachers and number of schools in Gambela *Woreda* in Academic year2024 18
Table 3. Health Institutions in gambela Woreda of 2020 and 2024 19
Table 4.T types and length of Roads, existing gambela woreda in the year 2020-2024 20
Table 5. Identified plant and crop species of Kabon forest and woodland ecosystem. 38
Table 6. Faunal species occurred in the forest and wood land ecosystem. 39
Table 7. Medicinal plants occurred in the ecosystem 43
Table 8:Threated plant and flora species 47
Table 9. Threatened faunas tic species in the ecosystem. 47

Abbreviations

AGP—Agricultural Growth Program

Avr – Average

CBD – Convention on Biological Diversity

CDM- Clean Development Mechanism

CRGE – Climate Resilience Green Economy

CSA - Central Statistical Agency

DLUMDR: Department of Land use Management directorate report 2011

DPSIR: Driver, Pressure, State, Impact and Response

E.C. - Ethiopian Calendar

EPA – Environmental Protection Authority

FAO –Food and Agriculture Organization-

FGD: Focus Group Discussion

GDP: Gross Domestic Product

GHG: Green House Gas

GTP: Growth and Transformation Plan

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation Nature

IWRM - Integrated Water Resources Management

MEA-Millennium Ecosystem Assessment

MoWIE - Ministry of Water, Irrigation, and Electricity

NGO - None Governmental Organizations

NMA – National Metrology Agency

NTFPs- Non-Timber Forest Products.

UNEP - United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

UNICEF - United Nations Children's Fun

GwFo-Gambela woreda finance office

WHO - World Health Organization

WMO: World Meteorological Organization.

WWAP - World Water Assessment Programme

GWAO- Gambela Woreda Agriculture office

GwEPA-Gambela Woreda Environmental Protection Ofice

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1. General Back ground

1.1 Environment for Green Economy Development

According to a report of *World Economic Outlook* (2020), economic growth is projected to rise by 3.3% in 2020 and 3.4% in 2021 in comparison to 2.9% in 2019. The increase in economic growth has resulted in worsening of environmental quality. As per International Energy Agency (2018) report, the level of production of goods and services doubled at a global scale from 1990 to 2015, which increased 45% of greenhouse gas (GHG) emissions and reached up to 50 giga tons (Gt) of carbon dioxide equivalent. It is well known that economic growth is crucial for giving greater opportunities to poor people, but it should be accomplished using more energy-efficient and environmentally sound models of growth. Moreover, continuous growth is necessary to develop more environmentally safe and adequate technologies to achieve sustainability goals. There is a strong link between the environment and sustainability, which is considered as a holistic approach for social well-being without any discrepancy. Now, one of the primary challenges is to assure that the developmental policies made for economic growth should be executed in a manner that works in harmony with environmental sustainability. The problems of environmental degradation and climate change have gained much attention over the past years, as they affect both developed and developing countries, though, the world has shifted toward a sustainable approach for meeting the demands of production and consumption. But still, the pace of this transition is not fast enough to reduce the extent of environmental problems.

However, in 1992, the relationship between environment and development was first discussed on a common platform at Rio in Brazil, which is known as “Earth Summit” or the United Nations Conference on Environment and Development (UNCED). This conference introduced the concept of “Sustainable Development,” which created more awareness in both developed and developing countries. However, for developing countries, where poverty is a major issue, environmental problems are gaining more attention, which requires the acceleration of economic growth. From the past few decades, economic growth is the primary aim of policymakers, which is considered as the tool for sustainable development. A fast-growing economy is always in demand due to its favourable socioeconomic outcomes; but at the same time, it also requires a healthy environment. In different studies, it has been established that the connection between economic development and the environment is intricate (Coondoo and Dinda, 2008; Grossman and Krueger, 1995; Lee and Lee, 2009; Lopez et al., 2014; Akbostanci

et al., 2009). All human activities have a direct or indirect impact on the environment, which is formulated and implemented for economic growth to meet the needs of a country. The argument on the relationship of economic growth with the environment in the 1970s and for a significant part of the 1980s was mainly governed by the material balance paradigm. It strongly suggested that ceteris paribus, i.e., economic development contributes to ecological degradation and that if a financial framework is physically in a steady state it can be environmentally sustainable. The amount of resources used in production for the well-being of humans is restrained to a level that does not over utilize its natural assets and exhaust nature's sinks (Stagl, 1999; Smulders, 2000).

Understanding the role of the natural environment in the economic growth of a country is necessary to meet the goals of sustainable development. Environment consists of terrestrial and aquatic assets and also the atmosphere, altogether which are essential for the economy. For the production of goods and services, nature provides the material inputs and also acts as a sink in which the wastes arising from economic activities are dumped. Natural resources have been serving mankind for several decades, and still they are an important part of economic development. The environment functions as a life support system for mankind. Any variation in the social and economic fields may have a positive or negative effect on the earth's environment and vice-versa, and most of the time, the negative results are irreversible. It is necessary to address the environmental issues now, as we are facing the challenge of environmental degradation and climate change across the globe.

In today's world, one of the biggest challenges faced by several economies is accomplishing a harmony between reducing environmental degradation amid the requirement for economic development and environmental feasibility. However, for the protection of the environment, several policies have been adopted by countries around the world, for example, the reduction of GHG emissions and prevention of climate change. It is now a well-known fact that carbon dioxide emission and other GHGs are mainly responsible for global climate change and the greenhouse effect (Lee and Chang, 2009). In transportation, the CO_2 emissions contribute around 90% of all released GHGs (Nocera and Cavallaro, 2011). Therefore, CO_2 emissions have been a subject of considerable attention concerning the reduction of polluting gases. As per the IPCC report (2018), anthropogenic sources, such as emissions of GHG and land-use land-cover (LULC) changes, have resulted in approximately 1°C of global warming which is higher than preindustrial levels, i.e., from 1850 to 1900. Between 2030 and 2052, global warming will reach around 1.5°C; if in case it keeps on expanding at the current rate it will

increase to, for example, about 2°C every decade. By 2100, global warming is supposed to reach 3–4°C above preindustrial levels with conceivably further warming in the future. It has been proposed that climate change will substantially decrease economic development in several developed and developing nations. Monetary and technological changes are fundamental to limit the worldwide temperature increase to 1.5–2.0°C above pre modern levels. The major components of such transition include the rapid decoupling of financial development from energy consumption and emissions of CO_2 and the adoption of low and zero-carbon or carbon-negative techniques globally.

In the early 1990s, certain questions were a significant part of several important studies (Apergis and Payne, 2010a, 2010b; Chang et al., 2009; Cheng, 1999). Will the constant economic growth prove to be more detrimental to the environment and earth or will higher incomes help in the recovery of the degraded environment? These studies proposed an inverted U-shaped relationship between per capita income and environmental deterioration related to pollutants such as SO_2, NOx, etc., and emission of carbon which was commonly known as Environment Kuznets Curve (EKC). The hypothesis of EKC received enormous attention in research and formulation of policies. This relationship for the first time stated the fact that economic growth could benefit the environment in several ways. EKC hypothesis describes an inverted U-shaped relationship, which means that as the income level increases the different indicators of environmental degradation initially decline and subsequently fall when income crosses some threshold limit.

Despite decades of research, there is no general acceptance of how development and environment are connected and the factors determining this relationship. This is mostly because of the absence of appropriate data and observational proof and a short period of time to allow robust connections and reliable projections. There is still significant scientific inaccuracy in characterizing the discussion, for example, on the utilitarian relationship between certain air and water contaminants and economic development, between climate change and economic development, and between natural resource utilization and economic development. Some of the researches in the literature describe “growth optimism” concerning the effect of growth and environmental quality and accomplishing sustainability of the environment, while others discover evidence for “growth pessimism” i.e., economic development is causing harm to the earth, in short, and/or long term. Thus, the objective of this chapter is to explore the relationship between the natural environment and economic growth and vice-versa. The current work gives a general survey of the existing literature on EKC, which deals with the “energy-environment

growth" nexus for both specific and multiple-country studies. Studies from different countries show that the connection between economic growth and pollution emissions differs significantly. These studies may be useful to draft policy recommendations for conservation of energy, emission reduction, and better efficiency in economic growth. For certain pollutants and certain countries, there is proof for EKC; however, its existence locally does not imply that it is a predefined, predictive, or robust Relationship on a larger scale and across time, and it is not meant for all forms of environmental constraints. Therefore, it is preferable to perform a separate investigation for each country to determine the major factors influencing certain indicators of the environment precisely.

Role of natural resources and the environment in economic growth

The natural environment assumes two vital roles in economic development. First, the environment supplies resources, which work as raw material for the manufacturing of goods and services. Manufacturing of goods relies upon advancements of fundamental services, movements of removed natural goods (organic and geographical, inexhaustible and exhaustible), and ecosystem services provided by natural frameworks. The Millennium ecosystem services (2005) has divided the services provided by nature into four broad categories: *Provisioning services*: products like fresh water, air, food, wood, medicines, biochemical, etc., *Regulating services:* regulation of natural processes, climate, water purification, erosion, disease control, air quality, etc. ,*Supporting services:* soil formulation, photosynthesis, nutrient and water cycling, etc. and *Cultural services*: tourism, recreation, spiritual enrichment, intellectual development, etc.

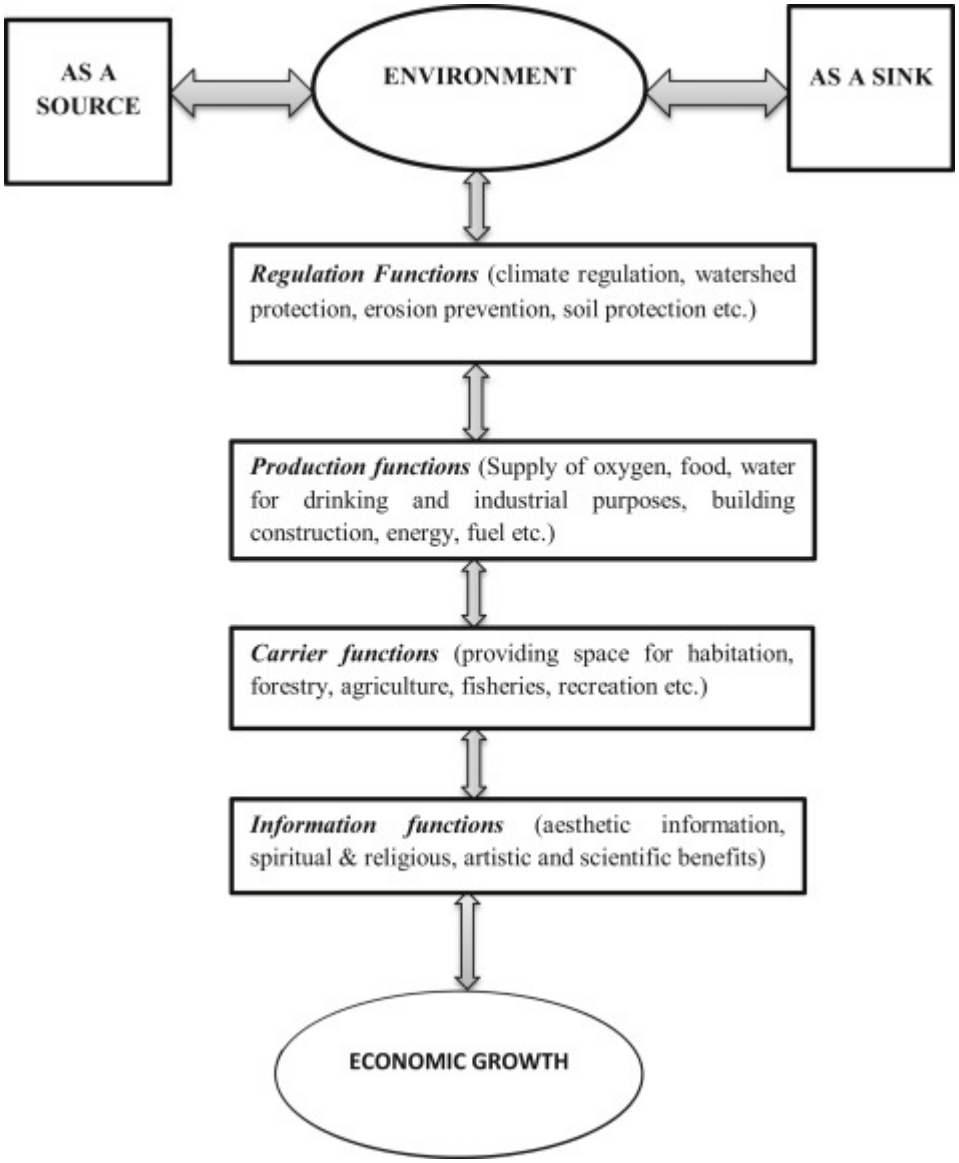


Figure 1. Environmental functions supporting economic growth.

Source: Heywood, V.H., Watson, R.T., 1995. Global Biodiversity Assessment, vol. 1140. Cambridge University Press, Cambridge.

The amount of wastes discharged to the earth's atmosphere depends upon the volume of material yield and on the development of services originated from another type of presumption by society, which is implemented to cope up with the undesirable effects of goods produced inside the economic structure. In literature, such kinds of services are outlined with the shorthand “by-products management capital” (Toman, 2003). The term “by-products management” refers both to pollution control (decrease in unwanted harmful results in comparison with wanted goods) and end-of-pipe solutions that reduce the harm caused by physical emissions. The inputs can be direct or indirect. Second, the natural environment

functions as a sink to the pollution which arises from economic productions and utilizations. Models incorporate harmful air, water, and solid contaminations, which are dispersed in the environment, which is additionally a storehouse for solid and hazardous waste.

At the point when the elements of the natural environment are truly impeded, economic development decelerates or can be negative. This is the situation when access to natural resources goes down quickly, for example, aquatic resources, woods, and minerals are being drained, or when nature's ability to assimilate or disperse waste and toxins is surpassed and when ecological quality is decreased. When the environmental quality is degraded, it has detrimental impacts on economic profitability, leading to a decline in the efficiency of diverse environmental services and some natural resources. It also has an immediate adverse impact on having spread out the different pathways through which natural assets and the environment are related to economic development and human well-being. Development might also be constrained because of policy measures which need huge investments for the reduction of pollution, which have lower economic profitability and returns in contrast with alternative costs.

From the past few decades, the environment is under immense pressure due to overexploitation by humans to meet their needs by being dependent on air, and water resources. Along with this, the environmental degradation is also caused by deforestation, species loss, climatic change, etc. Unrestricted utilization of natural assets has led to their quantitative and qualitative deterioration. For example, overfishing caused a reduction in catch per effort and subsequent changes in several aquatic systems disturbing the balance in ecological species. Overexploitation of groundwater has led to the deprivation of safe drinking water in several cities. Irrational exploitation of groundwater in coastal regions has led to seawater intrusion and salinization. For example, saltwater intrusion and salinization in coastal Bangladesh, coastal farms, and forests in southeast United States and California are caused by sea-level rise, storms and tides, droughts, and water resources management practices. Extensive deforestation has caused the loss of biodiversity and vegetation, which results in degradation and depletion of the soil. Several environmental problems such as eutrophication of water resources, global warming, climate change, and depletion of ozone have been caused due to industrialization. The natural environment is essential for economic activity and growth, as it provides the resources we require to produce goods and services, and uptakes and treats the undesired by products in the form of pollution and waste. The environment manages threats to economic and social activity, as it helps to control flood risks, regulate the local climate, and

retain the supply of clean water and other resources. This serves as the basis for economic activity and social welfare, and so balancing and restoring the natural assets is an important aspect in sustaining growth for the long term. Environmental performance and economic growth should run parallel to achieve sustainable development goals.

The environment and economic growth linkage

During the 1980s, there was a significant milestone in understanding the relation of economic development with the environment which identified the connection that existed between them. The environmental issues were incorporated in the planning process with an emphasis on a sustainable approach in the developmental process (World Commission on Environment and Development, 1987; Pearce and Warford, 1993). Grossman and Krueger (1991) supported inverted U-shaped linkage of economic growth (estimated by a rise in income per capita) with certain environmental quality indicators in their revolutionary effort of studying the probable impact of the North American Free Trade Agreement (NAFTA). The relationship is termed as Environmental "Kuznets curve" (EKC).

The growth-environment nexus has drawn the attention of researchers and academicians for discussions in different countries for a long time, and there is remarkable literature available on this relationship. Panayotou (1993), Grossman and Krueger (1993), and Selden and Song (1994) concluded that the positive or negative connection between economic development and the quality of the environment cannot be constant along developmental trajectories of a nation. It can change from positive to negative at an income level where people of the country need and support a strong economic base and a healthier natural environment. The environmental quality may produce positive or negative external factors that can stimulate economic growth by affecting human health. The relationship between energy vectors, economic development, and the quality of the environment was a matter of contradiction among the policymakers. This implies that understanding the dynamic linkage is essential to know the current policies on energy and environment, and it is one of the basic frameworks for designing robust economic guidelines with substantial goals.

The relationship of economic growth with the environment is, and may always remain, a subject of controversy. Most of the countries have achieved economic development without considering the environmental consequences. They are now facing several environmental problems like air and water pollution, pesticides in the food, ultraviolet rays penetrating the ozone layer, emission of greenhouse gases causing global warming, and so on. Some of the

complexities in meeting the challenges of economic growth are the occurrence of new pollution problems, failure in dealing with rising global temperatures, and the ever-increasing population. However, due to advancements in the field of technology, great progress has been made in providing sanitation facilities; improved air quality in major cities, and constant progression in human conditions. Economic growth degrades the environment through increasing pollution, while the degraded environment in turn limits the probability of further economic growth. Exhaustion of resources and waste production get accelerated as agricultural production and industrialization increase.

On the other hand, at higher developmental levels, the organizational transformation towards information-based services, effective technological approach, and the necessity for improving the quality of environment results in stabilization with a gradual reduction in environmental deterioration (Panayotou, 1993).

Nature is a sink for the undesirable by product of commercial activities that have normally not been given much attention. Nature disseminates harmful air, water, and solid pollutants as a sink, which is the storehouse for millions of tons of garbage and hazardous chemicals. Once the environment's capacity to absorb waste crosses a certain limit, environmental quality is affected and may limit the process of economic growth. This may be because degraded environmental quality demands cleaner technologies or mitigation efforts. It further lowers the investment returns, or maybe the damage caused to the ecosystem is such that it is beyond restoration. It finally establishes a new less productive and stable state.

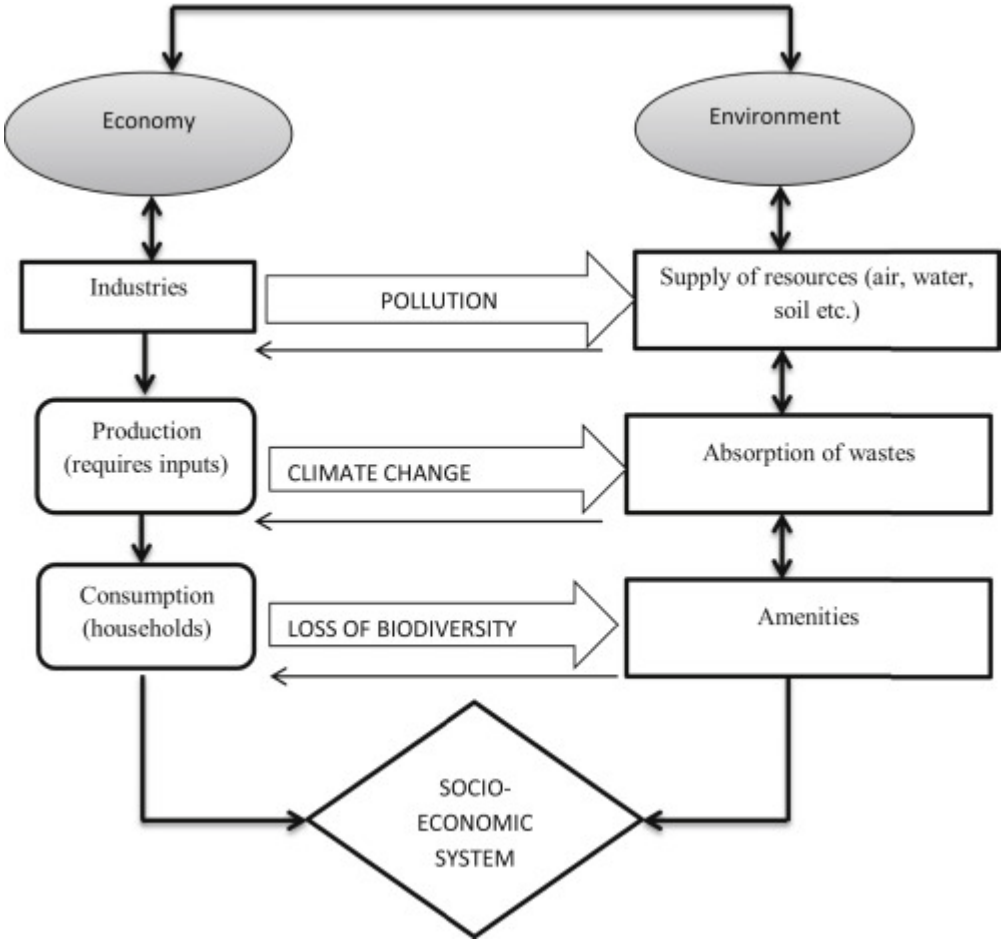


Figure 2. The link between economic growth and environment.

Expandable and sustainable natural resources contribute to the generation of numerous products and services. If the structure of yield and the strategies for production were permanent, at that point harm to the earth would be inseparably connected to the size of the worldwide monetary movement. Yet, considerable proof proposes that improvement leads to a rise in an additional change in what an economy produces (Syrquin, 1989). On a primary level, the efforts promoting the change in the composition and strategies of production might be adequately strong to more than balance the adverse impacts of increased economic activities on the environment.

However, the linkage of economic growth with the environment is often explained with the help of the EKC. This postulate establishes a relationship that is not linear but is relevant for different nations. The primary indicators utilized to depict the variations in conditions of the environment have been designed and used in numerous countries. A higher rate of economic development is a major and long-term goal of both government and people, mainly in

developing nations. The accelerated growth of the economy is closely linked to an increase in the manufacture and intake of commodities and services; as a result, this leads to an increase in the maximized goods of the people and consumption of income for each individual. Though evidences are supporting the existence of the EKC relationship for some countries, still it cannot be used for all types of environmental damage and across all the countries and income levels.

EKC hypothesis: explaining the relation between environment and economic growth

It is a well-known fact that the pollution and economy are closely related to each other since the history of mankind. However, the connection between environmental damage and economic improvement is unpredictable and complex. This linkage depends upon several factors like the economic size, the organization of the industry, the origin of the innovation, the need for better quality of environment, etc. All of these aspects are related to each other. The inconsistent link between the quality of income and per capita income can be identified practically and graphically utilizing the advanced tools of economic studies and can also be illustrated by the EKC. This theory was based on the proposition that at different levels of income growth, the distribution of income is not equal. Despite that, as the level of the economy expands, the distribution of income inclines to become even.

The EKC was introduced in 1955 for the first time by Kuznets to analyse the per capita income and environmental quality nexus. This assumes that during initial phases of economic development, the damage to the environment goes up or increases at a higher rate. But, after a certain threshold limit of economic growth, the movement tends to become inverted at a higher degree of economic development (Usenata, 2018). Grossman and Krueger (1991) were the first to apply the EKC, which resulted in an inverse linkage of GDP per capita with an indicator of the quality of the environment. In the early phase of industrialization, pollution in the EKC increases at a faster rate because individuals are more fascinated toward employments and income in comparison to healthy air and clean water. Most of the population is inefficient to even think about paying for reduction of pollution, and also environmental policies are correspondingly weak. With increase in income, the balance gets shifted. The leading industries tend to become cleaner, people start respecting the earth, and regulatory organizations gradually become more operational. Along the curve, pollution decreases in the medium income range but later on falls toward preindustrial levels in higher income range. At relatively lower degrees of per capita GDP, emissions increase with economic progression. At the final

stage, when the economic growth increases along with the expansion of agronomy and extraction of different resources, the rate of resource exhaustion starts to transcend the rate of resource restoration, generating more hazardous wastes. A shift toward information-based industries increased environmental concerns, and implementation of environmental guidelines, improved techniques, and greater environmental costs causes progressive reduction of environmental deterioration at higher levels of development. As income exceeds the EKC turning point (Fig. .3), it is expected that progress toward the improvement of environmental quality begins (Arrow et al., 1995). Thus, the EKC indicates that economic development can be utilized to address the environmental issues as economic development is probably compatible with environmental recovery (Kijima et al., 2010).

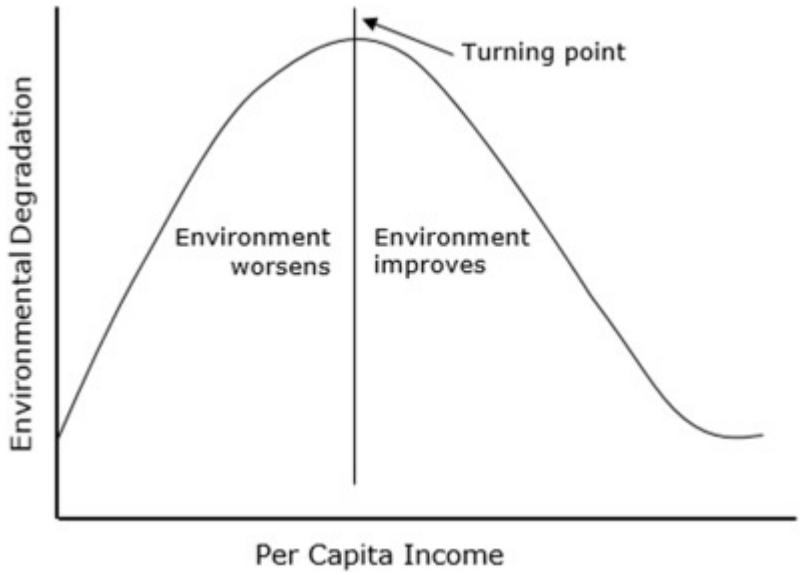


Figure 3. Environment Kuznets Curve.

The world development report 1992, "development and the environment," discusses the possible effects of the expected dramatic growth in the world's population. Industrial output, use of energy, and demand for food. Under current practices, the result could be appalling environmental conditions in both urban and rural areas. The world development report presents an alternative, albeit more difficult, path - one that, if taken, would allow future generations to witness improved environmental conditions accompanied by rapid economic development and the virtual eradication of widespread poverty. choosing this path will require that both industrial and developing countries seize the current moment of opportunity to reform policies, institutions, and aid programs.

Economic growth will be undermined without adequate environmental safeguards, and environmental protection will fail without economic growth. The earth's natural resources place limits on economic growth. These limits vary with the extent of resource substitution, technical progress, and structural changes.

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

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

2. Social and Economic Environment

2.1. Social Environment

The social environment refers to the combination of individuals and groups that interact and display various activities and characteristics. It includes the family environment, school environment, and community

Social environments encompass the immediate physical. Surroundings, social relationships, and cultural milieus. Within which defined groups of people function and. interact.Jul 11, 2017

The social environment subsumes many aspects of the physical environment, given that contemporary landscapes, water resources, and other natural resources have.

The social environment refers to an individual's physical surroundings, community resources and social relationships. The physical environment may include such things as housing, facilities for education and health care, workplaces and open space for recreation. Community resources include community structures (e.g. political governance) and organisations, knowledge and support within the community. The social environment is recognised as a key factor influencing an individual's health and better social environments are associated with a range of positive health outcomes including improve child development and reduced risk taking behaviour amongst adolescents.

The term economic environment refers to all the external economic factors that influence buying habits of consumers and businesses and therefore affect the performance of a company. These factors are often beyond a company's control, and may be either large-scale (macro) or small-scale

The **Gambela Region**, also spelled **Gambella**, and officially the **Gambela Peoples' Region** (Amharic: ጋምቤላ ሕዝቦች ክልል), is a regional state in western Ethiopia. Previously known as **Region 12**, its capital and largest city is Gambela. It is bordered by the Oromia Region to the east, the South West Ethiopia Region to the south, and the country of South Sudan to the west.

Gambela is situated between the Baro and Akobo Rivers, with its western part including the Openo River. It covers an area of approximately 29,783 square kilometers with a population of 525,000 inhabitants, making it one of Ethiopia's smallest regions and one of its least populous. Gambela is home to a diverse population which includes the Anuak, Nuer, and other indigenous groups collectively referred to as the Majang Komo and Opo.

History

This region served as slave-hunting grounds by Christian Abyssinians for centuries, and the Nilosaharan-speaking inhabitants were pejoratively called Shanqella (Šanqəlla, also Shanqila, Shankella) by the highland Ethiopians.[4]

The Gambella region has been a strategic point in the relations between Ethiopia and the Sudan since the end of the 19th century when the border between Ethiopia and the Anglo-Egyptian Sudan was drawn in 1902, the present day Gambella region was confirmed as an Ethiopian territory.[5]

Lij Tewodros, a son of Lij Iyasu, surfaced in the Gambela area in May 1941 proclaiming himself Emperor. His insurrection was put down by Belgian Congo troops before they left the area in February 1942.[5]

Demographics

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), the Gambela region has total population of 307,096, consisting of 159,787 men and 147,309 women; urban inhabitants number 77,925 or 25.37% of the population. With an estimated area of 29,782.82 square kilometers, this region has an estimated density of 10 people per square kilometer. For the entire region, 66,467 households were counted, which results in an average for the region of 4.6 persons to household, with urban *households* having on average 3.8 and rural households 4.9 people. Various Nilotic ethnic minority groups mainly inhabit the Gambela region: Anuak (Anywaa), Nuer,Majang and others.

In 1994, the national census reported the region's population to be 181,862 in 35,940 households, of whom 92,902 were men and 88,960 women; 27,424 or 15.08% were urban inhabitants. (This total also includes an estimate for all 19 kebeles of one woreda and six kebeles in two other woredas, which were not counted; these areas were estimated to have 19,465 inhabitants, of whom 9,203 were men and 10,262 women.) The six largest ethnic groups

of the region were Anuak (Anywaa), Nuer, Amhara, Oromo, Majang, Komo and other ethnic groups. Languages spoken are Anuak, Nuer,Amharic, Afaan Oromo, Majang; the remaining spoke all other primary languages reported. The projected population for 2017 was 435,999.[2]

Values for reported common indicators of the standard of living for Nuer as of 2005 include the following: 44% of the inhabitants fall into the lowest wealth quintile; adult literacy for men is 57.5% and for women 22.8%; and the regional infant mortality rate is 92 infant deaths per 1,000 live births, which is greater than the nationwide average of 77; at least half of these deaths occurred in the infants' first month of life.

Religion

Religion in Nuer Region (2007)

1. Christian/P'ent'ay (90%)
2. Ethiopian Orthodox (5%)
3. Muslim (3%)
4. Traditional faiths (1%)
5. Catholic (1%)
6. Other (0%)

90% of the region's population are Protestants, 5% Orthodox, 3% Muslim, 1% practice traditional religions, and 1% are Catholic.

Educational Institutions

- In gambela woreda has 2 governmental and 10 private educational institutions. There are ten full primary and elementary schools, five secondary schools, and one preparatory school. From **Transport**

Gambela is 720 kilometres from Addis Ababa,. The road from Addis Ababa to Gambela is asphalt. However, from gambelat to Kabon forest ecosystem no Aspalt

2.1.1. State and trend of social environment

population

The two main factors affecting population growth are the birth rate (b) and death rate (d). Population growth may also be affected by people coming into the population from somewhere else (immigration, i) or leaving the population for another area (emigration, e) Here, altitude and the attendant climatic differences determine the distributional pattern of the Ethiopian population more than any other single factor, but not in the manner it affects global population distribution.

According to the woreda report Gambela woreda has a total population of **143,385** of whom 65930 is men and 77,455 is women 59.98 % of its population is urban dwellers the rest is rural dwellers .

Table 1. Population Gambela woreda (2020-2024).

YEAR (G.C)	Rural population			Urban population		
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL
2020	21420	24451	45871	27232	29213	56445
2021	23432	26543	49975	29989	32908	62897
2022	34343	35222	69567	30123	32987	63110
2023	35333	35999	71332	30878	33232	64110
2024	35997	36434	**72431**	37999	38950	**76949**
Total Rural urbapopulation	**143385**					

Source: - Gambela woreda finance office (2024)

Resource use, waste production and environmental degradation are accelerated by population growth. As the population increases, their economic interest, the demand on infrastructure, food security, energy source, health facilities and basic necessities as a whole is increased. The consequences as we saw because of population increment year to year nearby Kabon Mountain Forest Ecosystem cover has reduced and changed to quarry site to the demand of mining .

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. In Gambela woreda people how has access to education is only 80% When comparing the enrolment of female students in primary education, elementary and high school is less than the enrolment male students more over the number of female teacher is also more less than as compared with male teachers .

Table 2. Students, teachers and number of schools in Gambela *Woreda* in Academic year2024

NO	**Level of School**	**Number of schools**	**Students in Gambela woreda 2020- 2024**		
			Male	**Female**	**Total**
1	Elementary school	19	2583(2020)	2479(2020)	5062

	Elementary schools		2683 (2024)	2554 (2024)	5155
2	Primary School (7-8)	6			
3	High School (9-12) preparatory	6			
4	Number of teachers	474	306	168	474

Source: WEDOF (2024)

Health

Health affects growth by augmenting worker productivity, by increasing average life expectancy and subsequent human capital accumulation, and by reducing the burden of disease. In the Indian context, the main source of increases in worker productivity has come from improving nutrition.

The Health service sector is one of the key sectors for economic development. Adequate health service is one aspect of social service that communities aspire to get from the government. To this end, theGovernment 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 exhibitedby increasing number of health institutions being established in different regions and city administrations including the rural clinics.

Health Institution & Health Coverage of Gambela woreda

The health institutions /especially primary hospital/ in Gambela woreda are providing various services to the area's population.heathe service coverage is 50% .

Table 3. Health Institutions in gambela Woreda of 2020 and 2024

No	Types of Health Institutions	Year				
		2020	2021	2022	22 2023	2016 2024
1	Governmental Health Center	0	0	0	0	0
1.1	Primary Hospital	0	0	0	0	0
1.2	Private pharmacy	2	2	2	2	2
1.3	Health post	12	12	12	12	12
2	Private Health Centers	2	2	2	2	2
2.1	Primary Health clinics	2	2	2	2	2
	Total	15	15	15	15	15

Source: - Gambela Woreda Health Report 2020and 2024

Road and Transport

Road is an essential infrastructure for a given area for economic and social development. It easesmobilization of resources and communication and there by hasten the socio economic development of a given area. The total existing road in the Gambela *Woreda* is 38 kilometers. Most of the rural roads are seasonal and old aged. According to 2016 report, gambela worwda has no asphalt road, 18 kilometers of all-weather roads and 20 kilometers of dry-weather roads, this shows that rood infrastructure is one of the biggest problem for the woreda community.

Table 4.T types and length of Roads, existing gambela woreda in the year 2020-2024

No	Road type	Length in km	% of population who has access to Road
1	Asphalt	0	0
2	All weather rood	18	
3	Dray weather rood	20	
	Total	38	

Source: GWRO 2016

Gambela Wereda Water Resource and Supply

In Gambela *woreda*, has ponds, revers and springs however currently due to various environmental problems some streams and springs were dried, while the volume of existing small streams and river as well as the discharge rate of springs has been decreasing from time to time.

Communication Services

Communication plays a vital part in building up a strong relationship across the world, either in organisational structure or outside of it. It is an essential pillar for people in sharing the ideas, delegating responsibilities, management of a team, building up a healthy relationship .Communication in Gambela Woreda, 24 hours telephone mobile services is available for all community .

Housing

Housing refers to the usage and possibly construction of shelter as living spaces, individually or collectively. Housing is a basic human need and a human right, playing a critical role in shaping the quality of life for individuals, families, and communities

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

Electric

Energy infrastructure may contribute to economic growth and development in several ways. First, electricity serves as a key factor of production for firms which, as research shows, has low substitutability with other factors of production and thus may constrain output when unavailable. *Electricity* is an essential infrastructure for a given area of economic and social development. According to FDG In Gambela *woreda* the total coverage of Electricity is 47% percent,. The other residents used fuel wood, charcoal as the source of energy and also they used kerosene as a source of light.

2.1.2. Drivers and pressure of social environment

Agricultural expansion continues to be the main driver of deforestation, forest degradation and forest biodiversity loss. The global food system is the primary driver of biodiversity loss.

Kabon forest Ecosystem is one of highly degraded ecosystem. The main drivers for the deterioration of the ecosystem are mainly deforestation and natural resource exploitation for the use of fuel wood,mining and land for agriculture

Drivers are human-related factors/activities and/or natural-system dynamics that help "drive" ecological resource. Drivers tend to be large scale, long term, and not easily controlled or changed. They are influencers of change in natural systems. Examples of drivers include: Climate change.

The biggest drivers of environmental degradation are the following

- Population The human population on Earth is expanding rapidly, which together with even more rapid economic growth is the main cause of the degradation of the environment. Humanity's appetite for resources is disrupting the environment's natural equilibrium.
- Fossil fuels – coal, oil and gas – are by far the largest contributor to global climate change, accounting for over 75 per cent of global greenhouse gas emissions and nearly 90 per cent of all carbon dioxide emissions. As greenhouse gas emissions blanket the Earth, they trap the sun's heat.
- Ecosystem degradation important direct drivers include climate change, nutrient pollution, land conversion leading to habitat change,
- Over exploitation, and invasive species and diseases. Those happen intermittently. Changes in ecosystem services can feed back to alter drivers.

2.1.3. Impacts due to social environment change

It is only logical that an increase in the world's population will cause additional strains on resources. More people means an increased demand for food, water, housing, energy, healthcare, transportation, and more. And all that consumption contributes to ecological degradation, increased conflicts, and a higher risk of large-scale disasters like pandemics. An increase in population will inevitably create pressures leading to more deforestation, decreased biodiversity, and spikes in pollution and emissions, which will exacerbate climate change. Ultimately, unless we take action to help minimize further population growth heading into the remainder of this century, many scientists believe the additional

stress on the planet will lead to ecological disruption and collapse so severe it threatens the viability of life on Earth as we know it.

Each spike in the global population has a measurable impact on the planet's health. According to estimates in a study by Wynes and Nicholas (2017), a family having one fewer child could reduce emissions by 58.6 tonnes CO2-equivalent per year in developed countries.

2.1.4. Responses to social Environment Change

Water shortages, soil exhaustion, deforestation, air and water pollution afflicts many areas. If the world population continues to multiply, the impact on environment could be devastating. Capita are depleting natural resources and degrading the environment. Population and Environment Linkages. As the population increases, more and more land is deforested and over-farmed. Forest coverage has declined from 40 percent 75 years ago to only 3 percent today. People must travel farther and farther to find firewood, the principal fuel, which reduces time spent farming. Without firewood, many resort to burning animal dung, instead of using it to fertilize their depleted soil. Without trees to help hold it in place, the soil erodes from the steep highlands. As a result, many previously habitable areas have now been transformed into dry lands and deserts.

This vicious cycle exacerbates the effects of Ethiopia's droughts, leading to severe and ever more frequent crises. The 2003 famine affected more than 13 million people, and at least 6 million people now suffer from permanent food insecurity. But drought is not entirely to blame, as Haile wryly pointed out: Ethiopia "faces famine when we have a bumper harvest and when we have drought" since the amount of arable land per person is so low (1/2 hectare for 8 people). Ethiopia's population growth compromises its ability to achieve the productivity gains necessary to break the cycle and eradicate extreme poverty and hunger.

This situation is highly unstable, and could make Ethiopia vulnerable to future conflict. Haile pointed out that the country meets six of the eight demographic criteria associated with instability and conflict in the security demographic (Cincotta et al., 2003):

- A high proportion of young adults;
- rapid urban population growth;
- diminishing levels of per capita cropland;
- high mortality rates among working-age adults;

- differential growth rates among ethnic groups; and
- Rapid migration.

The youth bulge is especially prominent: since Ethiopia's school age population of 21 million is 29 percent of the population, Haile believes that "how we address the youth challenge today will determine whether we are heading in the right direction or not." Women's Health: The Key to Development.

The poor state of women's health is also a barrier to development. Ethiopia is one of the lowest ranked countries in Save the Children's 2004 "Mother's Index." One out of every 14 women dies from complications during pregnancy, and 114 infants die for every 1000 live births. A majority of girls get married at an early age, continue child-bearing until late in middle age, and are not encouraged to use modern family planning methods. Reproductive rights are improving, however: new laws allow women to terminate pregnancies for compelling reasons, set the legal marriage age at eighteen, and prohibit traditional female circumcision practices. Yet, Haile said, "The unmet need for family planning in Ethiopia still remains at 36 percent, which means there is still work to be done."

Increasing girls' education and women's opportunities can help improve women's health and stabilize population growth. Although Ethiopia spends a "laudable" 19 percent of its budget on education, reproductive health is not yet well integrated into the curriculum. As in other countries, Haile observed, "young girls get less opportunities than boys because of domestic responsibilities." Although Ethiopia has increased its overall primary school enrolment rate from 20 percent in 1993 to an impressive 62 percent, female secondary school enrolment remains staggeringly low, at only 14 percent.

Developing Policies, Implementing Solutions

Underlying these problems is the Ethiopian government's poor implementation of policies. Although the government has committed itself to reducing poverty and meeting the Millennium Development Goals, its programs are not horizontally integrated, and focus on immediate crises rather than long-term environmental and population problems. Haile estimated that Ethiopia will need $122 billion in the next decade to achieve the Millennium Development Goals, but less than 0.5 percent of this amount has been allocated for reproductive health needs.

Although Ethiopia has developed an environmental policy that recognizes the impact of population factors on the environment, "like most of our policy documents, this one… suffers from lack of implementation," said Haile, who noted with frustration that Ethiopia's government seems to be "more interested in developing policies than implementing them." Government support is critical, since "any

development initiative that is not adopted by the government" has little chance of success. "If we want to…have a national impact, and a long-term sustainable impact, the government has to adopt that program.

2.1.5. Outlook for Socio Environment

Deforestations occur as a result of conversion of forest and shrub to farm land because of overpopulation and additional demands for farm land and mining Due to this reason, Crop land is increased while forest and wood land, shrub, and bush decreased respectively**.**

In the *woreda*. If the whole systems continue as it is, soil erosion, land degradation and deforestation aggravate.

2.2. Economic Environment

2.2.1. State and trend of the economic Environment

Agriculture is the most important income source in Gambela woreda 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, however, agricultural system in the region is at subsistence level and food insecurity problem is increasing at alarming rate.

According to the current (WAOF) report in 2024, Contribution of Agriculture and other sectors to Gambela *woreda* gross domestic product (GDP) is very high, which is:-

- Agriculture Sector 80 %
- Investment Sector 5 %

As Information collected during key informant and group discussion the main food crops utilized are maize, vegetables and root crops. They mainly consume cereal based foods together with vegetables and livestock product. Maize, sorghum, barley, wheat, are the major crops grown in the area.

The major trend of agricultural practices in the woreda

- Despite the woreda is rich in agricultural history, it faces various challenges in the sector today. The majority of farmers are smallholders with limited access to resources, modern technology, and market

linkages. Land fragmentation, inadequate infrastructure, and climate change impact further hinder agricultural productivity. Additionally, reliance on rain-fed agriculture makes the sector vulnerable to erratic weather patterns, leading to fluctuations in yields.

2.2.2. Drivers and pressures of the economy

The driving force behind economic policy-making lies in the macro-economic objectives. The macro-economic objectives should be environmentally and socially sustainable. Obviously, the macro-economic objectives are: economic growth measured in terms of the percentage change inthe Gross Domestic Product (GDP), employment, price stability, and equity. The very concept of studying population dynamics and economic environment is that its interlinked nature natural resources.

2.2.3. Impacts due to the Economic Condition

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

According to the data collected from the community The Natural resources of Gambela woreda Kabon forest Ecosystem where degraded .according to the woreda agriculture and natural resource office report from the total proportion of land affected by deferent factors. And also discussions from different members of the community Soil fertility is declining every production season. Forest coverage is very low and decreasing every year.

2.2.4. 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 environmentalprotection measures; and

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

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

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

Apart from the above major responses by the Government of Ethiopia, a new plan has been coined and put into practice by different components of the government in this fiscal yearGrowth and Transformation Plan (GTP II).

GTP II focuses on ensuring rapid, sustainable, and broad-based growth by enhancing the productivity of the agriculture and manufacturing sectors, improving the quality of production, and stimulating competition within the economy.

The major objectives of GTP are to:-

- Expand and ensure the qualities of education and health services there by achieving the MDGsin the social sectors,
- Establish favorable conditions for sustainable state building through the creation of stabledemocratic and developmental state.
- Ensure growth sustainability by realizing all the above objectives within stable macro-economic framework.

➢ This broad social, economic, and political aspect of the GTP are managed on thefollowing major pillars

- Sustaining faster and equitable economic growth

- Maintaining agriculture as a major source of economic growth

- Creating conducive conditions for the industry to play key role in the economy

- Enhancing expansion and quality of infrastructure development

2.2.5. Outlook for Economy

The number of population in the study area is incising year to year it reduces the quality and quantity of natural resources through overexploitation, intensive farming and land fragmentation. Regions with high population pressure face scarcity of arable land, which leads to shortened/removed fallow period, declining soil fertility and farm income due to farm subdivision. And the subsistence mode of economic situation that based on farming, Animal husbandry fuel wood collection will minimalize the limited natural resources. Then natural environment could not be able to provide the environment service.

2.2.6. Options for future Action

Ethiopia is gifted with abundant natural resources of adequate landmass, fertile soil, favorable climate, water, wildlife, and others. Many of its resources are not properly identified, well managed, and fully exploited. In Ethiopia, natural resources are under the influence of various interconnected factors like population pressure, agricultural expansion, migration, rapid urbanization, resettlement, climate change, and environmental pollution. Its huge population number had been putting a great burden on the sustainability of almost all types of natural resources. There is, therefore, serious degradation of land, water, forest, rangeland, and wildlife resources that appear to feed off each other. This results in severe soil loss, low vegetative cover, unsustainable farming practice, continuous use of dung and crop residues for fuel, overgrazing, and destruction and/or migration of wildlife, which again are intensifying the degradation of available resources in a vicious circle.

The Ethiopian governments have taken several steps to address these problems like launching soil and water conservation campaign, tree planting programs, and others; success to date, however, has been limited.

- Special attention has to be given to properly manage the natural resources and ecosystems; so that, it can continue to provide the goods and services the population need.
- Awareness creation should be given on the links of climate change, overpopulation natural resource degradation to the overall environment.

Control and limit human population, this is the major source of environmental degradation. Use only renewable and sustainable products, materials and energy. Protect natural and biological biodiversity. Limit and reduce economic growth, which comes at enormous environmental costs.

3. Biophysical Environment

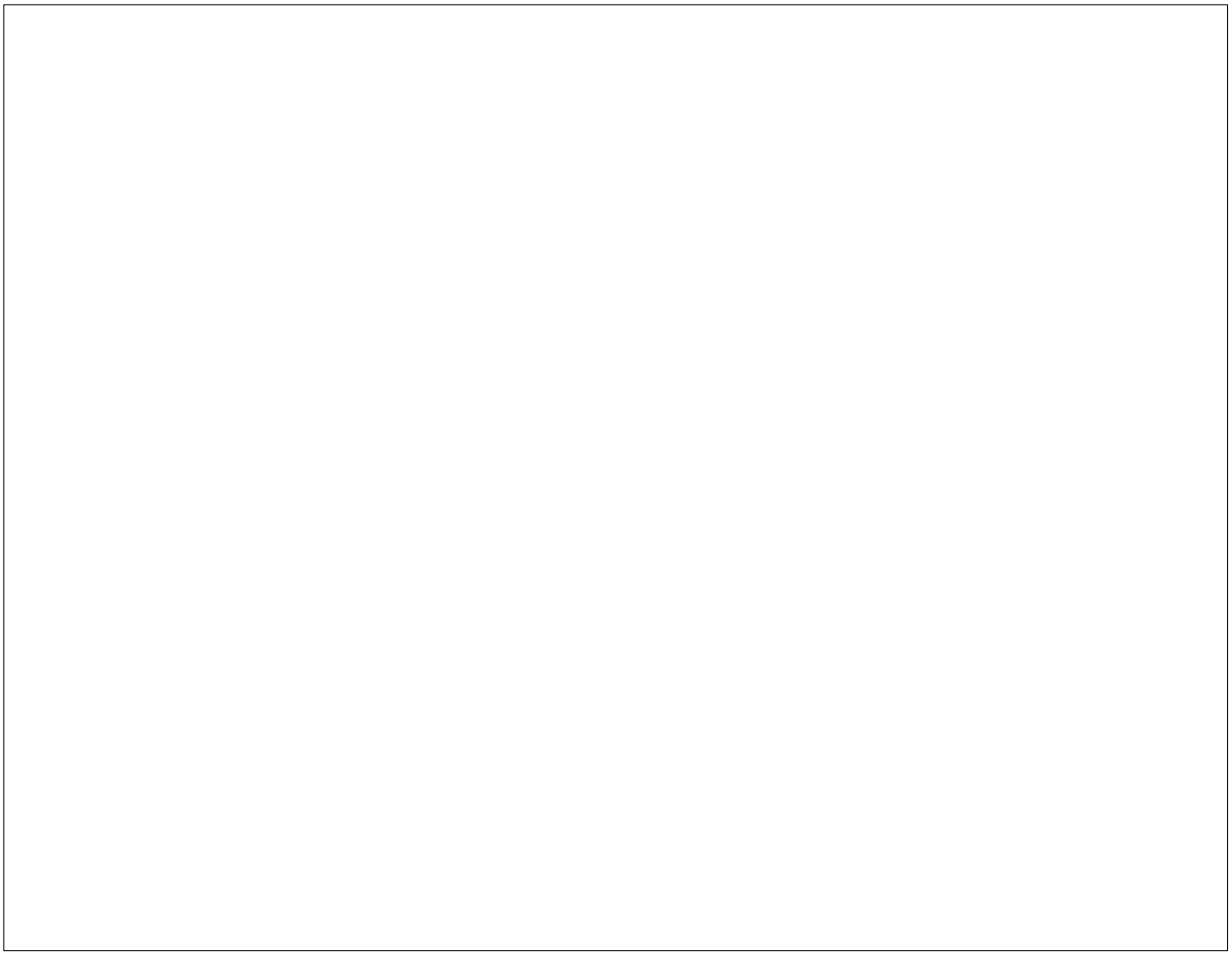
3.1. Land

Land is internationally defined as "a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soils and the terrain forms, the surface hydrology (including shallow lakes, rivers, marshes, and swamps), the near-surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity" (UN, 1994; CSD, 1996).

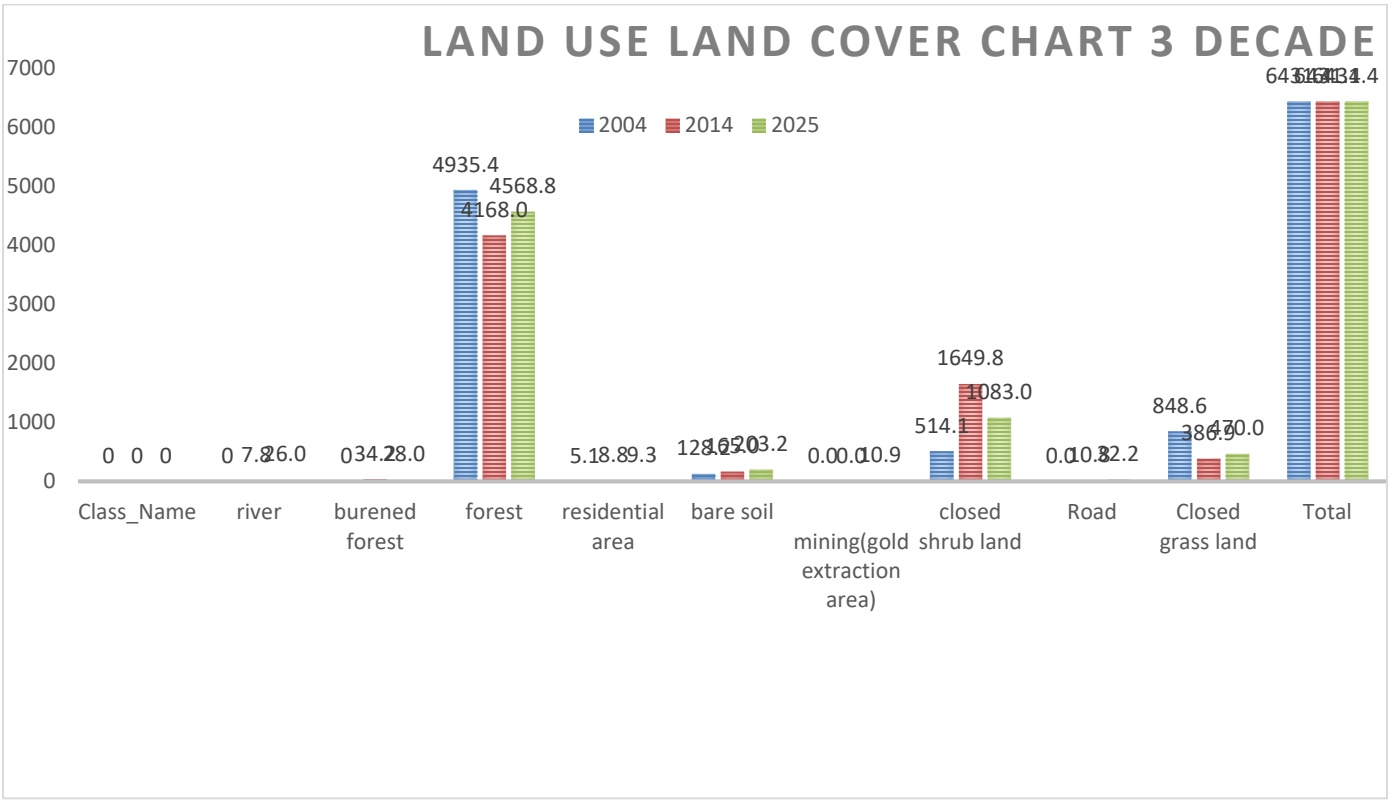
Land provides basic needs to human beings like: food and raw materials, shelter and recreation. The land on which we live in, its condition, and how we use and manage it, are therefore vital components of our existence.

The status of land includes both the land use and cover. The land use refers to the purpose for which that particular land is being used. During the land use activities, may be an existing forest cover would be cleared for instance to expand farm plots, or for investment like floriculture etc. Land use and land cover are highly interrelated.

3.1.1. State and trends of Land for Kabon forest in Gambella



land use land cover type	2004	2014	2025
Class_Name	Area_ha	Area_ha	Area_ha
River	Covere By Donse Forest	7.8	26.0
Burened Forest	None	34.2	28.0
Forest	4935.4	4168.0	4568.8
Residential Area	5.1	8.8	9.3
Bare Soil	128.2	165.0	203.2
Mining(Gold Extraction Area)	None	None	10.9
Closed Shrub Land	514.1	1649.8	1083.0
Road	None	10.8	32.2
Closed Grass Land	848.6	386.9	470.0
Total	6431.4	6431.4	6431.4





- **Forest Cover Decline**: Significant reduction in forested areas over recent decades e.g the forest cover of kobon were decline by 767.54 hectares from 2004to 2025 year,. Because of shifting cultivation, internal migration, mining and so on.
- **Biodiversity Loss**: Threats to native species like the Nile lechwe and white-eared kob due to habitat destruction.
- **Soil Degradation**: Reduced soil fertility and increased erosion in deforested areas.
- **Hydrological Changes**: Disruption of local water cycles, affecting rivers like Baro and Akobo.

3.1.2. Drivers and pressure for Kabon Land degeradation

➢ **Drivers**

- **Population Growth**: Increasing demand for farmland, firewood, and construction materials.

- **Economic Development**: Expansion of agriculture, particularly large-scale commercial farming (e.g., sugarcane and cotton plantations).
- **Refugee Influx**: The presence of refugees from South Sudan creates additional pressure on forest resources for fuelwood and shelter.
- **Policy Gaps**: Weak enforcement of land-use regulations and environmental policies.
- **Cultural Practices**: Traditional reliance on slash-and-burn agriculture.

Pressures

- **Deforestation**: Clearing forests for agriculture, settlements, and infrastructure development.
- **Overharvesting**: Excessive logging for firewood, charcoal production, and construction.
- **Overgrazing**: Encroachment of livestock into forested areas, degrading vegetation.
- **Climate Change**: Droughts and changing rainfall patterns exacerbate forest stress.

3.1.3. Impact of land degeradation

- **Environmental Impacts**:
  - Loss of carbon sequestration capacity, contributing to climate change.
  - Increased soil erosion and reduced water quality in rivers and streams.
- **Economic Impacts**:
  - Decline in resources for livelihoods (e.g., timber, non-timber forest products).
  - Reduced agricultural productivity due to degraded soils.
- **Social Impacts**:
  - Livelihood challenges for forest-dependent communities.
  - Increased human-wildlife conflict as animals lose natural habitats.
  - Displacement of indigenous people and disruption of traditional practices.

3.1.4. Response

- **Policy Measures**:
  - Strengthening forest conservation laws and land-use planning.
  - Introducing reforestation and afforestation programs.
- **Community Engagement**:
  - Promoting agroforestry and sustainable farming practices.
  - Educating local communities on forest conservation.

- **International Support**:
    - Leveraging initiatives like REDD+ (Reducing Emissions from Deforestation and Forest Degradation).
    - Collaboration with NGOs for conservation and reforestation projects.
- **Refugee Management**:
    - Providing alternative energy sources to reduce reliance on firewood.
    - Establishing sustainable resource management practices in refugee-hosting areas.

3.1.5. Out look

The forest coverage is decresed from 76% to 64 % and minig nincresed by 10 h/e hence urbanization increased from 5.1 h/e to 9.3 h/e thes shows that there was intenseive deforestation if conditions countinues bussenes us usual withen 20 years the forest coverage will decrese by 22% the mining activates are condacted accrose the river side they used hevy matals to extract mining these havey metals coused environmental pollution so that the regional government and other conserned bodes should ingajed to tacle the problem

3.2. Forest

3.2.1. State and Trend of Flora and Founa in the Kabon Forest Ecosystem

Ethiopia is one of the world countries, which is rich in faunal, floral and microbial diversity. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, of which about 15 percent or more are probably endemic. Ethiopia is considered as the fifth largest floral country in tropical Africa (http://chora.virtualave.net/biodiversity.htm). Ethiopia is also rich in faunastic diversity with mammals (277 spp.), birds (861 spp.), reptiles (78 spp.), amphibians (54 spp.), and fishes (101 spp.) (http://www.biodiv.be/ethiopia/). In developing countries where a large proportion of the human population depends almost entirely on natural resources for their livelihoods, there are competing demands for utilization, development and sustainable management of the land resources (e.g. natural vegetation), resulting in land-use and cover changes (Mwavu and Witkowski 2008). Ecosystems, which represent biological communities of interacting organisms and their physical environment, supply us with the air, water, and food that are essential for life, with the raw materials for our industry and consumption, and other irreplaceable services including regulation of disease and soil erosion, purification of air and water, and opportunities for spiritual reflection. Nonetheless, the current status of biodiversity and the benefits we drive from ecosystem services are less known both locally and beyond. The forest and woodland ecosystem represents the major and diverse terrestrial ecosystem of Ethiopia. This ecosystem is part of the two of the world‘s

36 biodiversity hotspots and houses the only global wild Arabica coffee populations. The estimated forest and woodland cover of Ethiopia

was close to 300,000 km2, which was about 27 % of the total land area of the country (Bekele and Berhanu, 2001). According to MEFCC (2018), however, forest and woodland covers estimated to be about 23.5 million ha (EFD 2024).

The forest and woodland ecosystem of Ethiopia makes the largest part of the major Protected Area Systems of the country such as National Parks, Wildlife Reserves, Sanctuaries and Controlled Hunting Areas. Furthermore, the 58 National Forest Priority Areas (NFPAs) were designated inside this ecosystem. The forest and woodland ecosystem of Ethiopia is under serious threats due to deforestation and forest degradation, overexploitation, overgrazing and invasive species. Poverty, population growth, lack of alternative livelihoods, inadequate policy support, inappropriate investment and inadequacy of law enforcement are the drivers for loss of forest and woodland ecosystem (IBC, 2009). Forests are one of the vegetation biome dominantly covered by trees of different species that inhabit several biotic lives (Mekonnen et al. 2018).

The world has a total forest area of 4.06 billion hectares (ha), which is 31 percent of the total land area. This area is equivalent to 0.52 ha per person although forests are not distributed equally among the world's peoples or geographically. The tropical domain has the largest proportion of the world's forests (45 percent), followed by the boreal, temperate and subtropical domains. More than half (54 percent) of the world's forests is in only five countries the Russian Federation, Brazil, Canada, the United States of America and China (FRA, 2020).

The term biodiversity (from "biological diversity") refers to the variety of life on Earth at all its levels, from genes to ecosystems, and can encompass the evolutionary, ecological, and cultural processes that sustain life (American Museum of Natural History). Biodiversity includes not only species we consider rare, threatened, or endangered but also every living thing from humans to organisms we know little about, such as microbes, fungi, and invertebrates (American Museum of Natural History).

At the centre for Biodiversity and Conservation, we include humans and human cultural diversity as a part of biodiversity. Use the term "bio cultural" to describe the dynamic, continually evolving and interconnected nature of people and place, and the perception that social and biological dimensions are interrelated. This concept recognizes that human use, knowledge, and beliefs influence, and in turn are influenced, by the ecological systems of which human communities are a part. This relationship makes all of biodiversity, including the species, land and seascapes, and the cultural links to the places where we live are right where we are or in distant lands

important to our wellbeing as they all play a role in maintaining a diverse and healthy planet (American Museum of Natural History).

Components of Kabon Forest and Wood Land Ecosystems

Biodiversity: the "variability among living organisms from all sources including diversity within species, between species and of ecosystems" (United Nations 1992, Article 2) helps regulate climate through carbon sequestration and control of local rainfall, filters air and water, and mitigates the impact of natural disasters such as landslides and coastal storms. A common way to measure biodiversity is to count the total number of species living within a particular area. Tropical regions, areas that are warm year-round, have the most biodiversity. Temperate regions, which have warm summers and cold winters, have less biodiversity. Regions with cold or dry conditions, such as mountaintops and deserts, have even less.

Generally, the closer a region is to the Equator, the greater the biodiversity. At least 40,000 different plant species live in the Amazon rain forest of South America, one of the most biologically diverse regions on the planet. Only about 2,800 live in Canada's Quebec province (global biodiversity, 2011). The warm waters of the western Pacific and Indian Oceans tend to be the most diverse marine environments (global biodiversity, 2011).

Conservation of habitat diversity leads to conservation of species and genetic diversity. The major ecosystems include: mountain, wetland .rangeland, agricultural and forest and woodland. The country has two biodiversity hotspots, the Horn of Africa, and the Ethiopian Highlands, which is a part of Eastern Afromonatane hot spot (Biodiversity hotspots). The existence of diverse ecosystems has resulted in rich floral, faunal, and microbial diversity. A good account of Ethiopia biodiversity is available the country reports submitted to secretariat CBD, FAO reports, and documentation of biodiversity through internet sources, (http://etflora.net/; http://www.ibc-et.org/; http://dad.fao.org/; http://www.biodiv.be/ethiopia/).

The extensive and unique conditions in the highlands of the country have contributed to the presence of a large number of endemic species. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, of which about 15 per cent are endemic. It has been said that Ethiopia is the fifth largest floral country in tropical Africa. The country is also rich in its faunistic diversity. The larger mammals are mainly concentrated in the south and southwest border and adjacent areas of the country. Mountain massifs in the North are also home to many endemic species of mammals, particularly the Walia Ibex, Semien Fox and Chelada Baboon .About 277 species of mammals, 861 species of birds, 201 reptile species (over 87 snakes, 101 lizards and 13 species of tortoises and turtles), 145 species of freshwater fish, of which over 87 species are from Baro River and

16 from Lake Abaya, 324 butterflies and 63 species of amphibians are known from Ethiopia. A total of 31 species of endemic mammals .

Floristic Diversity

Table 5. Identified plant and crop species of Kabon forest and woodland ecosystem.

	Local name	Scientific name
	Koso	*Hagenia abyssinica*
	Woyra	*Olea africana*
	Asita	*Erica arborea*
	Zigiba	*Podocarpus falcatus*
	Yetemenja Enchet	*Jacaranda mimosifolia*

Source: FGD and environmental protection forest development office 2024

Diversity of Crop Plant Species

In the Kabon forest and wood land eco system there are different types of plant species occurred in the area. Crop plants are known. Local cultivars/farmers varieties of several major food crops (wheat, barley, sorghum, regional food crops are having enormous genetic diversity are available in the ecosystem .

Faunal Diversity

Ethiopia is rich in faunistic diversity with mammals (277 spp.), birds (861 spp.), reptiles (78 spp.), and amphibians (54 spp.) and fishes (101 spp.) (http://www.biodiv.be/ethiopia/). Among these some of the them are found in the ecosystem. Cattle's (23750), chickens (2000), goat, horse and sheep However, not much information is available on diversity of invertebrates.

Table 6. Faunal species occurred in the forest and wood land ecosystem.

No	Amharic name	**Scientific name**
1	ጅብ	Hyena
2	*ነብር*	*Leopard tiger*
3	ጦጣ	Ape
4	ዓሳማ	Pig
5	ድኩላ	Bushbuck
6	ዝንጀሮ	Baboon
7	ሚዳቃ	Duiker
8	ጥንቸል	Hare Abyssinian
9	ከርከሮ	Warthog
10	ቀበሮ	Jackal
11	ጃርት	porcupine
12	አንበሳ	Lion
13	ጎሪዛ	Columbus Monkey
14	ጃርት	Porcupine

Source: From woreda environment protection office

Key terms or definition

- ✓ ***Biodiversity:*** The Convention on Biological Diversity (CBD) defines 'biological diversity' as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems" (CBD, 1992).

- ✓ The Millennium Ecosystem Assessment and TEEB 2004 (The Economics of Ecosystems and Biodiversity) demonstrated that biodiversity underpins ecosystem goods and services that are required for the survival of human societies and for the future of all life on the planet. In addition, biodiversity generates considerable economic value through the provision of goods such as food, water, and materials, and services such as climate regulation, pollination, disaster protection, and nutrient cycling.

- ✓ Wet land: a type of ecosystem characterized by water-saturated soils and a diverse array of plant and animal life. Wetlands can include marshes, swamps, and bogs, playing crucial roles in biodiversity, water filtration, and flood control.

- ✓ ***Drivers***: drivers are external factors that affect nature, and, as a consequence, also affect the supply of Nature Contributions to People (NCP). Drivers of change include indirect drivers (all anthropogenic: here Drivers) and direct drivers (both natural and anthropogenic: here Pressures) (IPBES, 2019).

- ✓ Pressures: are human activities that induce changes to the environment, for instance, the discharge of chemical, physical or biological agents, or land use changes. The intensity of the pressures depends on the technology and extent of activities that vary across geographic regions and spatial scales (Bradley & Yee: 2015).

- ✓ State: refers to the physical, chemical, and biological components of the natural environment (i.e. the living and non-living components).and also Refers to the current condition or status of wetland ecosystem. In this context, it pertains to the existing health, diversity, and composition of the fauna and flora in the wetland.

- ✓ Impacts: are the resulting changes in the quality and functioning of the ecosystem that influence living things including the production of ecosystem goods and services.

- ✓ Responses": are actions taken through policies and regulations to prevent, compensate, ameliorate, or adapt to changes in the state of the environment.

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

the proximate human activities or processes that have impacted, are impacting, or may impact the status of a tax on.

- ✓ Trend: indicates the general direction or change over time. It relates to patterns or shifts in the populations or health of species within the ecosystem, such as increases or declines.
- ✓ **Fauna**: refers to the animal life of a particular region, habitat, or ecosystem. In this case, it encompasses all the animals found in the kabon wetland.
- ✓ **Flora**: refers to the plant life of a particular region, habitat, or ecosystem. Here, it includes all the plant species present in the kabon forest and wood land ecosystem
- ✓ In Ethiopia, the forest is defined as land occupied with trees (natural and planted, including bamboo) attaining a height of more than 2 meters at maturity, a canopy cover of more than 20% and covering an area of more than 0.5 ha, with a minimum width of 20 meters (MEFCC 2018).
- ✓ This forest definition differs from the definition used for international reporting to the Global Forest Resources Assessment (FAO) and from the forest definition used in the National Forest Inventory which both applied the FAO (2015) forest definition with the thresholds of 10% canopy cover, a 0.5 ha area, and a 5 m height. The reason for Ethiopia to change its national forest definition is to better capture dry and lowland-moist vegetation resources
- ✓ **Importance of Biodiversity**

The flora and fauna of forests in Ethiopia, particularly within the context of wetlands, provide numerous ecological, economic, and social benefits. Here are some key benefits kabon forest and woodland ecosystem.

1. Ecological Benefits

- ➢ Biodiversity: forests and wetlands are rich in biodiversity, providing habitat for numerous species of plants, animals, and microorganisms. This diversity is crucial for ecosystem resilience and stability. Forest used for local community for the purpose of wood and charcoal, construction ,fuel ,timber ,for medicinal value ,for refreshment and for employment .

- Water Regulation: forest play a significant role in regulating water flow, maintaining water quality, and replenishing groundwater supplies. Forests help reduce soil erosion and filter pollutants.

- Carbon Sequestration: forests act as carbon sinks, absorbing CO2 from the atmosphere, which helps mitigate climate change.

- Soil Conservation: the root systems of forest plants help bind soil, preventing erosion and promoting soil fertility.

- Habitat for Wildlife: forests provide essential habitats for a variety of species, including endemic and migratory birds, mammals, and supporting ecological balance.

2. Economic Benefits

- Sustainable Resources: forests offer timber, fuel wood, and non-timber products like fruits, nuts, and medicinal plants, supporting local economies and livelihoods**.**

- Climate Resilience**-** forest absorb excess rainwater, reducing flooding risk, while also providing water during dry periods, contributing to climate resilience.

In general, the flora and fauna of Ethiopia's forests are vital for ecological health, economic development, and cultural integrity. Their preservation is essential for maintaining these benefits for future generations.

In general the Millennium Ecosystem Assessment (MEA) categorizes ecosystem services into four main types:

- Provisioning Services: These are the products obtained from ecosystems, such as food, timber, and fiber. For instance, fish consumed as food require a combination of fishing boats (built capital), skilled fishers (human capital), and supportive communities (social capital) to be effectively harvested.

- Regulating Services: These services help regulate ecosystem functions, contributing to flood control, water purification, air quality maintenance, and climate regulation. For example, coastal wetlands provide storm protection, necessitating built infrastructure and community engagement for effective management. Although these services are often not marketed, their societal value is significant.

- Cultural Services: These encompass non-material benefits derived from ecosystems, such as recreation, aesthetic enjoyment, and cultural identity. For example, a lake can provide recreational opportunities when paired with infrastructure (like trails), community engagement (families and friends), and appreciation of nature (human capital).
- Supporting Services: These are essential for maintaining ecosystem processes, including soil formation and habitat provision. Supporting services indirectly benefit human well-being by underpinning provisioning, regulating, and cultural services. They often represent foundational ecosystem functions that may not be immediately measurable but are crucial for sustaining overall ecosystem health.

Table 7. Medicinal plants occurred in the ecosystem

No	Amharic name	Scientific name	Remark
1	ብሳና	Croton	
2	ሸራፈው	Moringa	
3	ኮሶ	Hygienic Abyssinia	
4	ድንበላል		
5	ዝንጅበል		
6	ገራዋ		

3.2.2. Drivers and Pressures Of Degradation In Kabon Forest and Wood Land Ecosystem

For humans, biodiversity offers numerous advantages, including oxygen production, food sources, construction materials, medicines, and soil fertility, which prevents flooding and keeps water clean. Many industries, like agriculture and medicine, depend heavily on plant diversity. A decline in biodiversity can lead to significant economic impacts on local communities.

The first recorded biodiversity conservation oriented activity in Ethiopia dates back to the reign of Emperor Zere Yacob (1434-1468) (Vreugdenhil et al., 2012). The Emperor noticed the declining of forest cover on the Wachecha Mountain ecosystem near Addis Ababa and

took an inspiring action of collecting seeds and seedlings from other Juniperus forests and run replanting activities around Menagesha, and established the Menagesha State Forest. According to Pankhurst (1989). The Menagesha State Forest is the oldest conservation area in Africa, or the oldest formalized conservation effort in the continent. Currently, the country has several policies and different strategies pertinent to biodiversity conservation.

Globally, biodiversity is being lost and increasingly threatened through a range of anthropogenic actions (Dobson 2007). The most important notable drivers behind the current loss of biodiversity are habitat modification, overexploitation, climate change, invasive alien species, and chains of extinction (Powrie 2011). As mentioned in the IPCC (2013) report, global warming and precipitation is expected to increase, the changing climate is predicted to be one of the worst drivers for the loss of all level of biodiversity over the next 50–100 years, and further exaggerated the effects of earlier threats on biodiversity loss.

Historically, biodiversity has diminished due to human activities, particularly habitat destruction for agriculture and mining , as seen in the Kabon forest ecosystem. This degradation threatens not only ecological balance but also traditional practices, such as using local plants for medicine. Biodiversity has declined at an alarming rate in recent years, largely as a result of human activity. The major drivers and pressures of kabon forest and wood land ecosystem are:-

Population growth: the population growth of Gambela woreda increasing from time to.As result population growth and development, the encroachment of forest ecosystem for infrastructure, housing, and industrial activities poses significant challenges to ecosystem health. As populations expand, the demand for land intensifies particularly for agriculture, fuel wood, and timber leading, and charcoal\ to increased deforestation and environmental degradation (Contreras-Hermosilla, 2000). Urban expansion frequently encroaches on forest and woodland resulting in habitat loss and fragmentation, which disrupts the delicate balance of these ecosystems. The conversion of the flora and faunal area for city development and infrastructure, such as roads and residential areas, further reduces the natural area available to wildlife, undermining biodiversity and the ecosystem services these ecosystems provide. This transformation not only impacts local species but also affects broader environmental functions, highlighting the urgent need for sustainable land-use planning that prioritizes the preservation of wetland ecosystems in the face of growing human demands.

Agriculture: agriculture is a significant driver of change in forest and woodland ecosystems, influencing their structure, composition, and function. The expansion of agricultural land often leads to deforestation, as forests are cleared to make way for crops and livestock. This conversion not only results in habitat loss for numerous species but also disrupts ecological processes, such as carbon storage and water regulation.

Intensive agricultural practices and mining can degrade soil quality and lead to erosion, further compromising the integrity of surrounding forested areas. The demand for agricultural products, driven by population growth and changing dietary preferences, exacerbates these pressures. As agricultural areas expand, they often encroach on remaining woodlands, leading to fragmentation and isolation of forest habitats. This fragmentation can limit wildlife movement and genetic diversity, making ecosystems more vulnerable to climate change and other environmental stressors.

Fuel woods

Fuel wood demand is a critical driver of change in Kabon forest and woodland ecosystems; it serves as a primary source of energy for cooking and heating. This high demand leads to significant deforestation and degradation of forests as trees are cut down for fuel. The consequences of increased fuel wood extraction include habitat loss for various species, which can result in reduced biodiversity. As forests are depleted, the ecological balance is disrupted, affecting soil health, water cycles, and carbon storage capacity. These changes can exacerbate climate change by releasing stored carbon dioxide from the soil and vegetation.

In addition, the dependence on fuel wood can drive unsustainable harvesting practices, such as selective logging or overexploitation of specific tree species, which further compromises forest health. Communities may resort to cutting down trees at unsustainable rates, leading to a vicious cycle of environmental degradation and increased vulnerability to natural disasters, such as landslides and flooding.

House construction

House construction is a significant driver of change in forest and woodland ecosystems, often leading to deforestation and habitat loss. As urban populations grow and the demand for housing increases, forests are frequently cleared to make way for new developments. This process not only removes trees and vegetation but also disrupts local wildlife habitats, leading to decreased biodiversity and fragmented ecosystems.

The materials required for construction such as timber, concrete, and brick often come from forest resources. Unsustainable logging practices can aggravate this issue, as trees are harvested at rates faster than they can regenerate, further diminishing forest cover. Additionally, the infrastructure needed to support new housing, such as roads and utilities, often encroaches deeper into forested areas, causing further degradation.

The loss of trees and vegetation from house construction can have cascading environmental effects, including soil erosion, altered water cycles, and increased carbon emissions. As forested areas are replaced with impervious surfaces, local ecosystems can struggle to adapt, leading to issues like flooding and reduced water quality.



Figure 4.**FGD on the issue of flora and fauna degradation**

3.2.3. Impacts of Drivers and Pressures on Kabon Forest and Wood Land Ecosystem Degradation

Loss of biodiversity: Loss of biodiversity due to forest and woodland degradation has significant ecological, economic, and social implications. Here are some key impacts

Table 8: **Threated plant and flora species**

No	Amharic name	Remark
1	ግራር	
2	ዘንባባ	
3	ሮቃ	
4	ወይበታ	
5	ዳልኤ	

Table 9. Threatened faunas tic species in the ecosystem.

No	Amharic name	English	Remark
1	ነብር	Tiger	
2	ከርከሮ	Wart hog	
3	አቦሸማኔ	cha	
4	አሳማ	Pig	
5	ጉሪዛ	Bear	

- Loss of Ecosystem Functioning- biodiversity is crucial for maintaining ecological interactions, such as pollination, seed dispersal, and predator-prey dynamics. Loss of species can disrupt these relationships, leading to imbalances of each other.

- Loss of Species- Many species of plants and animals, particularly those that are specialized or have limited ranges, face extinction as their habitats are altered or destroyed. This loss is often irreversible and can lead to reduced genetic diversity within remaining populations.
- Endangered Species: Certain species become endangered as their habitats shrink, which can lead to a cascade of effects on other species that depend on them.
- Altered Ecosystem Services- biodiversity contributes to the availability of resources such as food, medicine, and raw materials. Loss of species can diminish the variety and quality of these resources. For example the community did not get enough and clean water for animals and the community

.

- Changes in biodiversity can affect local climate conditions, potentially leading to less favorable environments for both wildlife and human populations.
- Social and Health Consequences - Reduced biodiversity can threaten food systems, leading to increased vulnerability to food shortages and malnutrition.
- Health Risks: Loss of plant and animal species can limit the availability of medicinal resources, impacting healthcare options for local communities.

Soil Erosion

- Nutrient Loss: Erosion removes the topsoil, which is rich in organic matter and nutrients essential for plant growth. This leads to decreased soil fertility, affecting agricultural productivity and forest regeneration.
- Altered Hydrology; healthy forests help retain water in the soil. Erosion diminishes this capacity, leading to reduced groundwater recharge and higher runoff, which can exacerbate flooding.
- Loss of Biodiversity-Erosion can lead to the loss of habitats for various plant and animal species, contributing to a decline in biodiversity and disrupting ecosystem dynamics.
- Species Migration: As habitats change, species may be forced to migrate, which can lead to competition and further biodiversity loss.
- Economic Impacts-Farmers may face decreased yields due to loss of fertile soil, leading to economic challenges and food insecurity.
- Social Consequences-Communities that depend on agriculture and forestry may face hardships due to decreased productivity, leading to increased poverty and food insecurity.

- Displacement: in extreme cases, communities may be forced to relocate due to land degradation, leading to social and cultural disruption.
- Long-term Sustainability
- Erosion undermines the essential ecosystem services provided by forests and woodlands, such as water purification, climate regulation, and habitat provision.
- The long-term impacts of soil erosion can affect future generations, limiting their ability to sustain agriculture and natural resources.

Climate Regulation- Climate regulation is a critical function of forests and woodlands, and their degradation can have significant negative impacts on this vital ecosystem service. Here are the main ways in which forest and woodland degradation affects climate regulation:

- Loss of forest cover can exacerbate extreme weather events, such as heat waves and heavy rainfall, increasing vulnerability for both ecosystems and human communities.
- Disruption of Water Cycles- Forests plays a crucial role in the water cycle through evapotranspiration, which helps cool the air and maintain moisture. Degradation reduces this process, leading to drier conditions and altered precipitation patterns.
- Impact on Watersheds: Healthy forests protect watersheds and maintain water quality. Degradation can lead to increased runoff, reduced groundwater recharge, and heightened flood risks, affecting both ecosystems and human water supplies.
- Biodiversity and Ecosystem Resilience-Biodiversity ecosystems are more resilient to climate change impacts. Degradation reduces species diversity, weakening ecosystems' ability to adapt to changing conditions.
- Diverse plant and animal species contribute to ecosystem functions that help mitigate climate impacts. Their loss can hinder natural adaptation processes.
- Forest degradation often leads to soil erosion and nutrient loss, which reduces the soil's ability to store carbon and support healthy plant growth, further diminishing carbon sequestration.
- Healthy forests support diverse soil micro biomes that play a role in carbon cycling. Degradation can disrupt these communities, impacting their capacity to store carbon.
- Social and Economic Impacts- Changes in climate regulation can affect agriculture, forestry, and fisheries, threatening the livelihoods of communities that depend on these resources.
- As climate-related challenges grow, communities and governments may face increased costs for disaster relief, infrastructure repair, and adaptation measures.

- Social Impacts: Communities that depend on forests for resources and livelihoods face increased poverty and loss of cultural identity.

Economic Consequences- Forest and woodland degradation leads to several significant economic consequences that affect local communities, national economies, and global markets. Here are the key impacts:

- Reduced Timber and Non-Timber Products-Degradation diminishes the availability of timber, which can drive up prices and affect industries reliant on wood products, from construction to furniture manufacturing.
- Loss of Non-Timber Forest Products (NTFPs): Many communities depend on NTFPs (e.g., fruits, nuts, medicinal plants) for income. Degradation reduces these resources, impacting livelihoods and food security.
- Soil Erosion and Fertility Loss: Erosion and soil degradation reduce agricultural productivity, leading to lower crop yields and increased food insecurity. Farmers may face higher costs for fertilizers and soil restoration.
- Impact on Livelihoods: Reduced agricultural output can threaten the livelihoods of farming communities, leading to economic instability and increased poverty.
- Restoration Expenses: Once degraded, forests often require significant investment for restoration, including reforestation and sustainable management practices.
- Conservation Costs: Governments and NGOs may need to allocate more resources to conservation efforts, diverting funds from other important services and infrastructure.
- Decline in Ecosystem Services: Forests provide crucial services such as water purification, climate regulation, and flood control. Degradation can lead to the loss of these services, increasing costs for water treatment and disaster management
- Impact on Tourism: Healthy forests attract tourists for recreation and ecotourism. Degradation can diminish the natural beauty and biodiversity that draw visitors, impacting local economies dependent on tourism.
- Economic Risks: Degraded forests are less resilient to climate impacts, increasing vulnerability to extreme weather events. This can lead to costly damages to infrastructure and agricultural systems.
- Insurance and Recovery Costs: Communities may face higher insurance premiums and recovery costs due to increased climate-related disasters linked to forest degradation.

- Resource Scarcity: Degradation can lead to resource scarcity, resulting in conflicts over land and resources, which can destabilize communities and economies.
- Displacement of Communities: Economic pressures from degradation may force communities to relocate, leading to social disruption and additional economic challenges.

3.2.4. Response Taken to Improve the Status of the Kabon Forest Ecosystem.

The response to reverse biodiversity loss in the Kabon forest flora and fauna has been insufficient, government and community should work together

3.2.5. Conclusion

In conclusion, the Kabon forest ecosystem is highly degraded due to diffrent environmental and social factors, so that the community and the covernment should work togatethry enorder to takel the problem

3.2.6. Outlook

If everything continues as business as usual, Kabon forest Ecosystem in Gambela woreda The natural environment could not be able to provide the environment service.

3.3. Atomospher

3.3.1. State and Trend of Climate Change on the Kabon Forest Ecosystem

Climate

Climate is the "average weather" or more specifically the statistical aspects of the atmosphere-hydrosphere-land surface system that varies over time ranging from months to decades of years. The classical period for averaging climatic variables as defined by the World Meteorological Organization is 30 years.

The Atlantic Ocean and the wind blow 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 rainy seasons. Such weather pattern provides the highlands with most of its rainfall during a period that generally lasts from mid-June to mid-September. Due to difference in elevation and seasonal change in atmospheric pressure that causes Variations in precipitation throughout the country and several regions receive rainfall throughout most of the year, but in other areas precipitation is seasonal.

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 season's 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.

Climate Change

Climate change refers to a statistically significant variation in either the main state of the climate or in its variability, persisting for an extended period, typically for decades or longer. The change may be due to natural process or anthropogenic forces in the composition of the atmosphere. The Climate Change is any significant change in measures of climate (such as temperature or precipitation) lasting for an extended period of time (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 that alters the composition of the global atmosphere'. Increasing GHGs in the atmosphere_ that is the Issue! According to the International Panel on Climate Change (IPCC fifth assessment report, 2014) the global surface temperature increase by the end of the 21st century is likely to exceed 1.5 °C relative to the 1850 to 1900 period for most scenarios, and is likely to exceed 2.0 °C for many scenarios Climate conditions change with elevation, the average temperature drops 0.6°C for every 100m increase in elevation.

3.3.2. Driver and pressure

Over Grazing

Over-grazing was the main driver of the environmental degradation in the study area; the people who live around Kabon Forest ecosystem were partially engaged in the rearing of the animal. Therefore, farmers freely grazing animals in the forest

Agricultural Activities

The economic activities of the people around the Kabon Forest Ecosystem were mainly dependent on Agriculture and farmers were extended to the Kabon forest by the case of deliberate wildfire in the dry season and then cultivate.

In addition to the agricultural expansion the community and new settlers were severely scrambling the forest land with limited government exclusion, to fulfill their demands like fuel wood, constriction of house, domestic materials, to light, etc.

Deforestation

Forests are a great contribution in determining the accumulation of greenhouse gases in the atmosphere. As well as being critical to slowing or even stopping climate change, forests are important for reducing their current and future effects on people. They also regulate waterways; protect soil, and ecosystem. However, Deforestation is the main responsible factor for the loss of the above mentioned use and climate variability and /or change impact in the study area.

In the study area forest coverage is decreasing from time to time mainly due to agricultural activities, Above-mentioned driver and pressures are responsible for micro-climate change and variability in the study area.

3.3.3. Impact of climate change

The amount of greenhouse gases increase in the atmosphere case for increasing surface temperature this conditions largely affected developing country such as Ethiopia, which have limited capacity to coup with the effect of a changing climate

Climate change is accelerating high levels of land degradation and soil erosion, increase vulnerability to **droughts and floods**, and negatively impact agricultural productivity. It was also responsible for the shifting of the crop cultivation period, loss of agricultural productivity, and expansion of insects, pests, and the occurrence of animal diseases was a known problem in the study area

3.3.4. Outlook

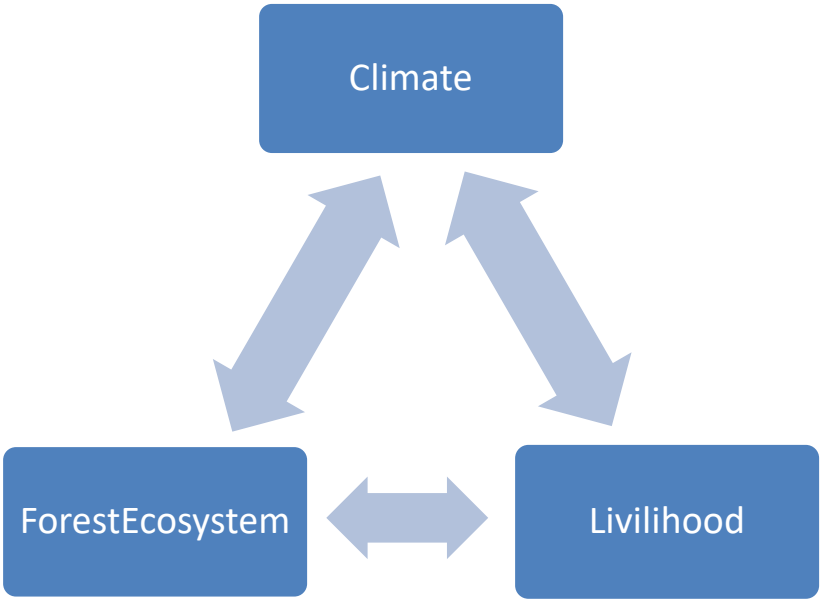
If the rate of deforestation will continue without implemented the recommended points and other additional research over the next three-decade,

- Climate variability high in the study area due to this; Kabon Forest Ecosystem will be difficult to survive
- The severe climatic conditions for human activates and animal husbandry.

If strongly implement adaptation option like reforestation, afforestation, area closure and ensuring better management of soil and water and Zero grazing will implement properly may minimize the impact. Therefore the government and any concerned body should think of the possible solution recover.

3.3.5. Recommendation

To reduce the impact of climate change on the forest and livelihood and vise versa it needs an integrated climate, forest and livelihoods sustainable management. Therefore to assure sustainable development and rehabilitate Forest Ecosystem it needs to ***break*** the negative impacts of the **vicious circle** and establish a friendly interlink between climate, forest and livelihoods..



The following measures have to be taken:-

- **Climate Change**
  - Reduce carbon emission from deforestation and forest degradation
  - Promote climate change mitigation efforts by reducing carbon emission

- **Forest Ecosystem**
  - Improved catchment land conservation and restoration
  - Enhance area enclosures to protect ecological degradation and loss of biodiversity.

- Strengthening participatory forest ecosystem management practices in coloration with the government, the society and NGO.
- Adaptation options should focus on reforestation, area closure and ensuring better management

➢ **Livelihoods**

- Developing ownership/tenure law which is fair, stable and unambiguous with clear rights and duties (state, common, private).
- Developing perceptive legal instruments (policy, law and regulation) that consider as the main "pull" of participatory forest management
- 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
- Campaign and awareness on the need of sustainable development assurance through advocacy, law enforcement and establish system
- Livelihood comprises capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from the stress and shocks and maintain or enhance its capacities and assets both now and in the future without undermining the natural resource base.
- At the local level primarily create awareness about potential climate change and existing climate variability of the current and the future climate itself. Then the coping mechanism to climate variability and adaptation option for climate change should be studied and implemented.

3.4. Water

3.4.1. State and trend of Water in the Gambela worda ecosystem

3.4.1.1. State and trend of Water availability Gambela woreda Forest ecosystem

Water is considered the solution of life in the world. 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).

According to Prasifka (1994), water covers about three-quarters of the earth's surface. However, it is worth noting that freshwater is unevenly distributed 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 increase in water demand in agricultural production has been of great concern worldwide in recent years, the provision of water for energy production is ignored by water professionals and development experts. Sustainable development and advanced economic growth, sanitation, wastewater treatment, and water supply cannot be 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 voiced nowadays, focuses on the necessary integration of water management between sectors, policies, and institutions. These can be 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 is characterized by a chain of lakes varying in size, hydrological and hydrogeological setting. Some of the lakes and tributary rivers are 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 56% of the world's population had an unsafe water source.

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 beverage services are improved sources accessible to the premises, available when needed, and free from fecal and specified chemical contamination (WHO and UNICEF, 2019).

According to report by the Central Statistical Agency of Ethiopia (2017), nationally 13 percent of the population is considered using safely managed services (CSA, 2017).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 Ministry of Water, Irrigation and Electricity (MoWIE) estimates, rural water supply coverage

reached 63% by mid-2016 (or 57% according to the Ethiopian Demographic and Health Survey 2016).Source-based water safety measures and protecting water from cross contamination at point of use are important strategies to improve water quality in the water supply system and to minimize associated health consequences. 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.

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

Population Growth

According to Gambela woreda water mineral and energy office, the amount of waste water generated from urban area residences and other households increasing from time to time.

Agricultural Practices-

- Agricultural practices significantly drive water degradation Kabon ecosystems through several mechanisms. The application of synthetic crop fertilizers can lead to runoff during rainstorms, introducing excess nitrogen and phosphorus into nearby water bodies. This can cause contaminating water sources and impacting non-target species, including beneficial insects and aquatic organism's eutrophication, resulting in algal blooms that deplete oxygen and harm aquatic life.
- Soil Erosion-poor soil management, such as over-tilling, monoculture, and lack of cover crops, can lead to soil erosion. Sediment runoff can smother aquatic habitats and reduce water quality. Intensive irrigation can deplete local water resources, reducing the availability of water for wetlands and other ecosystems. Over-extraction can also lower groundwater levels, affecting nearby water bodies.
- Livestock population -Runoff from livestock operations can introduce pathogens and nutrients into water bodies. Overgrazing can also lead to soil compaction and increased erosion.
- out compete native vegetation, alter habitat structures, and negatively impact local water dynamics.
- Changes in Land Cover-Converting natural landscapes to agricultural and urban settlement land reduce vegetation cover, impacting water retention and increasing runoff and erosion.

Overexploitation of Resources

- Overexploitation of resources is a significant driver of water degradation in ecosystems through several key mechanisms:
- 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.
- Altered Landscapes: Clearing land for resource extraction can lead to increased erosion and sedimentation in nearby water bodies, degrading water quality and aquatic habitats.

- **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

Hydrological Alterations

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

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.

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, impacting water quality.

Climate Change

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

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.

Overexploitation

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

3.4.3. Impact of Water Resource Degradation on the Local Community

The region faces significant water resource challenges despite having perennial rivers like Baro with high surface water potential. These challenges stem from the uneven spatial and temporal distribution of water, which requires substantial investment for development and extension to water-scarce areas.

Drought Risk:.

1. Loss of Biodiversity- fish, birds, amphibians, and many other species depend on forest areas as vital habitats. Sensitive species may experience population decreases and perhaps extinction as a result of their deterioration. Food webs, ecological functioning, and the local community's access to clean drinking water are all impacted by the loss of Forest biodiversity.

2. Enhanced Vulnerability: The loss of forest intensifies the effects of climate change, increasing the region's susceptibility to draughts, flooding, and other extreme weather events**.**

3. Exposed for water borne diseases- exposure to water-borne diseases: Key informants and focus group discussions revealed that individuals had been exposed to cholera, diarrhea, bilharzia, Malarya and other water-borne diseases throughout time as a result of various activities that have degraded the quality of the water. In particular, animals, women, and children are traveling excessive distances to obtain water. However, the population now has to travel at least two to four hours to obtain water for their consumption.

2.4.4. Responses to protect Kabon forest ecosystem

Local communities and woreda administration respond to water pollution by taking steps to lessen its effects and restore its quality. Water shade management (soil and water conservation techniques), community awareness and education initiatives are frequently implemented to educate locals on the value of conserving water and the effects of degradation.

2.4.5. Out look

Because of the fast population grwth , agricultural expansion, urbanization, mining and climate change, Kabon forest ecosystem is becoming more and more degeraded honey prodauction decresed this couse high economic and environmental problem for farmers live near to the forest so that cominuty partesepation conservation activety should encourage .

2.4.6. Conclusion

Kabon Forest must be preserved and restored in order to support sustainable forest ecosystems and to save the community from the impact of climate chang .Restoring degraded landscapes, increasing resource efficiency, and putting conservation methods into practice can all help to minimize ecosystem lose. Not only government interfirance but olso community mobilization to save the forest is a must

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