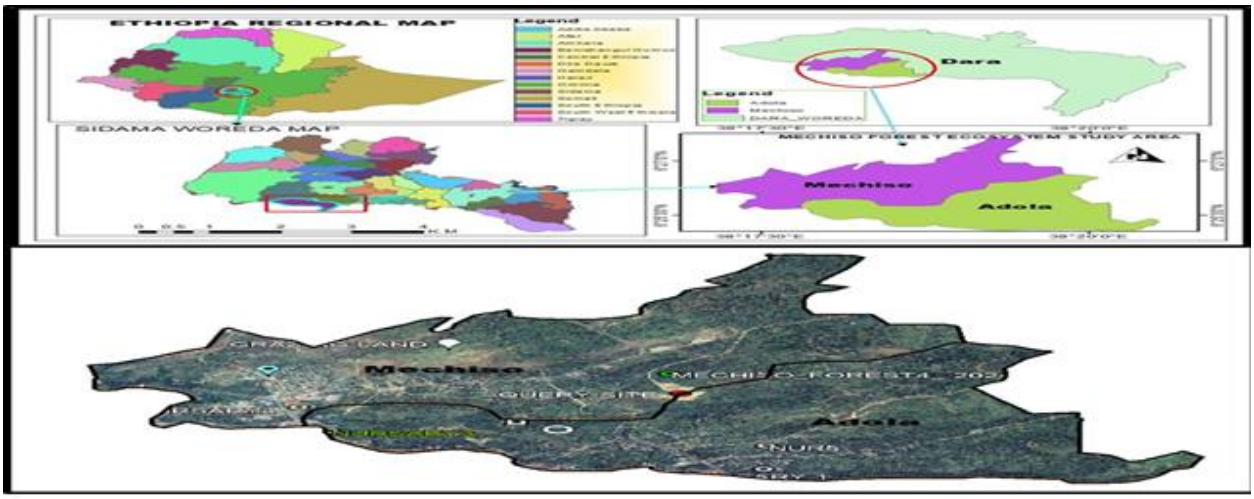
The Federal Democratic Republic of Ethiopia

Environment Protection Authority

Fact Sheet of Machisho Forest Ecosystem In Sidama Region



Prepared By State of Environment Data Study and Report Preparation Desk

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Acronym and Abbreviations

AGP—Agricultural Growth Program

Avr – Average

CBD—Conventions on Biological Diversity

CDM- Clean Development Mechanism

CH4 - Methane

Climate Resilient Green Economy

CO2 - Carbon dioxide

CO2e - Carbon dioxide equivalent

COP – Committee of Parties

CRGE – Climate Resilience Green Economy

CRGE-Climate Resilience Green Economy

CSA- Central Statistical Agency

CSA: Central Statistics Agency CRGE

DARA: Dara woreda

DLUMDR: Department of Land use Management directorate report 2011

DPSIR: Driver, Pressure, State, Impact and Response

DWWRS Dara Woreda Water Resource supply

EPA – Environmental Protection Authority

FAO –Food and Agriculture Organization-

FGD – Focal Group Discussion

FGD -Focal Person Dissection

FGD: Focus Group Discussion

GDP: Gross Domestic Product

GEF-Global Environment Facility

GHG – Green House Gas

GIS –Geographical Information system

GTP: Growth and Transformation Plan

IPCC – Intergovernmental Parties for Climate Change

IUCN-The International Union for Conservation of Nature

JARC: Jinka Agricultural Research Center

KI: Key informants

LULCC- Land Use Land Cover Change

MAOD: Meteorology Agency office

Max – Maximum

Min – Minimum

MoWIE- Ministry of Water Irrigation and Energy

Mt – Million tones

N2O - Nitrous oxide

NGO - None Governmental Organizations

RF- Rain Fall

SWC- Soil and Water Conservation

T – Temperature

UNFCCC - The United Nations Framework Convention on Climate Change

UNICEF- United Nations International Children's Emergency Fund

WHO-World Health Organization

WMO: World Meteorological Organization.

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 overutilize 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.

2. 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.

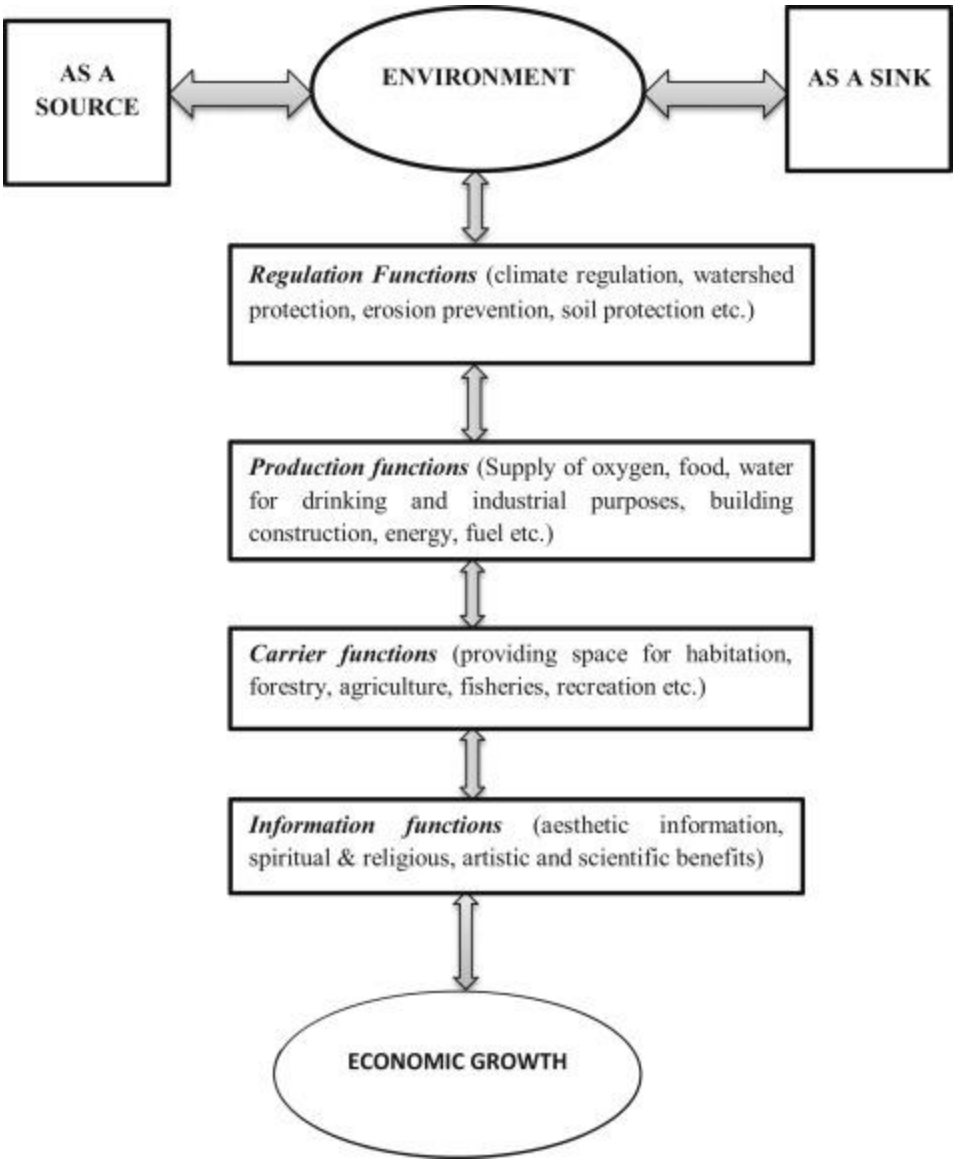

Figure 1 Environmental functions supporting economic growth.

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.

3. 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.

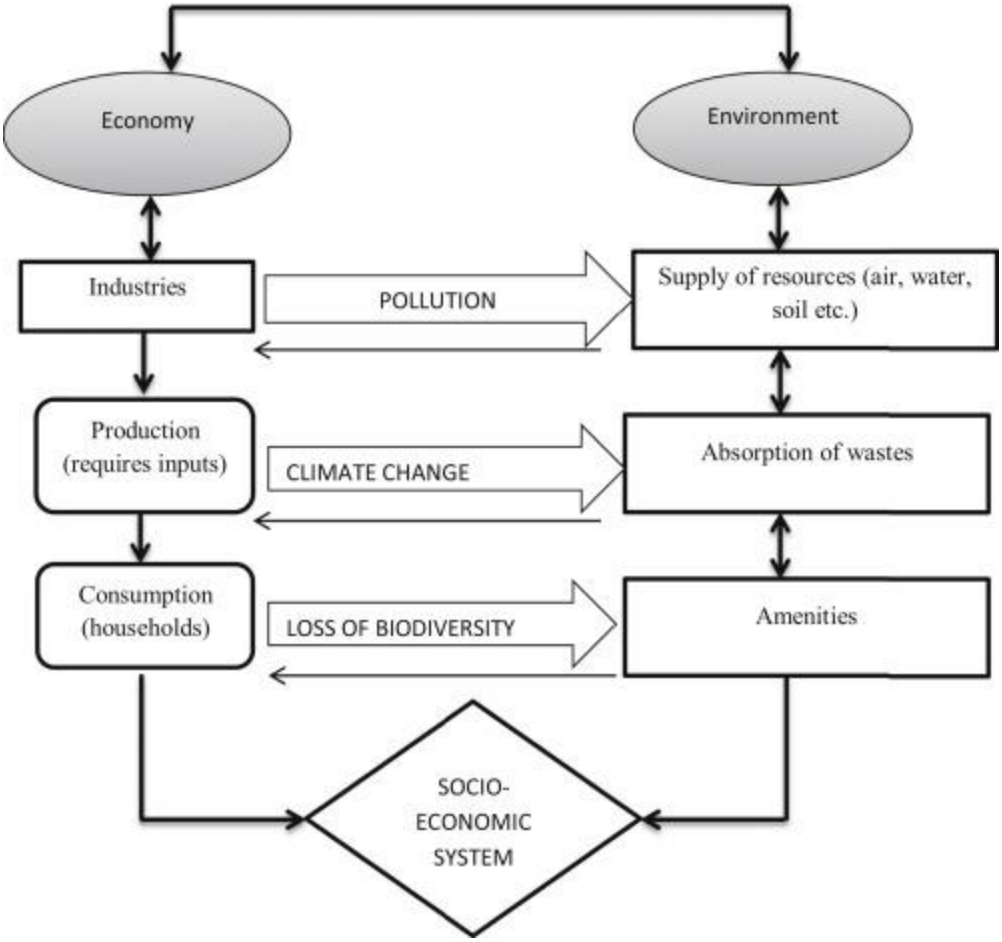

Figure 2 The Link Between Economic Growth and Environment.

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.

4. 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).

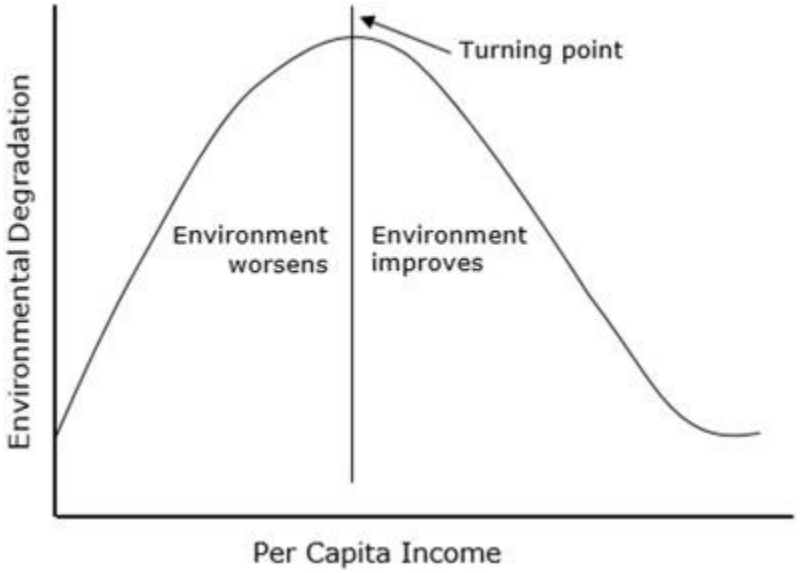

Figure 3 Environment Kuznets Curve.

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

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

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

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

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

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

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 organizations, knowledge and support within the community. The social environment is recognized 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 behavior 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 (micro).

Traditionally, Ethiopia including
S i d a m a r e g i o n aremajorlycharacterizedbythreeagroclimaticoragro-ecologicalzones (Dejene, 2003; Mengistu2006b; Chamberlin and Schmidt, 2012):

- *Kolla:* the tropical zone between500and1, 500ma.s.l, warm and semi-arid with an annual rainfall of approximately200 to 800mm.
- *Weynadega:*thesub-tropicalzonebetween1,500and2,300 ma.s.l, cool and sub-humid with an annual rainfall from 800 to 1,200mm
- *Dega:*the cool zone between 2,300m and 3,200ma.s.l., cool and humid with an annual rainfall lfrom 900 to 1,200mm Therefore; the three districts were characterized and the results presented based on this classification.

Sidama Region is northeast of Lake Abaya and southeast of Lake Hawassa. Sidama is bordered on the south by the Oromia Region (except for a short stretch in the middle where it shares a border with Gedeo zone), on the west by the Bilate River, which separates it from Wolayita zone, and on the north and east by the Oromia. The Sidama live between TikurWuha River in the north and Dilla town in the south, spread out in a cone-shaped area of the middle of southern Ethiopia. Sidama is generally a fertile area, varying from flat land (warm to hot) to highland (warm to cold).

Sidama has geographic coordinates of latitude, North: 5'45" and 6'45" and longitude, East, 38' and 39'. It has a total area of 10,000 km^2, of which 97.71% is land and 2.29% is covered by water. Hawassa Lake and Logita falls are water bodies that attract tourists. Of the land, 48.70% is cultivated, 2.29% is forested, 5.04% is shrub and bush land, 17.47% is grazing land, 18.02% is uncultivated, 6.38% is unproductive and 2.10% has other uses. Some of the cultivated lands are in undulating escarpment and create difficulties for the farmers in the area.

Sidama has a variety of climatic conditions. Warm conditions cover 54% of the area. Locally known as Gamoojje or Woinadega, this is a temperate zone ranging from an elevation of 1500 m to 2500 m above sea level. The mean annual rainfall of the area varies between 1200 mm and 1599 mm, with 15 °C to 19.9 °C average annual temperature. A hot climatic zone, Kolla, covers 30% of the total area. Its elevation ranges from 500 m to 1500 m above sea level. It has a mean annual rainfall of 400 mm to 799 mm, and the mean annual temperature ranges from 20 °C to

24.9 °C. Cool climatic conditions known as Aliicho or Dega exist in the mountainous highlands. This covers 16% of the total area with an elevation between 2500 m and 3500 m above sea level. This part gets the highest amount of rainfall, ranging from 1600 mm to 1999 mm. It has a mean annual temperature of 15 °C to 19.9 °C.

Based on the 2007 census by the CSA, the region has a total population of 2,954,136, of whom 1,491,248 are men and 1,462,888 women; with an area of 6,538.17 square kilometers, Sidama has a population density of 451.83. While 162,632 or 5.51% are urban inhabitants, a further 5,438 or 0.18% are pastoralists. A total of 592,539 households were counted in this region, which results in an average of 4.99 persons to a household, and 566,926 housing units. The three largest ethnic groups reported in this region were the Sidama (93.01%), the Oromo (2.53%), and the Amhara (1.91%); all other ethnic groups made up 2.55% of the population. Sidamo is spoken as a first language by 94.23% of the inhabitants, 2.14% speak Amharic, and 2.07% Oromiffa; the remaining 1.56% spoke all other primary languages reported. 84.38% of the population said they were Protestants, 4.62% were Muslim, 3.35% practiced Ethiopian Orthodox Christianity, 3.01% embraced Catholicism, and 2.72% observed traditional religions.

In the 1994 census, Sidama had a population of 2,044,836 in 439,057 households, of whom 1,039,587 were men and 1,005,249 women; 143,534 or 7.02% of its population were urban dwellers. The four largest ethnic groups reported in this region were the Sidama (88.6%), the Amhara (4.15%), the Oromo (2.97%), and the Welayta (1.84%); all other ethnic groups made up 2.44% of the population. Sidama is spoken as a first language by 88.6% of the inhabitants, 4.15% speak Amharic, 2.97% Oromiffa, and 1.84% Welayta; the remaining 2.44% spoke all other primary languages reported. 62.54% of the population said they were Protestants, 13.64% observed traditional religions, 8.24% practiced Ethiopian Orthodox Christianity, 8% were Muslim, and 4.24% embraced Catholicism.

Dara is one of the woredas in the Sidama Region of Ethiopia. Part of the Sidama Region, Dara is bordered on the south by the Gedeo Zone and on either side of it by the Oromia Region, on the northwest by Chuko, on the north by AletaWendo, and on the northeast by Hula. Towns in Dara include Kebado, TeferiKela Abera and Machisho

According to a 2004 report, Dara had 8 kilometres of asphalt road, 66 kilometres of all-weather roads and 16 kilometres of dry-weather roads, for an average road density of 369 kilometres per 1000 square kilometres.Source SNNPR bureau of finance and economic development website.

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 Daraworeda has a total population of **129,953** of whom 64,643 is men and 65,310 is women 51.98 % of its population is urban dwellers the rest is rural dwellers . The four largest ethnic groups reported in Dara were the Sidama (89.68%), the Amhara (5.28%), the Silte (1.62%), and the Oromo (1.37%); all other ethnic groups made up 2.05% of the population. Sidamo is spoken as a primary languages reported. 64.4% of the population said they were Protestants, 15.82% observed traditional religions, 11.85% practiced Ethiopian Orthodox Christianity, 4.23% were Muslim, and 1.4% were Catholic. First language by 92.54% of the in habitants, and 5.42% speak Amharic; the remaining 2.04% spoke all other.

Table 1 PopulationTrend DaraWoreda(2020-2024).

YEAR (G.C)	Ruralpopulate			Urban. populatio		
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL
2020	26496	32497	58993	27589	33530	61192

2021	29475	30621	60096	29333	32757	62090
2022	30334	31034	61368	30565	32802	63367
2023	31232	31139	62371	31422	33563	64985
2024	31222	31183	**62,405**	33421	34127	**67,548**
Total Rural urban population	**129,953**					

Source:-DARA woreda AFO (2024)

Source SNNPR bureau of finance and economic development website.

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 consequencesas we saw because of population increment year to year nearby Machisho Mountain Forest Ecosystem coverhas reduced and changed to quarry site.

Education

Education isthe most important factor that playsa leading role in human development. Itpromotes a productive and informed citizenry and creates opportunities for the socially andeconomicallyunderprivilegedsectionofthesociety.OneoftheprimarygoalsofFDREMinistry 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 Daraworeda ,27.91% of the population were considered literate; 9.76% of children aged 7–12 were in primary school; 1.82% of the children aged 13–14 were in junior secondary school; and 1.36% of the inhabitants aged 15–18 were in senior secondary school.

Source, Woreda AFO , and SNNPR bureau of finance and economic development website.

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 DaraWoreda in Academicyear2024

NO	Level ofSchool	Number of schools	StudentsinDaraworeda 2020- 2024		
			Male	Female	Total
1	Elementary schools	29	8,069	7,614	15,683
2	PrimarySchool(7-8)	39	3,151	2945	6,099
3	HighSchool (9-12) preparatory	2	2984	2849	5833
4	Number of teachers		784	470	1254

Source:DWEDOF(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, the Government of Ethiopia is putting the maximum possible effort to set targets towards societal development such as GTP goals and targets, and other policies and strategies. This is exhibited by increasing number of health institutions being established indifferent regions and city administrations including the rural clinics.

Health Institution & Health Coverage Daraworeda

The health institutions /especially primary hospital/ in Daraworeda are providing various services to the area's population. Concerning sanitary conditions, about 62.94% of the urban

houses and 20.04% of all houses had access to safe drinking water at the time of the census, while about 83.53% of the urban and 28.97% of the total had toilet facilities.

Currently the health coverage of the *Woreda* was reached to 97% percent. Between 2020 and 2024 the number of health institution increment is constant within five years.

Table 3 Health Institutions in DaraWoreda of 2020 and 2024

No	TypesofHealth Institutions	year				
		2020	2021	2022	2023	2024
1	GovernmentalHealth Center	3	3	3	4	
1.1	PrimaryHospital	1	1	1	1	1
1.2	Private pharmacy	3	3	3	3	3
1.3	Healthpost	24	24	24	24	24
2	PrivateHealthCenters	6	6	6	6	6
2.1	PrimaryHealthclinics	3	3	3	3	3
	Total	40	30	40	40	41

Source:-DaraWoredaHealthReport2020and 2024

Road and Transport

Road is an essential infrastructure for a given area for economic and social development. It eases mobilization of resources and communication and there by hasten the socio economic development of a given area. The total existing road in the Dara*Woreda* is 90 kilometers. Most of the rural roads are seasonal and old aged. According to 2016 report, Daraworwda has 8 kilometers of asphalt road, 66 kilometers of all-weather roads and 16 kilometers of dry-weather roads, or an average road density of 369 kilometers per 1000 square kilometers .The population who has access to Road infrastructure is around 52% this shows that rood infrastructure is one of the biggest problem for the woreda community.

Table 4 Types and length of Roads, existing Daraiworeda in the year 2020-2024

No	Roadtype	Lengthin km	%ofpopulationwhohasaccesstoRoad
1	Asphalt	8	**10**
2	All weather rood	66	32
3	Dray weather rood	16	10
	Total	90	52

Source :(WAOF 2016)

Water Resource and Supply

In dara*woreda*, there are a number of small stream and rivers among the revers The Loke rivers is the biggest river in the woreda, however currently due to various environmental problems some streams and springs were dried including LOKE, while the volume of existing small streams and river as well as the discharge rate of springs has beendecreasingfrom time to time. Recent data shows that, the water supply coverage of the *woreda*is **47%** that means 32% of the total population has access to clean drinking water. (*DWwo, 2024*) this indicates that access to clean water for the community is not enough as compared with the number of population of the woreda.

According to the formal discussion of (KI) Key informants and Focus Group Discussions (FGD) Machisho Mountain Forest Ecosystem is the major water source of the area. However, now a time because of different environmental factors water quality and quantity decreased. Among the deferent environmental factors deforestation for the purpose of quarry site can take the larger share.

Communication Services

Communication plays a vital part in building up a strong relationship across the world, either in organizational 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 Dara*Woreda*, 24 hours telephone mobile services is available for all community and almost 20% of the population has access to communication service.

Electricity

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. In Dara *woreda* the total coverage of Electricity is 62.5percent, from 24 Kebeles only energy 15kebeleshave accesses to electric services. The other residents used fuel wood, charcoals the source of and also they used kerosene as a source of light.

Housing

Housing is one of the three basic needs for human being; there is no problem of housing as mentioned during key informant, group discussion and dara*woreda* final report. In the woreda the houses mostly where constructed by different materials like woods, stone and mud.

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, with agriculture alone being the identified threat of more than 85 per cent of the 28,000 species at risk of extinction.

Machisho mountains forest Ecosystem is one of highly degraded ecosystem. The main drivers for the deterioration of the ecosystem are mainly deforestation and natural resource exploitation due to quire site that leads to forest and Natural resource degradation. The society use Machisho forest for fuel wood and for different household's construction materials and stone for asphalt constriction.

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 driver 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. That happens 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 CO_2-equivalent per year in developed countries.In Machisho mountain forest area, because of extreme soil degradation and deforestation due to quire Site Mountains forest ecosystem highly affected, wild animals and medicinal plants are disappear, decrease water quality and quantity, decrease crop production and productivity , Climate variability change make for the society more vulnerable for drought..

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 of Machisho

129,953 peoples is living in Dara *woreda*. , deforestations occur as a result of quire site and conversion of forest and shrub to farm land because of overpopulation Coursed additional demands for farm land. Due to this reason, from 1990-2015 Crop land is increased by 1257 hectare while forest 4%, shrub,33% and bush decreased respectively (source woreda agriculture office)

In the*woreda*. If the whole system continues as it is, soil erosion, land degradation and deforestation aggravate, and increase loss of soil fertility this Couse decries in agricultural productivity.

2.2. Economic Environment

- State and trend of the economic Environment

Agriculture is the most important determinant of the Sdama Region’s economy and it will continue to play the leading role in the overall economy development of the region. The

livelihood of the people is dependent on agriculture, 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 Dara*woreda* gross domestic product (GDP) is very high, which is:-

- Agriculture Sector 38%
- Industry Sector5%
- InvestmentSector32 %
- Service sectors 25

As Information collected 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 live stock product. Maize, sorghum, barley, wheat, teff and coffee are the major crops grown in the area. However, the topography of the woreda soil erosion, climate variability, deforestation etc are resulting in low production and productivity due to this facts agricultural productivity is decreasing by 15% in each year moreover more than 1525 peoples are affected by flood within 25 years. The proportion of Agricultural land 12578.85h/a, grazing land 415.02 h/a, forest and wood land 1534.36 h/a land, water body 22.206h/a other purposeare841h respectively

According to the woreda Agricultural office information the average land distribution per house hold is 0.25 h/a . However rill erosion, 5098,h/a sheet erosion 648 h/a, gully erosion 298 h/a, flooding 467h/a, affect the land respectively.

Themajortrend ofagriculturalpractices intheworeda

- Despite the woreda is rich in agricultural history, 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.

2.2.1. 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 in the Gross Domestic Product (GDP), employment, price stability, and equity. The very concept of studying population dynamics and economic environment is that its interlinked nature. Natural resources.

2.2.2. Impacts due to the Economic Condition

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

The Natural resources of Daraworeda Machisho Mountain forest Ecosystem where degraded Approximately 25%, .according to the woreda agriculture and natural resource office report from the total proportion of land affected by deferent factors such as rill erosion 5098 h/a, sheet erosion 6480.856,gully erosion 293h/a and flooding 467 h/a respectively . 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, due to the above factors.

2.2.4. Response Measures

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

i. Closing thegapbetweenhighpopulationgrowthandloweconomicproductivitythroughPlannedreduction of population growth;
ii. improvingthecarryingcapacityoftheenvironmentbytakingappropriateenvironmentalprotectionmeasures; and

iii. Improvingthesocialandeconomicstatusofvulnerablegroups(women,childrenandelderly).

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 inoff-farm activities, live stock 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 leguminouscropswhichfacilitatesoildevelopment/increasingsoilfertilitytoincreaseproductionandproductivity. In addition, population policy, family planning policy, forest protection policy and health policy (family planning, human health), education policy and sector plan (quality education for all) has practically implemented at grass root level.

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

Apart from the above major responses by the Government of Ethiopia, a new plan has beencoinedandputintopracticebydifferentcomponentsofthegovernmentinthisfiscalyearGrowth 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:-

- Expandandensurethequalitiesofeducationandhealthservicesthereby achievingtheMDGsinthesocial sectors,
- Establishfavorableconditionsfor sustainablestatebuilding throughthecreationofstabledemocratic and developmental state.
- Ensuregrowthsustainabilitybyrealizingalltheaboveobjectiveswithinstablemacro-economicframework.

- Thisbroadsocial,economic,andpoliticalaspectoftheGTParem anagedonthefollowingmajorpillars

- 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 minimize the limited natural resources. Then natural environment could not be able to provide the environment service.

2.2.6. Option 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. Physical Environment of Lake Hashenge

3.1. Land

3.1.1. State and Trend of LULC and Land Degradation in Machisho Forest Ecosystem, Sidama Region

In Ethiopia, LULC changes especially forest cover transition has been more severe in the highland areas (altitude >1500 m) over the past few decades (*Kidaneet, al, 2012*), as a result of increasing population, which led to significant forest clearance for agricultural use, overgrazing, etc. The forest under this threat covers more than half of the Afromontane forests of the country, which is one of the key biodiversity hotspots in Eastern Africa with a diverse flora and significant ecological reservoirs (Kulmatiski A*, et.al,* 2013). According to FAO, 2010, Ethiopia's forest cover decreased from 15.11 million ha in 1990 to 12.5 million ha in 2015. Several recent studies have also shown that the proportion of forested land reduced by 8.2% in the Northern, 3.5% in the North-western, 34.45% in the Western, over 45% in the south western, and 13% in the central highlands of Ethiopia (*Worku G. et.al,2021*). A substantial decline in forest cover has been attributed to its conversion to abandoned pasture and croplands. In most cases, immense pressures from anthropogenic activities (e.g., poor agricultural practices, deforestation, overgrazing, etc.) coupled with a rapidly increasing population are the main drivers for changes. As a result, forest resources, mainly natural forests, are increasingly becoming scarce (Kidane Y,

2012) resulting in habitat fragmentation, biodiversity loss, and a reduction in ecosystem services. Ecosystem services refer to the benefits that humans derive from natural ecosystems and their components, including provisioning services (e.g., food, timber, fodder, water, medicinal products), regulating services (e.g., carbon storage and sequestration, water purification, preventing soil erosion), supporting services (e.g., habitat, biodiversity conservation), and cultural services (e.g., aesthetic, recreational, and tourism) (Qiu H *etal,*2021) . Human well-being and the functioning of the global economy depend on ecosystem services, but these services are under threat because of the intricate interplays between people and the environment, which result in ecosystem degradation and biodiversity loss and lead to economic impoverishment.

To avert the scenarios of forest degradation, Ethiopia's government has adopted the Green Legacy Initiative through sustainable forest management and restoration programs, which aims to address the issue of forest degradation and loss of ecosystem services through sustainable forest management and restoration programs (CRGE, 2015). These initiatives are designed to monitor and manage regional ecosystem changes, provide a framework for ecological restoration and conservation, and also form sustainable development policies, with a focus on the highlands. The North-eastern highlands of Ethiopia are notable for having mosaics of different LULC types where dry evergreen Afromontane forests have historically been degraded as a result of human pressure. However, there have been recent efforts by the government to restore these forests, including community-driven initiatives such as tree planting, enclosures, and enclosures, as well as soil and water conservation measures (SWC) for over two decades.

Sidama, Southern Nations, Nationalities and Peoples, Ethiopia Deforestation Rates & Statistics | GFW. In 2010, Sidama had 248 kha of tree cover, extending over 36% of its land area. In 2022, it lost 175 ha of tree cover, equivalent to 63.5 kt of CO_2 emissions.

This study was conducted in Sidama region, Daraworeda in Machisho forest ecosystem. According to the data obtained from Daraworeda Agriculture office, there are different land uses in the woreda with total area of 15391 ha from these 415.02 ha grazing land, 22.21ha water body,12578.8 ha Agricultural land, 1534.36 ha forest and woodland and 841 ha of land used for other purposes. The number of household who got land certificate were 16749 and also there was 10 conflicts raised on land ownership. The average land distribution per household for different purposes are 0.25 ha.

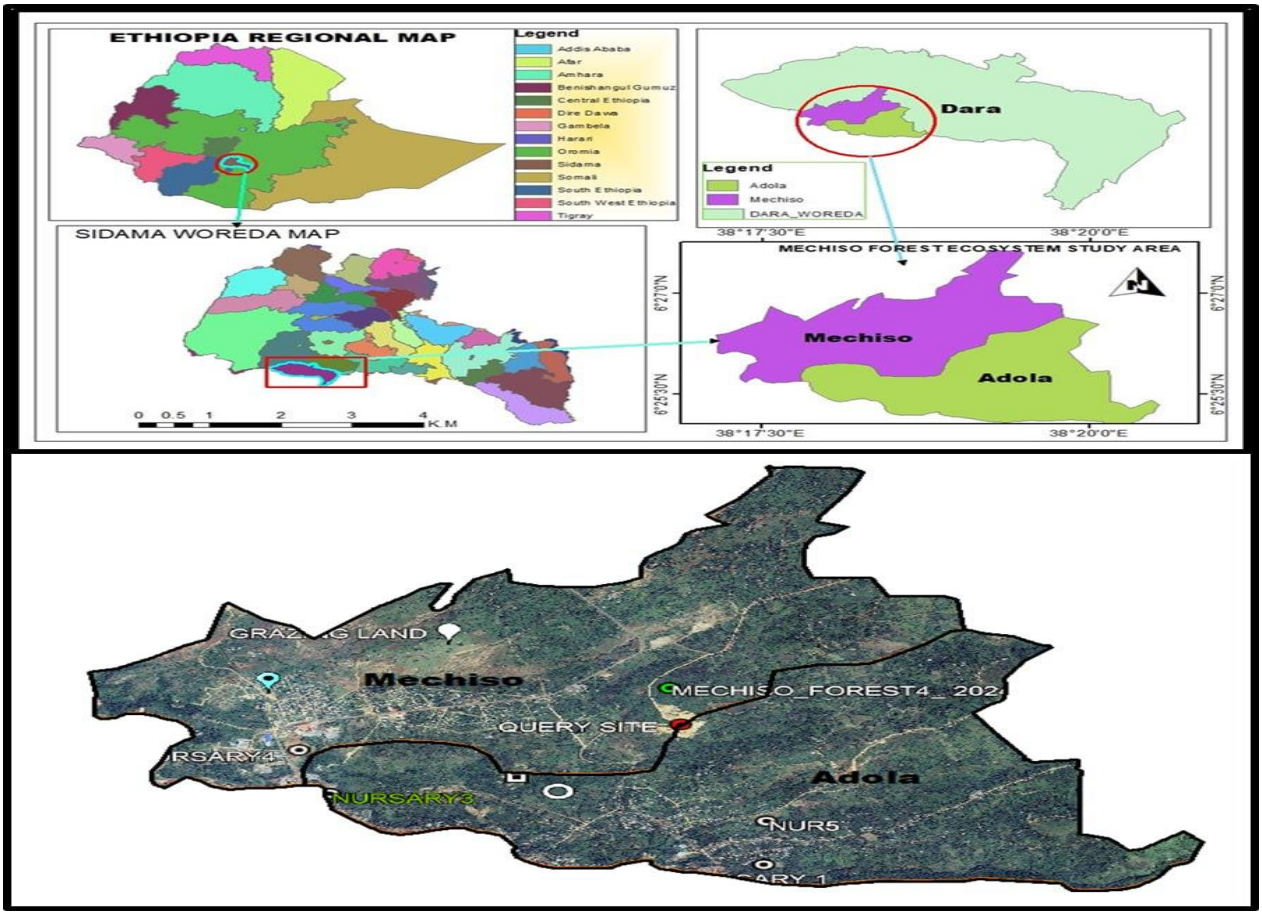

Figure 4 Study Map of Machisho Forest Ecosystem

Figure 5 Forest coverage and Query site changes in 2004, 2012 and 2024 G.c

Based on the map in the above and the explained in LULC table below the query site in 2004 was 3.33 ha, in 2012 G.c the query extraction was increased into 10.75 ha but in 2024 the amount of extraction was reduced into 7.25 ha because the local community change their income source from query extraction in to planting decrees tree for charcoal production. Due to these reason the total forests in Machisho forest and its surrounding buffer are was covered by plantation forest.

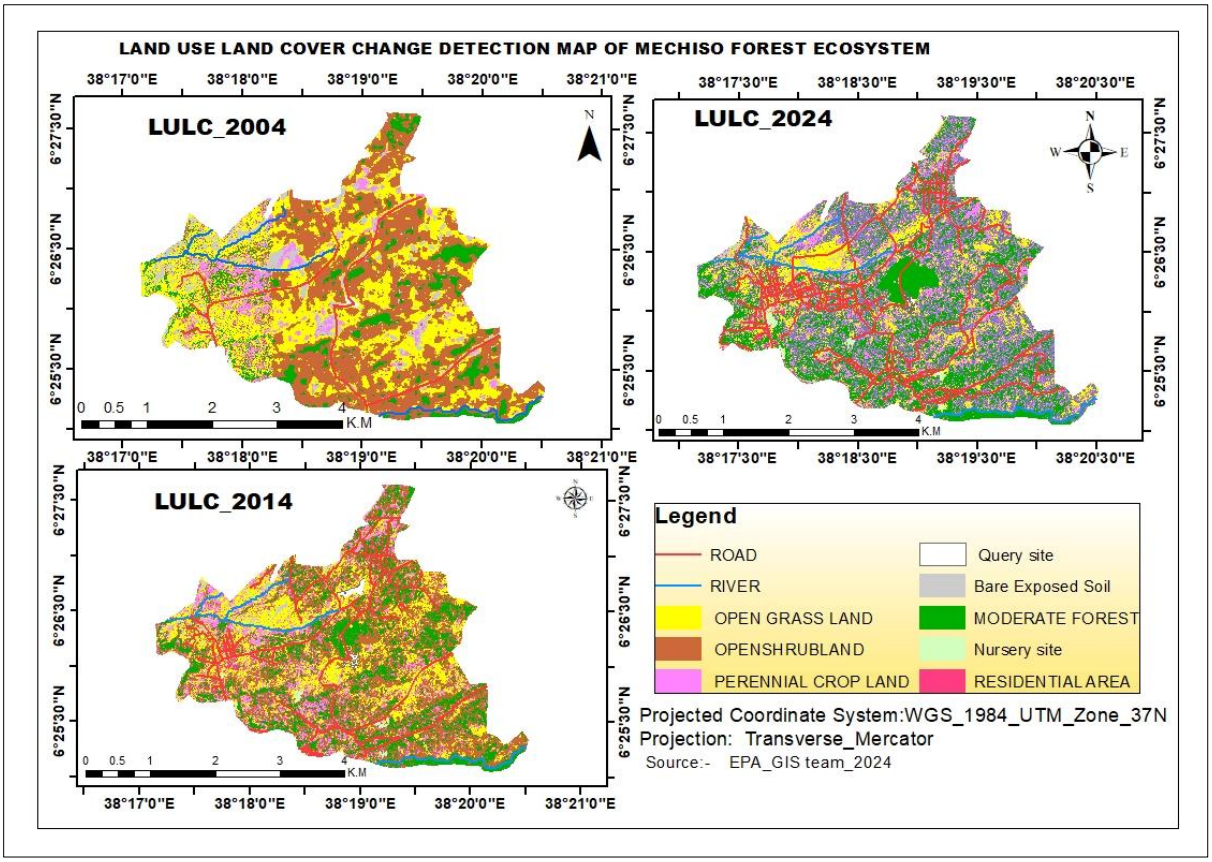

Figure 6 LULC Map, 2024

(Source: GIS Team)

Table 5 Land Use Land Cover Change Map of Machisho Forest Ecosystem

Class Name	2004 Area_Ha	2014 Area_Ha	2024 Area_Ha

Nursery Site	2.41	5.56	7.81
Query Site	3.33	10.75	7.25
Moderate Forest	146.58	309.84	464.70
Residential Area	18.92	29.67	39.70
Perennial Crop	81.88	201.05	271.27
Bare Exposed Soil	119.63	40.28	46.71
Open Grassland	505.21	342.71	405.43
Open Shrub land	647.41	585.50	282.49
Total	1525.35	1525.35	1525.35

Source: EPA GIS Team, 2024

As indicated in the classification scheme Open Grass land, Open Shrub land, Bare exposed soil, Moderate forest, Query Site, Nursery Site and Perennial Crop Land are the major LULC classes for the study periods. As it has been observed from the above LULC table, the total area from the year 2002 to 2012G.c,Open Grass land was reduced from 505.2 ha in the year 2004 G.c to 342.7 ha but in the year 2014 it was raised in to 405.4 ha, Open Shrub land in the year 2004 was 647.4 ha, in 2014 G.c it covers 585.5 ha, in 2024 282.5 ha;Bare exposed soil in 2004 G.c 119.6 ha, in 2014, 40.28 ha in 2024, 46.7 ha; Moderate forest in 2004 it was 146.56 ha, in 2014 it was 309.8 ha, in 2024 it was 464.7 ha, Query Site coverage in 2004 G.c 3.33 ha, in 2014 G.c it covers 10.75 ha and also in 2024 it covers 7.25 ha:the nursery site coverage in the year 2004 G.c was 2.41 ha, in 2014 it covers 5.56 ha and also in 2024 the nursery site covers 7.81 ha of land. According to the above LULC table moderate forest coverage, nursery site and residential and the coverage of perennial crop were increased in the consecutive sample years from the year 2004 to 2024 G.c. On the other hand the coverage of open shrub land was reduced highly because the previous shrub lands was converted in to moderate forest land. However, Open Grassland was reduced from 505.2 ha to 342.7 ha from the year 2004 to 2014 but the coverage was increased from 342.7 ha to 405.4 ha since the year 2014 to 2024 G.c. This indicates most of the grasslands was converted in to plantation forest.

Table 6 Change matrix table between 2004 and 2024

LandUseClass	**2024 landcover class name**

Name		Exposedsoil	Grassland	Moderateforest	Nurserysite	Openshrubland	Perennialcroplland	Querysite	Residentialarea	Grandtotal
2004_landcoverclass name	Bare exposed soil	11.00	45.57	19.02	0.39	21.57	18.08	0.42	3.58	119.63
	Crop land	5.92	24.15	16.15	0.44	18.08	13.47	0.07	3.58	81.88
	Moderate forest	2.07	12.08	73.80	0.12	33.09	22.02	0.00	3.40	146.58
	Nursery	0.08	0.38	0.43	1.00	0.07	0.10	---	0.34	2.41
	Open grass land	15.76	116.32	123.50	4.10	135.34	93.45	2.74	14.00	505.21
	Open shrub land	11.05	79.64	225.89	1.19	192.70	121.08	2.55	13.31	647.4
	Quarry site	0.22	0.41	0.57	--	0.18	0.11	1.40	0.44	3.33
	Residentialarea	0.60	3.94	5.33	0.55	4.40	2.97	0.08	1.05	18.92
	Grand total	46.71	282.49	464.70	7.81	405.43	271.27	7.25	39.70	1525.4

Source: EPA GIS Team, 2024

According to LULCC matrix table above 11 ha of bare exposed soil remain unchanged from the year 2004 to 2024 but the 45.5ha,21.57 ha,19.02 ha and 18.08 ha of bare land was changed in to grass land, open shrub land and perennial crop land respectively. In the change matrix table 24.15 ha of crop land remains unchanged. The matrix table also shows that 225.89 ha of open shrub land was changed in to Moderate forest land but 121.08 ha of open shrub land remained unchanged.

Table 7 Change matrix table between 2014 and 2024

LandUseClassName		2024landclass								
		Exposed soil	Grasslan d	Moderatefor est	Nursrysite	Openshrub land	Perrnialcrop land	Querysite	Residentialarea	Grandtotal
2014landclas	OpenGrass Land	16.77	116.50	47.97	1.58	84.95	63.30	1.98	9.66	342.71
	Open shrub land	9.14	72.94	195.54	1.06	184.28	109.65	0.65	12.24	585.50

	Perennial CropLand	8.73	43.49	43.33	0.54	56.98	42.78	0.16	5.03	201.05
	Querysite	0.33	4.82	0.51	0.00	0.47	0.39	4.02	0.21	10.75
	Bare Exposed Soil	6.71	18.29	3.67	0.26	4.31	4.58	0.23	2.24	40.28
	Moderate Forest	2.50	18.13	167.62	0.05	69.56	46.34	0.09	5.55	309.84
	Nurserysite	0.14	0.73	0.28	3.73	0.35	0.23		0.11	5.56
	Residential Area	2.40	7.59	5.77	0.58	4.54	4.01	0.12	4.66	29.67
	Grand Total	46.71	282.49	464.70	7.81	405.43	271.27	7.25	39.70	1525.35

Source: EPA GIS Team, 2024

According to change matrix table mentioned in the above, 116.5 ha of open grass land, 184.28 ha of open shrub land, 42.78 ha perennial crop, 167.6 ha of moderate forest and 4.66 ha of residential area remains unchanged from the year 2014 to 2024 G.c. Whereas, 63.3 ha of open grass land was changed in to open shrub land and also 43.3 ha Perennial Crop Land was changed in to moderate forest, reversing 46.3 ha of moderate forest was changed in to Perennial Crop Land in the same year.

Table 8 Changematrixtablebetween2004 and 2014

LandClass Name		2014 LULCClassName								
		Open grass land	Open shrub land	Perennial crop land	Quersite	Bare ExposedSoil	Moderate forest	Nursery site	Residential area	GrandTotal
2004L	Bare Exposed Soil	49.27	29.46	15.90	1.25	11.42	9.56	0.08	2.71	119.63
	Crop Land	27.63	23.69	16.34	0.14	3.69	7.81	0.34	2.24	81.88
	Moderate Forest	12.63	54.03	13.80	0.01	1.43	62.23	0.04	2.42	146.58
	Nursery	0.47	0.45	0.27	0.00	0.05	0.07	0.78	0.32	2.41
	Open grass Land	149.93	183.94	72.01	5.60	15.78	63.53	2.85	11.56	505.21
	Open	97.9	286.89	80.47	2.0	7.22	162.54	1.16	9.15	647.

	Shrub Land	1			6					41
	Query Site	0.63	0.44	0.02	1.39	0.26	0.09		0.50	3.33
	Residential Area	4.25	6.60	2.24	0.29	0.43	4.01	0.31	0.77	18.92
	Grand Total	**342.71**	**585.50**	**201.05**	**10.75**	**40.28**	**309.84**	**5.56**	**29.67**	**1525.35**

Source: EPA GIS Team, 2024

The Change matrix table mentioned in the above, 11.42 ha of bare exposed soil, 16.34 ha of crop land, 62.23 ha of moderate forest,286.89 ha of open shrub land and 149.9 ha of open grass land remains unchanged from the year 2004 to 2014 G.c. Whereas, 54.03 ha of moderate forest land was changed in to open shrub land and also 183.94 ha open grass land Crop Land was changed in to 0pen shrub land, on the other hand 162.54 ha of open shrub land was changed in to moderate forest in the same year.

Land Degradation in Machisho Forest Ecosystem

Land degradation is the common environmental problem in Ethiopia. It is one of the major causes of low and declining agricultural productivity and continuing food insecurity and rural poverty. In addition, land degradation directly affected the type of plant grown on the area, reduced availability of potable water, lessened volumes of surface water, depletion of aquifers and biodiversity loss. The major causes are rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production. Topography, soil types and agro-ecological parameters are also additional factors affecting the land degradation processes in Ethiopia influenced by human activity (GEF (Global Environmental Facility) (2006).

Land degradation is a great threat for the future and it requires great effort and resources to ameliorate. Utilization of dung and crop residues for fuel and other uses disturbs the sustainability of land resources. The supply of inputs such as fertilizer, farm machinery and credits are very low. The balance between crop, livestock, and forest production is disturbed, and the farmer is forced to put more land into crop production. For environmentally and socially sustainable development, there is an urgent need to promote awareness and understanding of the

interdependence of natural, socioeconomic, and political systems at local and national levels. Understanding the current status and causes of land degradation is very important.

Soil erosion and related forms cause the serious problem in many parts of Ethiopia at present, particularly in the sidama, which is situated on the high and step-faulted western side of the Ethiopian Rift Valley.

According to the participants in FGD, there was many causes for the degradation of land resource around Machisho forest, from these query extraction around the forest ecosystem predominantly affect the ecosystem highly

3.1.2. Driver and pressures of LULCC and Land Degradation in Machisho Forest Eco

- Population Pressure
- Query Extraction
- Urbanization
- Infrastructure Development

Figure: Massive query site extraction

3.1.3. Impacts of Land/Use Land Cover Change and land degradation

Land degradation has multiple and complex impacts on the global environment through a range of direct and indirect processes affecting a wide array of ecosystem functions and services (GEF 2006). The principal environmental impacts of land degradation include a rapid loss of habitat and biodiversity, modifications of water flows, and sedimentation of reservoirs and coastal zones. The resultant ecological impacts of land degradation in Ethiopia include loss in the chemical, physical and/or biological properties of soil which directly affects the type of plant that are grown on the area, reduced availability of potable water, lessened volumes of surface water, depletion of aquifers due to lack of recharge, and biodiversity loss. Similarly, land degradation is threatening biological resources and agricultural productivity. Land degradation also interrupts the regulating and provisioning services of ecosystems, in particular nutrient cycling, the global carbon cycle and the hydrological cycle. Generally, land degradation has a number of environmental impacts on regional and global level. First, degradation of forests and woodlands has impacts on global biodiversity. Second, changes in forest cover and wetlands are impacting the flow of major rivers. Third, large scale loss of forest cover changes the albedo and air circulation patterns and may affect global climate change. Fourth, soil erosion may cause excessive siltation in rivers and inland lakes, causing reduced water storage capacity in lakes, as well as eutrophication and water quality problems.

According to Dara woreda Agriculture office report, 2024 G.c the proportion of land affected by rill erosion was 5098 ha, by sheet erosion 6480 ha, by Gully erosion 293 ha, by stream bank erosion 240 ha and also the proportion of land affected by flooding 467 ha.This office also explained the proportion of land affected by deforestation was 730 ha.

3.1.4. Responses

According to Coxhead and ygard (2008), the main environmental principles for reducing land degradation are to maximize vegetation cover to prevent erosion, replace nutrients removed, and to put in place structures (terraces, bunds, vegetation strips) so as to reduce the speed and volumes of water flow over the soil. From this perspective, tree crops, perennial crops, intercropping and reduced-tillage systems are preferred.forests and tree cover combat land degradation and desertification by stabilizing soils, reducing water and wind erosion and maintaining nutrient cycling in soils. Therefore, sustainable use of goods and services from

forest ecosystems and the development of agro forestry systems can contribute to poverty reduction, making the rural poor less vulnerable to the impacts of land degradation.

Even if there was many options to reduce forest and land degradation to reduce those impacts in Machisho forest any responses was not taken from federal to local level.

3.1.5. Outlooks

Based on LULCC table, in the study area query site and residential area was highly increased from the year 2004 to 2024 due to various reasons, which directly affect the forest ecosystem, the land resource as well as biodiversity around and in Machisho forest. Unless the concerned bodies (federal to local community) take appropriate measures to reduce those risks, with in the last 30 years the productivity of land & coverage of forest resource will totally change in to bareness.

3.2. STATE AND TREND OF FOREST FAUNA AND FLORA IN DAARRA QEBADO WOREDA MACHISHO FOREST ECOSYSETM

Ethiopia is endowed with unique ecosystems and biodiversity that provide considerable contribution to people at local, regional, nationaland global levels. A great proportion of these biodiversity and ecosystem services are mainly prevailing in forest and woodland ecosystem of the country. The livelihoods of most the peoples in the country are highly interlinked directly or indirectly with forest resources. It plays enormous environmental, socio-economic significance and thereby contributes a great role in the sustainable development of the country as well. Forests and woodlands play vital roles in ensuring food security and sustainable livelihoods for millions of households throughout Ethiopia. According to a study report (UNEP, 2016), Ethiopia‘s forests generated economic benefits in the form of cash and in-kind income equivalent to USD 16.7 billion, or 12.9% of the measured value of GDPin the year 2012-13. Recent estimates indicate that about 26-30% of the total coffee production of the country originates from wild and semi-managed coffee forests and the value of wild coffee is estimated at USD 130 million/annum (Tesfaye, 2006; Lemenih, 2009). Furthermore, Ethiopia has also earned USD 12.68 million from the export of gums and incense in the year 2009/10 (MoFED, 2010). Since the 1960s, much effort has gone into designating protected areas in Ethiopia with the hope of saving areas of crucial importance for biodiversity conservation. However, most of the forest

fauna and flora resources of Ethiopia are highly exposed to degradation at an alarming rate. A century ago, forests covered about 40 % of the total landmass of the country. The spatial pattern of the forest has been shown a rapid decrement from 40% in 1900 to 16% in 1954, 8% in 1961, 4% in 1975, 3.2% (Journal of Resources Development and Management,Vol.67, 2020) and now it is estimated to be 17.35 million ha 15.7% (EFCCC 2015). The spatiotemporal forest cover change in Ethiopia has been attributed to natural and more importantly manmade factors. The major drivers of forest cover decline can be grouped as proximate driving factors and underlying driving factors in Ethiopia. Proximate driving factors include; expansion of resettlement, expansion of agricultural practices and charcoal burning and cutting trees for fuel whereas, underlying driving factors include; economic, institutional, technological, cultural, demographic and biophysical factors. The alarming rates of forest fauna and flora degradation have been posing environmental, social, and economic problems. The environmental implications of forest degradation are climate change, siltation of water bodies, and degradation of wetlands, soil erosion, and a reduction in agricultural production. The study was conducted in the Sidama regional state's DarraQebado-WordaMachisho forest eco system. The total forest ecosystem area is estimated to 2076.875 ha of land, from this Machisho forest ecosystem covers 1000 ha, and it contains different forest flora and fauna species from those species the natural forest flora is dominant in the ecosystem.

The study collected data from primary sources, including field visits (FGD) of three surrounding kebeles (Machishogetre, Machishomilinumm, and Odolla) and key informants with kebele administrators and development agents while Secondary data was gathered from published documents, region and woreda reports, and Landsat images to understand the impact of forest cover change and deforestation.

Key terms

- The Convention on Biological Diversity (CBD) defines biodiversity 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.”

- The Millennium Ecosystem Assessment and TEEB (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.
- 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. In specific, the reason for lowering the tree height from 5 to 2 m is to capture Termilania-Combretum dense woodlands found in Gambella and Benishangul Gumuz Regional States which in its primary state consists of trees reaching a height of around 2-3 m and above (MEFCC 2016).
    - Drivers -are the social and economic imperatives that seek to fulfill human needs by creating the necessary conditions and, through material consumption, support wellbeing, health, security, and freedom. The provisions for supporting life include food and raw materials, water, shelter, health, culture, security, and infrastructure (Bradley & Yee (2015).

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

- ***Impacts*-**are the resulting changes in the quality and functioning of the ecosystem that influence living things including the production of ecosystem goods and services.
- ***Responses*-**are actions taken through policies and regulations to prevent, compensate, ameliorate, or adapt to changes in the state of the environment.

Benefits of forest flora and fauna:- Biodiversity provides many valuable goods and services –nature's contributions to people. Biodiversityhelps regulate climate through carbon storage and control of local rainfall, filters air and water, and mitigates the impact of natural disasters such as landslides and coastal storms. Direct benefits include timber from forests, fish from oceans and freshwater systems, crops and medicines from plants, cultural identity, and the health benefits gained from access to nature.

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

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

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

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

lake accessible and safe). Even “existence” and other “non-use” values” require people (human capital) and their cultures (social and built capital) to appreciate.

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

3.2.1. State and Trends of Flora and Fauna in Machisho Forest Ecosystem

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 or more are probably endemic. Ethiopia is considered as the fifth largest floral country in tropical Africa (http://chora.virtualave.net/biodiversity.htm. Flora and fauna are the collections of all plants (flora) and animals (fauna) living in a particular region that interact in various ways to form an ecosystem. Flora and fauna have different roles in the oxygen and carbon dioxide cycles. Flora uses carbon dioxide in the air to produce oxygen, while fauna produces carbon dioxide when they respire. The benefits obtained from forest and woodland ecosystem fall into the four major categories (provisioning, regulating, supporting and cultural) services

Table 9 Flora (plant) Species are found in the study area.

R.no	Scientific name	Amharic name	Remark
1	Accaciaabyssinica	ቆንጥር	
2	Accacialbida	ግራር	
3	Accaciabrevispica	ቀንጠፋ	
4	Croton macrostachyus	ብሳና	
5	Grevillearobusta	ግራቪሊያ	
6	Carbaedulis	ጫት	
7	Celtis Africana	አምላቃ	
8	Cordia Africana	ዋንዛ	

9	Olea European	ወይራ	
10	Cyperusdigitatus	ፊላ	
11	Diospyrosabyssinica	ሰለቸኝ	
12	Croton macrostachyus	ብሳና	
13	Ehretiacymosa	ኡላጋ	
14	FicusVasta	ዋርካ	
15	Eucalypptusamaldulensis	ቀይባርዛፍ	

Table 10 Faunal species are found in the area.

No	Scientific name	Amharic name	Remark
1	Columbus Monkey	ጉሬዛ	
2	Bush pig	የዱርአሳማ	
3	Common Bush buck	ድኩላ	
4	Klipspringer	ሰስ	
5	Bush Duiker	ሚዳቋ	
6	Jackal	ቀበሮ	
7	Mangoose	ሽለመጥማጥ	
8	Vervet Monkey	ጦጣ	
9	Hayena	ጅብ	

Source:-from filed observation 2024

Table 11 Land Use Land Cover Change Map of Machisho Forest Ecosystem

Class Name	2004area_ha	2014area_ha	2024area_ha
Nursery site	2.41	5.56	7.81
Query site	3.33	10.75	7.25
Moderate forest	146.58	309.84	464.70

Residential area	18.92	29.67	39.70
perennial crop	81.88	201.05	271.27
Bare exposed soil	119.63	40.28	46.71
Open grassland	505.21	342.71	405.43
Open shrub land	647.41	585.50	282.49
Total	1525.35	1525.35	1525.35

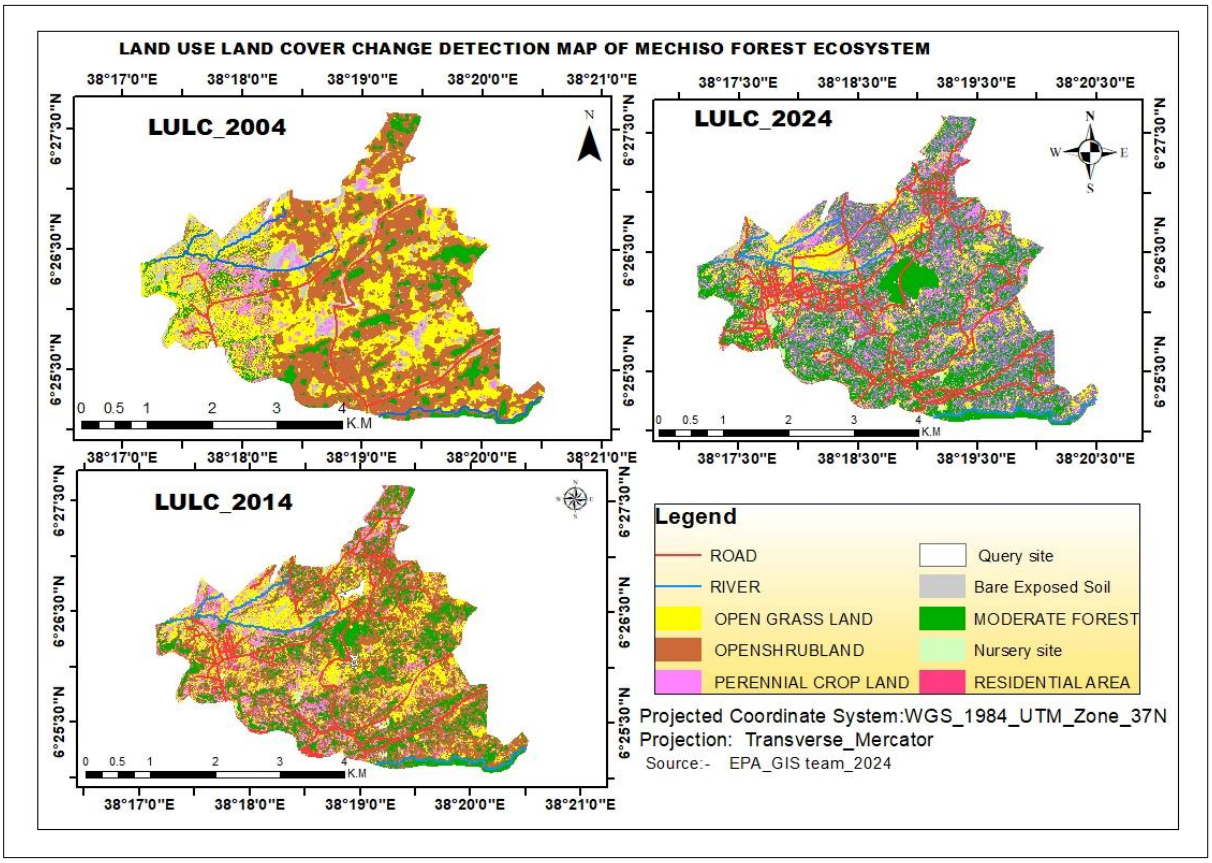

Figure 7 land use land cover detection 2024

Source:

3.2.2. Driver and pressures Of Forest Flora and Fauna on The Forest Ecosystem.

The Millennium Ecosystem Assessment highlighted the five main direct drivers of biodiversity loss: habitat change, overexploitation or unsustainable use, invasive alien species, climate

change, and pollution. more recent analyses, including the Global Biodiversity Outlook 3, reported that these five drivers remain the principal causes of biodiversity loss and are either constant or increasing in intensity. An analysis of the proportion of threatened species on the IUCN Red List (mammals, birds, amphibians) affected by each driver showed that more than 80% are under threat from habitat loss, 70% from overexploitation and unsustainable use, and almost 30% from invasive alien species. Although climate change is an emerging driver, less that 20% of threatened species are affected by climate change and only 10% by pollution. The biggest driver of biodiversity loss is how people use the land and sea. This includes the conversion of land covers such as forests, wetlands and other natural habitats for agricultural and urban uses. Since 1990, around 420 million hectares of forest have been lost through conversion to other land uses. Sep 5, 2023.

Direct/Proximate driving Factors expanding agricultural activities (burning and removing of the tree, and overgrazing), fuel wood and charcoal, and resettlement expansion program leads to deforestation and forest degradation (Walle et al. 2011; Oljirra 2019) .The main direct drivers of deforestation are generally agreed to be logging and the expansion of agriculture and infrastructure. Forest fauna and flora ecosystem has long been threatened by a variety of land use pressures in Ethiopia. Deforestation and forest degradation in Ethiopia are driven by various factors including expanding agricultural activities, logging, and resettlement programs. Key drivers include logging, unsustainable exploitation of forest resources, logging, non-forestry investment, and new settlements. Forest fires, invasive species, and insect pest outbreaks also pose significant threats to the ecosystem. Demand for wood fuels is a major driver of forest degradation in Ethiopia. Though the role of firewood in forest degradation is somewhat contested, charcoal dominates cooking energy choices in urban areas and uncontrolled fires, livestock grazing in forest fauna and flora are widely recognized to contribute to forest degradation (Zerga&Gebeyehu 2016).

Figure 8 Machisho Forest Ecosystem

Source – filed photo 2024

The main drivers and pressures of Machisho forest ecosystems are:

According to Bradley and Yee (2015), the DPSIR model is useful for conveying complex environmental issues. As a systems-thinking framework, it considers the component parts of a system and how they relate to and interact with one another and other systems. The DPSIR model is commonly used in environmental management contexts to demonstrate the cause-and-effect relationships between interacting components of social, economic and environmental systems (Bradley and Yee (2015).

Population growth:-one of the most frequently cited underlying causes of forest decline is population pressure. That more population should translate into more deforestation and thus higher pressures to degrade forests makes intuitive sense. With an increased population, there would be more families in search of land for agriculture or looking for fuel wood or timber

(Contreras-Hermosilla 2000). Population growth can affect the environment not only through consumption and use of natural resources, but also through its impact on other factors. This includes decrement of land productivity, gully formation, loss of ground water. its effects on the probability of conflict between the community over limited resources, and its impact on rapid and unplanned urbanization around the area. This decrease in forest flora and fauna increases demand for land for farming, fuel wood, building supplies, settlement sites, and infrastructure.

Table 12 Population growth statistics in DaarraQebadoworeda.

Year	Men	Women	Total
1990	**66414**	**73518**	**139932**
1991	67519	74118	141637
1992	67114	74628	141742
1993	68514	75125	143639
1994	7001	75864	82865
1995	70980	76192	147172
1996	72190	77110	149300
1997	73820	77690	151510
1998	76475	78220	154695
1999	76680	78790	155470
2000	77114	79030	156144
2001	77614	79226	156840
2002	77912	79452	157364
2003	78119	80124	158243
2004	78418	80663	159081
2005	78621	80848	159469
2006	79021	81214	160235
2007	79843	81314	161157
2008	80126	81812	161938
2009	80992	82642	163634
2010	81118	83142	164260
2011	81321	83912	165233

2012	81624	84992	166616
2013	**82446**	**85286**	**167,732**

Source: DarraQebadoworeda Environmental Protection and Forest Development Office.

The population's growth shows that in DaarraQebado, woreda 139,932 **reached 167,732 within the last 20 years.** Many FGD and key informant respondents indicated population growth as the main factor of change in Machisho forest ecosystems, as 4% of the forest coverage decreased per year and the rate of deforestation increased from 12.8 ha/year to 14.6 ha/year from 1990 to 2015.

2. Land tenure system and weak land use policy: land privatization is a topic of considerable disagreement in Ethiopia. The government owns all forest and agricultural land, granting usufruct rights to citizens in the case of farmland and maintaining all management authority in the case of forestlands (Guillozet et al. 2011). Uncertain land tenure systems leading to low investment, including lack of ownership, trigger illegal logging and the so-called tragedy of the commons (Assefa& Bork 2014). Likewise, weak policy implementation on land use, low capacity of forest institutions, land use conflict, and policy discrepancies are aggravating forest cover loss in Ethiopia (Moges et al. 2010). The lack of responsibility among local populations for common forest resources leads to unenforced forest laws and regulations. To protect natural forests sustainably, communities need to gain the power to utilize and protect resources. The absence of clear ownership over wetland resources has caused irreversible changes in forest flora and fauna in Machisho ecosystems.

3. Institutional factors: the underlying driving factors of forest cover change in the area include: competing for jurisdictional authority over activities affecting forests; weak enforcement capacity; political superiority of forestry to quarrying site purpose, inexperience in enforcing reforestation regulations, unclear tenure arrangements and boundaries, and unclear reporting requirements widely practiced in forest areas. Ethiopia's land privatization debate revolves around the government's ownership of forest and agricultural land, leading to low investment and illegal logging. The system is also exacerbated by weak policy implementation, low capacity of forest institutions, and policy discrepancies as a result of this Machisho forest ecosystem, which is degrading alarmingly. Forest logging, whether legal or illegal, leads to deforestation. Ethiopia

loses about 141,000 hectares of natural forests each year due to firewood collection, conservation of farmland, overgrazing, and the use of wood for building materials (Oljirra 2019).

4. Infrastructure: Stone quarrying or road construction as an element of the ongoing attempts to expand the transportation network due to this reason forest flora clearance is very high. Land use land cover 2024 detection indicated that more than 10 ha of the forest coverage changed to guy ring site . Some parts of the area changed to gully and bare lands. Many human interventions in ecosystems generate abrupt and large scale changes that trigger loss of biodiversity and make it more difficult for ecosystems to recover from the negative impacts associated with these human interventions.

5. **Invasive alien species (IAPS):** are considered to be one of the major drivers of forest biodiversity loss, thereby altering ecosystem services and socio-economic conditions through different mechanisms. Invasive alien species are animals, plants, fungi, and microorganisms that have entered and established themselves in the environment from outside of their natural habitat. They reproduce rapidly, out compete native species for food, water, and space, and are one of the main causes of global biodiversity loss.

3.2.3. Impact of the degradation of forest fauna and flora in Mechiisho forest ecosystems

Habitat degradation and fragmentation: Habitat loss and degradation are the ultimate threats to biodiversity in the tropics (Haddad et al., 2015). This is caused by deforestation for wood products (especially fuel wood), fire, agricultural expansion, and overgrazing (EBI, 2014) .In the Machisho forest ecosystem intensive agriculture, firewood collection, free livestock grazing, climate change, biological invasion, land use and cover changes, infrastructure construction (road), erosion, climate change, overexploitation, and invasive species are increasingly threatening the biodiversity of forest flora and fauna and their ecosystem services to society and the environment. Because of such forest ecosystem degradation, some flora and fauna species are becoming locally endangered, and more than 4,564 communities are economically affected (exposed to poverty). For example, the forest fauna of Zebera and warthogs and the forest flora Podocarpusfalcatus, Cordiaafricana, and Juniperusprocera are highly threatened tree species in the area.

2. Land use land covers change of forest ecosystem

- Direct loss of habitat at intersection locations, particularly on account of damage to the existing vegetation due to quarrying site activities and transport.
- Gully formation of the area due to the quarrying and deforestation activities
- Fragmentation to the forest and other important habitat areas may reduce home range and cause isolation of the forest fauna species.
- Decline in the faunal population, their flow, and their movement. Due to the impacts of deforestation and quarrying activities, direct loss and fragmentation of habitat, noise, sound, and anthropogenic effects, the decline of the forest fauna is expected. Particularly for the small creatures that live in that proposed alignment and its adjacent areas.

3. Direct loss in the form of the removal of trees: by the pressures and drivers of activities' approximately 372.17 ha of trees and shrubs removed, which might have a significant effect on the current ecosystem like:

- The loss of trees will lead to a higher degree of soil erosion.
- The loss of trees will reduce the ambient air quality since trees act as adsorbents of air pollutants, thereby improving the air quality.
- The reduction in the number of trees, especially in or near congested market places, will enhance the weather conditions in the area.
- Loss of such large numbers of trees may affect the ecosystem severely in the form of a change in the microhabitat.
- Loss of diversity in agro ecosystems increases their vulnerability and thus reduces the sustainability of many production systems.
- Reductions in the provision of regulating and support services can drive additional chemical use and may create harmful feedback loops (WHO and SCBD 2015, p. 5). There is some evidence that farmers in homogeneous landscapes have higher incomes than farmers in heterogeneous landscapes (Watts and Williamson, 2015).
- Loss and extinction of water bodies like the Loke, Amicha, and Vlaule rivers.

- **Expansion of Invasive Alien Species: The** rapid expansion of invasive alien species into the forest ecosystem was another prevailing impact, as confirmed by FGD and key informants.

Figure 9 Impact of Quarrying Activities

Source: filed photo 2024

Figure 10 Forest Degradation in Machisho Forest Ecosystem
source: filed photo 2024

Figure 11 Focus Group Discussion

source :filed photo 2024

Figure 12 Different activities in Machisho

Source: filed photo 2024

3.2.4. Response taken to improve the status of the Machisho forest ecosystem

Therefore so as to reverse the current situation of forest fauna and forest flora degradation and maintain ecological balance, there has to be an inclusive responsibility by all levels of

communities, the governmental and non-governmental organizations, farmers as well as the private sectors should play their own role in protecting the forest ecosystem.

- **Awareness Generation**: Knowledge and technical skills are pre-requisites for human capital to perform in a desired manner. It is, therefore, suggested that the information in regard to species of plants and animals existing in the eco system, the importance of these species for humans as socially, environmentally, and economically, and ecological processes essential for ecological balance at the site, threats for their survival, and suitable packages of practices for conservation of biodiversity need to be made available to the local people and other stakeholders through different ways of media. Local festivals and fairs can be better opportunities for awareness generation and improving understanding and awareness.
- **Participating women's in conservation practices**: access to or control over resources and biodiversity, as well as education, training, information, and control of the benefits of production, also influences the type of knowledge that rural men and women have and how they use that knowledge. Women often take the lead in the selection and improvement of local plant varieties, as well as seed exchange and management, and thus play a critical role in the sustainable use of plant and genetic resources. In many areas, they are also the primary collectors of wild foods in forests, and they possess extensive knowledge of their location and characteristics. In spite of the important contributions that women make to the conservation and sustainable use of forest biodiversity and agro-biodiversity, women's roles and knowledge are often overlooked or underestimated in biodiversity programs, projects, and policies related to the management of these and other ecosystems.
- Habitat Management for Wildlife: both regulatory (for human actions) and habitat management practices, including work devices, need to be utilized for managing and improving habitats for forest fauna. Habitat management practices such as fencing along roadside habitats.

  - Strengthening government institutions and their management bodies or decision-makers concerned with forests.
  - Providing appropriate legal and institutional mechanisms.

- Biodiversity mainstreaming is focused on embedding biodiversity considerations into the policies, strategies, and practices of key public and private actors that impact or rely on biodiversity. Mainstreaming enables biodiversity to persevere across entire landscapes.
- Providing ecosystem-based adaptation includes the sustainable management, conservation, and restoration of ecosystems to provide services that help people adapt to the adverse effects of climate change.
- Providing restoration of areas that have been converted to agriculture land and gulley, especially those degraded by quarrying activities or low-productivity lands.

3.2.5. Outlook

According to the data obtained from GIS land use land cover detection 2024, primary and secondary data in the natural forest coverage of the forest ecosystem from 2004 to 2024 indicate an increment of 0.31%, or 318.12 ha, compared to the previous 10 years, but other stone querying sites increased by 0.308% and shrubs decreased by 0.436%, or 364.92 ha of land. If the ecosystem management trend continues as business as usual, in the next 10 years, shrubs will decrease by 0.218%, or 61.58ha of land, which shows the probability that the shrub area is endangered. Quarrying sites will increase by 0.155%. Other driver factors, like population growth and settlement, also increased and had a greater impact on forest flora and fauna. This will in turn contribute to livelihood and food insecurity among people living in the forest ecosystem.

3.3. State and trend of Water Machisho Forest ecosystem

3.3.1. State and trend of Water availability Machisho Forest ecosystem

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).

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).

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.

The study was conducted in Sidama Region, Daraworeda is one of the woreda in sidama regions of Ethiopia includingkebado, Teferikela Abera and Machisho towns.

The regional state has been striving to provide equal access to safe and affordable drinking water supply for all inhabitants. In 2013 E.C the regional pure water access coverage in urban is 58.5 %, in rural areas is 46% and the average pure water coverage is 52.25%.According to the data obtained from Sidama water and Mining Office, the percentage of population with access to safe drinking water was 32%. The water and Mining Office also explained water demand in household was 21%, Agriculture 3% and also Industry 8%.

The major sources of potable water supply for rural and urban community are natural Tap water, springs, Deep water burrow, hand dug wells and shallow wells. In addition to the government there are several non-Governmental Organizations working on water supply in the region.

Table 13Drinking water coverage of each woreda in Sidama Region

No	Woreda /Town Adminsration Name	Number Of Population			Drinking Water Supply Beneficiery			Access Coverage		
		Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
	Regional	926111	4105028	5054579		1539417	1539417	58.5	46	52.25
1	A/ Chuko-Woreda		191386	191386		65933	65933		35.5	35.5
2	A/Chuko Town	43511		43511	16151		16151	37.1		37.1
3	A/Wondo Town	56807		56807	40401		40401	71.1		71.1
4	Aleta Wondo-Wereda		206314	206314		79,990	79990		39.9	39.9
5	Arbegona-Wereda	13003	163645	176648		64,577	64577		40.9	40.9
6	Aroresa-Wereda	5743	122815	128558		48068	48068		40.9	40.9
7	Bensa-Wereda		208610	208610		78,921	78921		38.9	38.9
8	Bilate Zuria Woreda	7168	143165	150333		56,313	56313		40.9	40.9
9	Bona Zuria-Wereda	11597	169536	181133		56,978	56978		34.8	34.8
10	Boricha-Wereda	8012	126264	134276		44,450	44450		36.7	36.7
11	Burra Woreda	4442	59117	63559		17,269	17269		31.7	31.7
12	Bursa-Wereda	337756	104772	442528		36,758	36758		36.9	36.9
13	Chabe Gambeltu Woreda		83934	83934		32338	32338		40.9	40.9
14	Chire-Wereda	4544	127797	132341		50099	50099		40.9	40.9
15	Chirone Woreda		46236	46236		17,043	17043		40.9	40.9
16	Daela Woreda		45597	45597		16784	16784		40.9	40.9
17	Dale-Wereda		270279	270279		107,941	107941		40.9	40.9
18	Darara Woreda		138617	138617		50,486	50486		37.9	37.9
19	Dara-Wereda	14136	137534	151670		50,975	50975		38.6	38.6
20	Darra Otilcho	6413	118336	124749		46,246	46246		40.9	40.9
21	Daye Town	49130		49130	28420		28420	57.8		57.8
22	Gorche-Wereda	5756	137652	143408		51,088	51088		38.6	38.6
23	Hawassa Zuriya-Wereda	0	232984	232984	0	91,149	91149		40.9	40.9
24	Hawela Woreda		116492	116492		45,547	45547		40.9	40.9
25	Hokko Woreda		109015	109015		42514	42514		40.9	40.9
26	Hula-Wereda	12357	112477	124834		43,823	43823		40.9	40.9
27	Leku Town	40603		40603	23130		23130	56.9		56.9
28	Loka-Abaya Woreda	2041	123644	125685		45,433	45433		38.3	38.3
29	Malga-Wereda	7743	163446	171189		64,537	64537		40.9	40.9
30	Shafamo Woreda		67856	67856		18,814	18814		29.8	29.8
31	Shebedino-Wereda		214135	214135		80,163	80163		38.5	38.5
32	Teticha Woreda		82472	82472		28,745	28745		37	37
33	W/G Chuko Town	53534		53534	26745		26745	50		50
34	Wondo Genet-Wereda		148792	148792		55,582	55582		38.8	38.8
35	Wonsho-Woreda	3930	132109	136039		50,853	50853		40.1	40.1
36	Yirgalem Town	80300		80300	50739		50739	63.1		63.1
37	Hawassa City Admin	390569		**390569**	235638		**235638**	60.3		60.3

According to the above table from the total coverage of water in the region (52.25%) the urban centers get 58.5% of water access whereas rural areas 46% of water access. This indicates most of the urban area prone to water shortage so they obliges to travel long distance to fetch water. Due to this reason rural women's are more vulnerable to water shortage. The coverage of drinking water in Daraworeda was 38.6%.

The participant in the FGD explained that there was many water sources lake loke and Atolto rivers constantly flow in both summer and winter seasons before the last 20 years but know water sources was declined very quickly and also the local community get water by digging boreholes easily but know it is difficult to get water easily because of forest degradation in the surrounding environment. The FGD and key informant interview also explained that the decline in the coverage of water in the region as well as DaraWoreda prawn to water shortage and also females' travel long distance to fetch water.

State of Water Quality in Dara woreda,Sidama Region

The water quality of rivers and lake in Sidama Region is remarkably getting deteriorated due to land use and land cover changes because of agricultural land expansion, an increase in investment in river and lake shore. The base flow of the rivers is getting decreased due to the increased consumption of river waters for irrigation and other purposes. Water quality assessment in few rivers showed that there was an increase in mineral content, likely because of agriculture inputs, and mining activities from river surface. Nutrient concentrations were found to be highest in crop cultivation area, while organic matter was most abundant at the river's source and mouth in the wetlands around Lake Hawassa. The highest concentrations of sediments from the cultivated as well as degraded land and fluoride were found in Lake Hawassa. Moreover, the wastewater generated from coffee processing has high concentrations of organic pollutants like pectin, proteins and sugars (Dadi et al., 2018) has been affecting the rivers‟ water quality. Due to high pollutant content, its disposal without treatment in water bodies has become undesirable due to the danger this poses for the water bodies and to human health. Disposing untreated coffee wastewater into local water bodies polluted the downstream water sources and people residing in the vicinity of the wet coffee processing plants. This polluted water causes the people living in the downstream suffer from different types of diseases.

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

Population Growth

The driving forces for the water quality degradation of the region‟s surface water resources (Rivers and Lakes) are population growth (2.9%), coffee processing wet mills, agricultural expansion, deforestation, livestock raising, mining (sand and pumice) from the lake's and the

rivers‟ watersheds. The highlands areas of the rivers watersheds are favorable for agriculture, pastoralism and wildlife activities, whereas the mid and the lowlands areas of the rivers watersheds are favorable for coffee production which attracts an increasing number of investment and location of service providers such as Hotels and Hospitals near the lake are also causing the water quality to be degraded. In the highlands and midlands of the region, the expansion of cultivated land caused pastoralists difficulty in supporting their families and increased their vulnerability to drought and causes cattle to suffer a lot due to lack of cline water to drink. The lower water levels during dry season caused by land cover changes not only affect pastoralists but also people whose livelihoods depend on agriculture. Dara Woreda is the one suffering from lack of adequate clean water resource for cattle as well as for human. Flow regime changes cause faster surface runoff from the catchment which decelerates water infiltration into subsurface layers and decrease the groundwater recharge. As a result, soil erosion and degradation are enhanced resulting in decrease in base flow of the rivers. Nutrient concentrations in the lake exceed natural levels, and apparently lead to eutrophication. The source of this eutrophication is unfathomable, but agriculture is presumed to be the main driving force since the highest nutrient concentrations are found in the most intensive agriculture area near the lake shore. Pollution is also a growing risk in the region.

Urbanization

According to Dara woreda water and mining office, the amount of waste water generated from urban area and households was 1,190,500 and 5,108,300 cubic meter respectively. These indicates expansion of Urbanization is one of the major cause for massive waste water disposal.

Industrial Effluent

The south western part of the wetland has been a direct contact with discharges from factories operating in the area. These industries have been releasing effluent since their establishment in 1980s. During our field observations we have come to see the industrial effluent flowing into the wetland. Although several industries such as beverage, soap, textile, plastic, meat processing and many others are operating in the area, it was evident that the brewery factory, has prominently discharged its waste. The nature and amount of waste discharged are not adequately studied. Its impacts could be many. One of our informants at of Chaffee KotiJebessaKebele who lives close

to the waste drainage structure states: The industrial effluents coming from Brewery and Hawassa Textile Factory have caused several health and economic problems on humans and animals. We have a direct contact with the waste. We have been suffering from skin irritation and respiratory diseases due to direct contact and pungent smell. Children are affected by the waste, which smells alcohol, while they often use it for swimming during the rainy season. Animals have been contaminated and drink when they cross the industrial effluent to grazing field. The waste cause's fetal abortion, reduces milk production, discolors milk and emaciates animals. Occasionally, it leads to the death of animals (Interview, Dec., 2021). During field visits we have confirmed that the industrial waste has been used for different purposes. Domestic animals have been drinking it when they cross the waste drainage. Moreover, people use the waste for domestic and vegetable productions. Children who fetch the waste water (for the construction of mud houses) are direct victims.

According to Dara woreda water and mining office, the amount of waste water generated from Industries was 1,892,350 cubic meter. These indicates expansion of industries is also another cause of waste water disposal.

Emergence of social institutions

Institutions governing human relations can be categorized as formal and informal ones. The formal ones are those institutions which govern people interactions on the bases of written rules and regulations. On the other hand informal institutions run relations through implicit ways. In and around the Dara woreda, both the formal and informal institutions are working concurrently, though the formal relations are dominating the informal ones. Road construction has been crucial social and economic institution for connecting peoples in different localities. At the upstream northwest and northeast of the wetland a new road is paved. The road joins the new settlements with Hawassa-Shashemene asphalted highway. Cars, donkey carts and motor cycles are transporting goods and facilitating service provisions into and from the local settlers. Road accesses have strong power in transforming temporary settlements into permanent ones. Tutu spring is one of water sources coming out of the foot of a big mountain in the northern part of the wetland. The spring has been built and developed to provide drinking water for human and domestic animals, and washing cloth for the community living in the area. Some people also come to fetch the spring water from such distant areas as Toga village. At close proximity to

Tulu spring, we find newly established elementary school, mosque and protestant church. In addition, the lowest government structures (Kebeles) of the Oromia and SSNPR States are in place. They administer the people and the land in and around the wetland.

3.3.3. Impact of Water Resource Degradation on the Local Community

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

The driving forces for the water quality degradation of the region‟s surface water resources (Rivers and Lakes) are population growth (2.9%), coffee processing wet mills, agricultural expansion, deforestation, livestock raising, mining (sand and pumice) from the lake's and the rivers‟ watersheds. The highlands areas of the rivers watersheds are favorable for agriculture, pastoralism and wildlife activities, whereas the mid and the lowlands areas of the rivers watersheds are favorable for coffee production which attracts an increasing number of investment and location of service providers such as Hotels and Hospitals near the lake are also causing the water quality to be degraded. In the highlands and midlands of the region, the expansion of cultivated land caused pastoralists difficulty in supporting their families and increased their vulnerability to drought and causes cattle to suffer a lot due to lack of cline water to drink. The lower water levels during dry season caused by land cover changes not only affect pastoralists but also people whose livelihoods depend on agriculture. Loka Abay Woreda is the one suffering from lack of adequate clean water resource for cattle as well as for human. Flow regime changes cause faster surface runoff from the catchment which decelerates water infiltration into subsurface layers and decrease the groundwater recharge. As a result, soil

erosion and degradation are enhanced resulting in decrease in base flow of the rivers. Nutrient concentrations in the lake exceed natural levels, and apparently lead to eutrophication. The source of this eutrophication is unfathomable, but agriculture is presumed to be the main driving force since the highest nutrient concentrations are found in the most intensive agriculture area near the lake shore. Pollution is also a growing risk in the region.

Water scarcity

Water Scarcity refers to the situation where the potable, unpolluted water is lower than the demand in the region. According to recent reports, nearly 1.2 billion people of the world lack access to clean drinking water. From this amount the majority of people found in developing countries and Ethiopia is one of the countries suffering from the water scarcity. In Sidama region various woredas like Boricha, HawassaZuriya, BilateZuriya, Darara, Lokka Abaya and Shebedino are mainly suffering from the water scarcity. Furthermore, the other remaining woredas are also encountered water scarcity partially. The livelihood of these woredas depends on the rainfall and rainfed agriculture. Water shortages in the region are causing a variety of illnesses which can range from food poisoning to cholera. Typically, water scarcity in the region is driven by two important factors such as the increasing use of freshwater due to high population growth and depletion of usable freshwater resources. Furthermore, the scarcity can be of two types which are physical water scarcity and economic water scarcity. Physical water scarcity is caused when a natural water resource is unable to meet the demands of a particular region where the physical lack of water available to satisfy demand exist. Economic water scarcity is caused by the mismanagement of sufficiently available water resource where the lack of infrastructure development that controls storage, distribution and access exist.

According to Dara Woreda Water & Mining Office, the number of drying water bodies was three in total from these two of them are boreholes and one of them are springs. The office also explains due to shortage of water the local community travel 30 minute to 1 and half hour to fetch water.

3.3.4. Responses to Water Pollution

The region is working with international NGOs to reduce the rivers water pollution of the rivers. The Techno Serve Ethiopia has been started working with the region to support wet mills to implement innovative waste management solutions to prevent both wastewater and coffee pulp from being released in the rivers. After its three-phase program in which the project supported 87 wet mills along the kola rivers, as well as other neighboring rivers including the Malewo, Jigesa, Raro, Bisandima, and Chico rivers. Techno Serve continued to work a three-year period (2019-2021) to improve wastewater treatment at an additional 20 wet mills in Dale and Shebedino Woredas of Sidama region through the installation of pulp separation and Vetiver grass wetlands to treat and filter wastewater.

According to Daraworeda water and mining office, there is no water treatment plants until know and also there is not sewerage system in the Woreda.

3.3.5. Outlook

Water quality deterioration and scarcity occurred in Sidama as well as Dara woreda was due to the expansion of industries and population increment around there. Based on the type of industry, various levels, and quantities of pollutants can be discharged into the environment directly or indirectly. While the most precious natural resource, water is polluted in such a way, no state measure is taken to protect the hydrogeological environment. According to the study conducted by Wubalem G.et, al (2021), the wet coffee processing industries use a large quantity of water (an average of 147 m3/day) for pulping, fermentation, and washing of the coffee cherry with no recirculation. Consequently, the wet coffee processing sections are generating large amounts of high-strength wastewater and discharge directly into the water bodies or partially treated before discharging to the environment. The wastewater generated from coffee processing is characterized as high a concentration of Biological Oxygen Demand (BOD) up to 20 000 mg/L and a Chemical Oxygen Demand (COD) of up to 50 000 mg/L as well as the acidity of below pH

Unless the government of Ethiopia, Regional state, private sectors and other concerned bodies will take any action to reduce water pollution, for the coming few years there will prawn a disorder on the whole human and animal health and also the Aquatic life will be totally destructed.

3.4 **Baseline State and Trends Climate for Sidama Region (1960 < 1990)**

The world's climate has already changed and will change dramatically. Under the no emission scenario, the average global surface temperature is predicted to increase by 2.8ºC during this century (IPCC, 2007). Such global warming would alter the natural climate, leading to increased frequency of extreme weather events (such as droughts, storms, and flooding), rising sea levels, reversal of ocean currents, and changes in precipitation patterns.

The Ethiopia climate patterns mainly rainfall and temperature are modulated by altitude and latitudinal differences For this baseline study the state of the climate is considering the 30-year climate trend 1960 -1990 Then based on the weather parameters of mean annual minimum & maximal temperature and annual rainfall variability and trend observed are summarized as follow:-

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

The year to year variation of annual minimum & maximum temperatures expressed in terms of temperature differences from the mean can observed from the Figure below. The country has experienced both warm and cool years over the last 30 years, however, the later years are the warmest compared to the early years. The Figure clearly reveals that there has been a warming trend in the annual minimum temperature over the past 30 years.

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

The average annual minimum temperature over the country has been increasing by about 0.25^0C every ten years while average annual maximum temperature has been increasing by about 0.1^0C every decade. It is interesting to note that the average annual minimum temperature is increasing faster than the average annual maximum temperature. For the past four decades, the average annual temperature has been increasing by 0.37ºC every ten years, which is slightly lower than the ***average global temperature rise***. (Global is 0.7 - 1 degree certificate titrate)

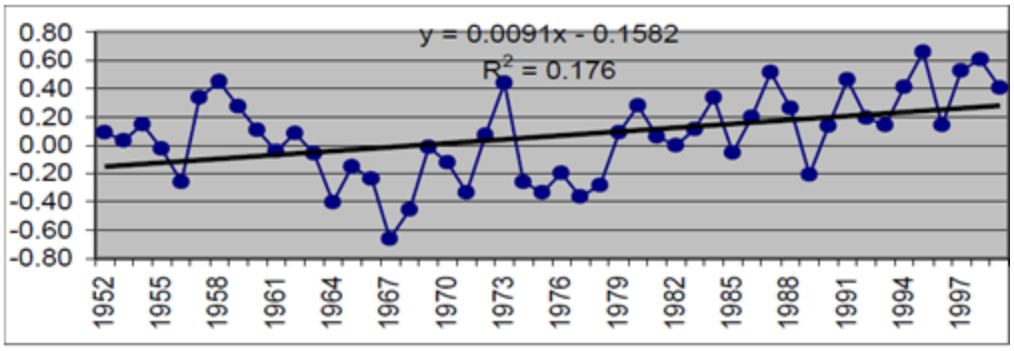

Figure 13 Year to Year Annual Mean Maximum Temperature Variability and Trend over Ethiopia

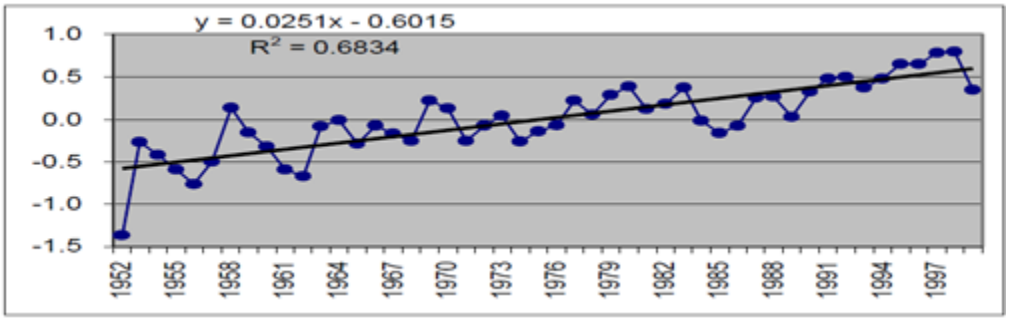

Figure 14 Year to Year Annual Mean Minimum Temperature Variability and Trend over Ethiopia

At country level the temperature rise was more pronounced in the dry and hot spots located in the northern, northeastern, and eastern parts. The mean annual temperature varies from less than 10ºc over the central high lands to more than 35º c over Northeastern and Southeastern low lands.

See also Fig map of Ethiopia atmospheric temperature for the past 10 years.

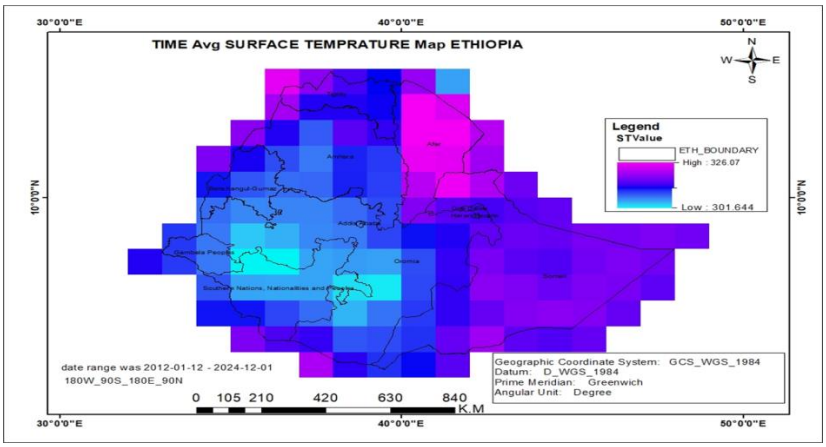

Figure 15 Time Average Surface Temperature Map of Ethiopia

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

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

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

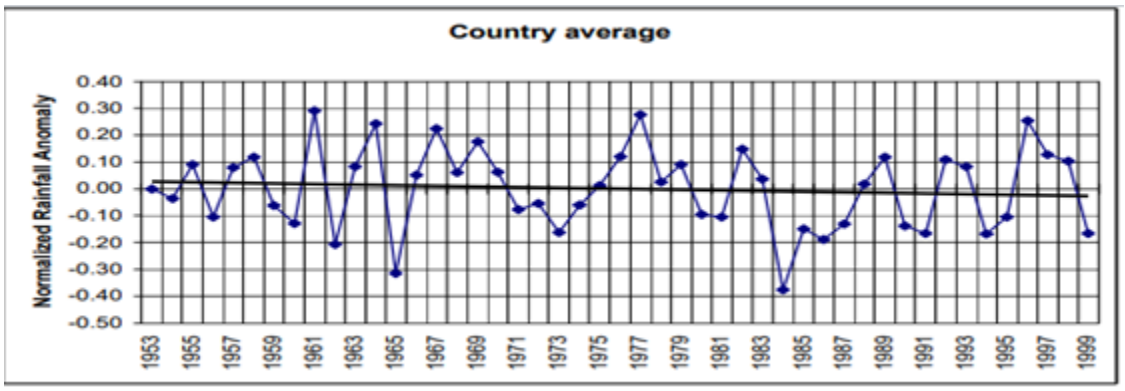

Figure 16 Year to Year Variability of Annual Rainfall Over Ethiopia Expressed in Normalized Deviation

The trend analysis of annual rainfall shows that rainfall remained more or less constant when averaged over the whole country it has also experienced both dry and wet years over the same period

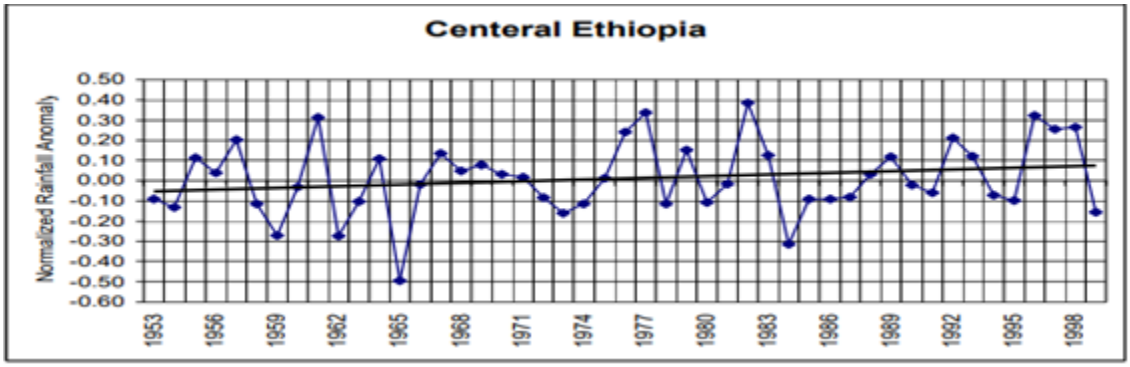

Figure 17 Year to Year Variability of Annual Rainfall over Central Ethiopia Expressed in Normalized Deviation

Trend analysis of annual rainfall shows that rainfall in the region is increasing while a declining trend has been observed over the lowlands on contrary the highland moutons areas have increased.

3.4.1. State and Trend Climate Change for MachishoForest Ecosystem (1990 – 2020)

Rainfall

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

Table 14 Monthly Average Monthly Sum of Rainfall from 1990-2020.

Month	Avr RF
January	22.68377
February	35.49377
March	74.54077
April	173.1315
May	168.7917
June	91.25765
July	77.02219
August	87.83681
September	123.2376
October	167.6318
November	60.86187
December	27.84568
sum	**1110.335**

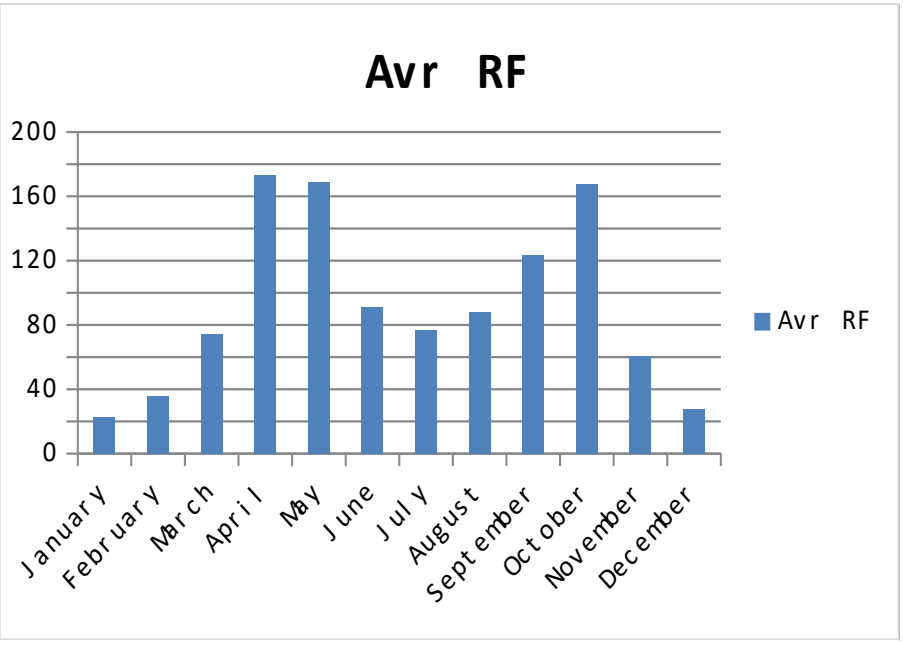

Figure 18 Machisho Average Monthly Sum of rainfall from 1990-*2020.*

One can observe that the peak average monthly rainfall was recorded during April, it reached around 173.13 mm. The positive rainfall anomaly was recorded in April up to October months. The positive sign was an implication that the monthly averages were higher than the 30-year normal. On the other hand, all the other eight months have a negative anomaly which means the monthly average rainfall was recorded lower than the 30-year average normal.

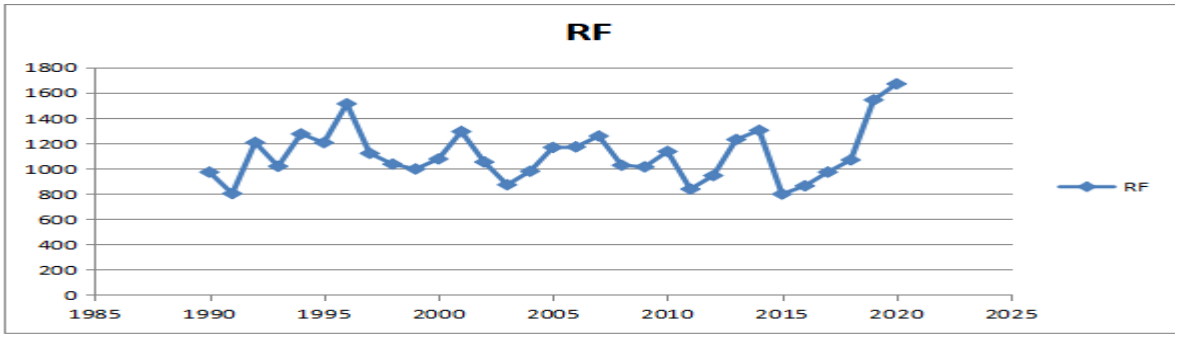

Figure 19 Machisho annual Rainfall from 1990- 2020

The amount of annual of rainfall was highly variable from year to year. The highest Rainfall was recorded around 1670.85 mm in 2020 and the lowest rainfall was recorded in 2015 which was 798.083 mm,

The highest negative anomaly was - 404 mm in 2015 which indicate that in these years the average rainfall received was far below the reference normal. On the other hand, the highest positive rainfall anomaly was recorded in 2018 which is +468 mm above the reference normal as illustrated above

Temperature

Machisho forest ecosystem have has been experienced a warm pattern classified as the long rainy season (June –September) and cool (February-May) locally referred as Meher and Bega respectively.

Table 15Monthly Average Maximum Temperature

Month	Avr T Max
January	28.89539
February	29.19542
March	28.23361
April	26.24226
May	25.4949
June	24.04287
July	23.247
August	24.654
September	24.9711
October	24.90555
November	26.18119
December	27.23042
Avr T Max	26.10781

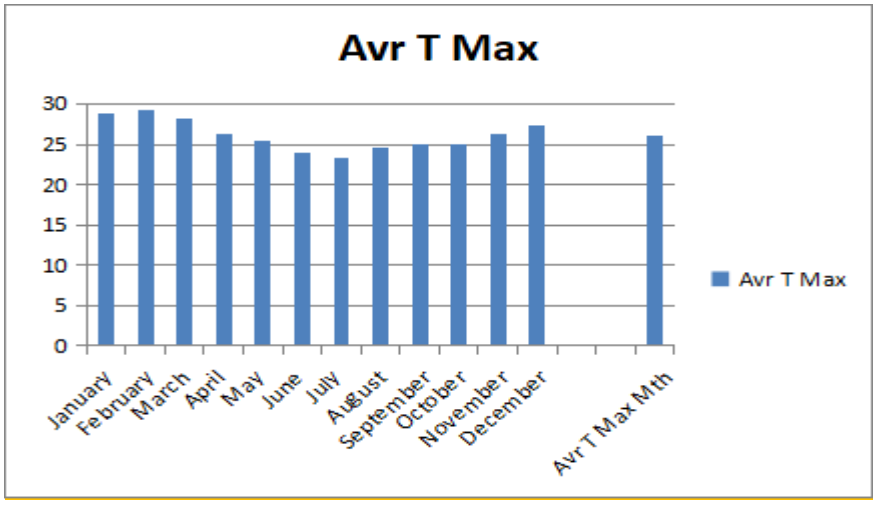

Figure 20 Monthly Average Maximum Temperature

Table 16 Monthly Average Minimum Temperature

Month	Avr T Min
January	10.34329
February	10.60503
March	11.30652
April	11.69197
May	11.98987
June	12.03868
July	11.99423
August	11.67174
September	11.59277
October	11.55503
November	10.80887
December	10.15565
Avr T mi	**11.3128**

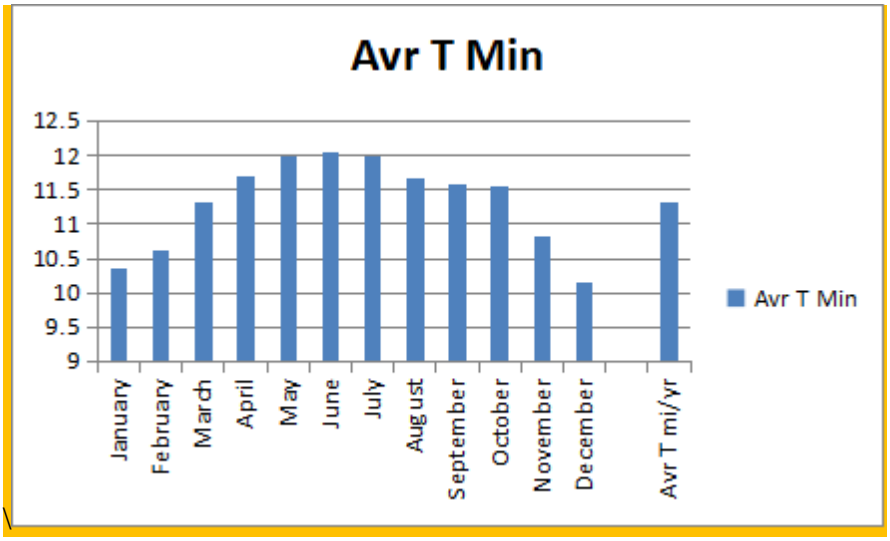

Figure 21 Monthly Average Maximum Temperature

The hottest month for the 1960 - 2020 period was the months of February with an average maximum temperature of 29.22 °C against the normal reference of 26.10 °C an while the coldest month was the months of July with a maximum average of 23.30 °C against the normal reference of 26.10 °C.

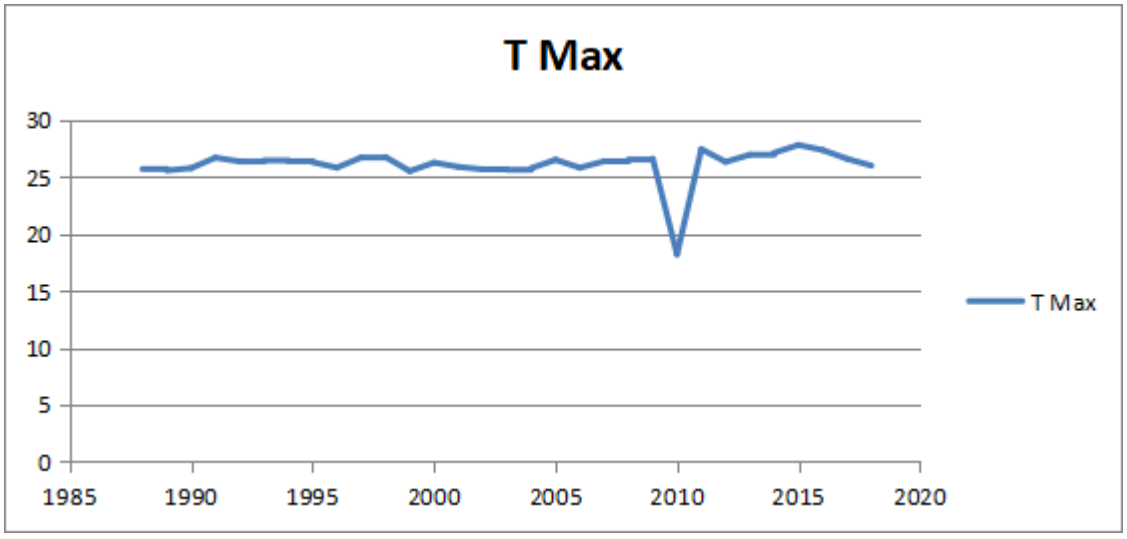

Figure 22 Annual Maximum Temperature

Within the period of between 1960 – 2020 considering the reference normal of 26.10 °C the average annual maximum temperature recorded

- Highest recorded was 27.82 °C in 2015 with anomaly +1.72 . While
- Lowest recorded was 18.22 °C anomaly of -7.88 the reference normal of 26.10 °C.

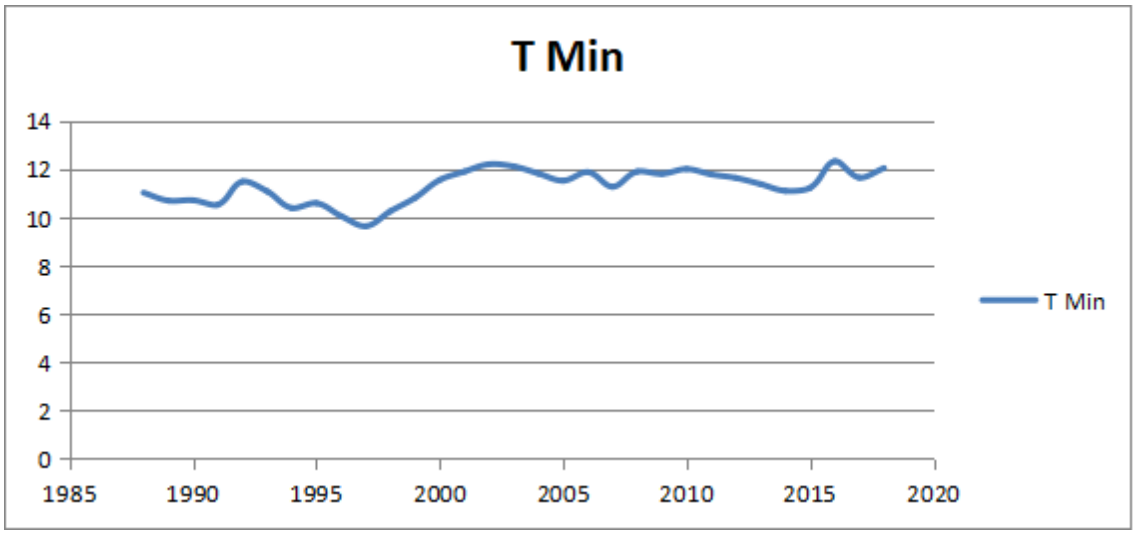

Figure 23Annual Minimum Temperature

Within the period of between 1960 – 2020 considering the reference normal of 11.31 °C the average annual **minimum** temperature recorded

- Highest recorded was 12.34 °C in 2016 with anomaly +1.03 . While
- Lowest recorded was 9.65 °C in 1997 with anomaly of -1.66 the reference normal of 26.10 °C.

Climate variability and anomalies observation from FGD

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

Drought effects /moisture stress

- Machisho Forest Ecosystem and vicinity areas rainfall is decreasing as compared to the increasing rainfall of the central region. As a result of this the forest area and nearby mountains they are exposed to drought,

- **Loss of** crop production and productivity. As a result cereals productivity was reduced
- Rainfall is highly erratic and typically falls in the form of intensive convective storms such variability cause shifting of crops seasons

Temperature effects

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

3.4.2. The Drivers and Pressure of Climate Change

- **Global Driver**

Spread of the Culture of Western Consumption Ideology

is a social and economic order in which the aspirations of many individuals include the acquisition of goods and services beyond those necessary for survival. It emerged in Western Europe before the **Industrial Revolution** and later became a economic policies that encourage & emphasize consumption. Consumerist societies are more prone to damage the environment, contribute to global warming and use resources at a higher rate than other societies.

In the **21st century's** globalized economy, consumerism has become a noticeable part of the culture. Critics of the phenomenon not only criticized it against what is environmentally sustainable, but also the spread of consumerism in cultural aspects. However, several scholars have written about the relationship between environmentalism and consumerism in a **market economy society**.

- First, capitalism entered a qualitatively new globalizing phase in the 1950s. As the **electronic revolution** got underway, significant changes began to occur in the

productivity of capitalist factories, systems of extraction, processing of raw materials, product design, marketing and distribution of goods and services.

- Second, the technical and social relations that structured the **mass media** all over the world made it very easy for new consumerist lifestyles to become the dominant motif for these media, which became in time extraordinarily efficient vehicles for the broadcasting of the **culture-ideology** of consumerism globally

The spread of consumerism enhanced by the market economy cause unseasonable development of high GHG emissions causing global warming ad climate changes,

➢ National and Local Drivers

- **The huge number of animal population**:

Under the business as usual scenario farming of livestock-cattle, sheep, goat, and chickens contribute around 140 million tons of greenhouse gases (carbon dioxide, methane and nitrous oxide) to the atmosphere by 2030. This could represent up to 60% of the national emissions.

- **Overpopulation**;

According to CSA (2013), the population would have reached above 90 million in 2015, which makes Ethiopia the most populous nations in Eastern Africa and the second-most populous in Africa after Nigeria (CRGE 2011). With the current annual population growth of over 2 percent, Ethiopia will have more than 120 million people by 2030. Over the past 50 years poor rural families have not got sufficient social security support and turned therefore to various other kinds of social security net surrogates. These surrogates have been, for instance, ***large families***, which

- Provided sufficient household labor for family livelihood.
- Secondly, the families in villages and town communities have to support each other during the difficult times.
- The third social security net surrogate has been exploitable forests, which could provide many goods and services free of charge such as wood energy, construction wood, food and fodder, new farm and housing land and drinking water.

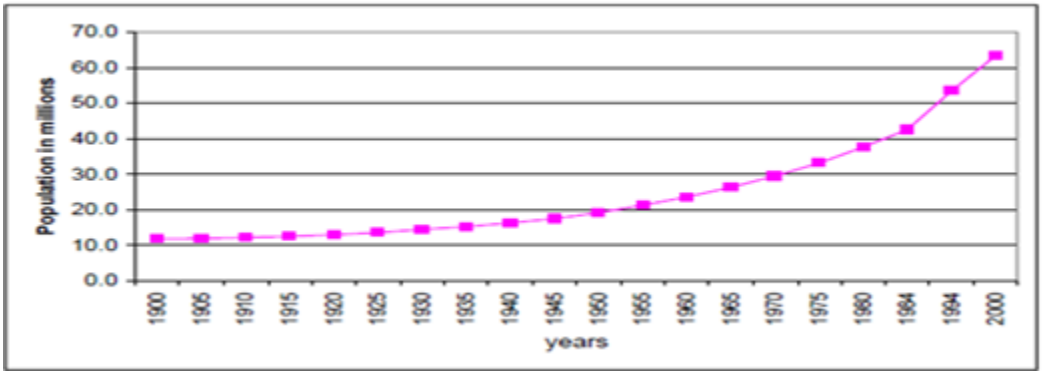

Figure 24 Population Growth Over the Year

Source: MEDaC,1999 and CSA,1998

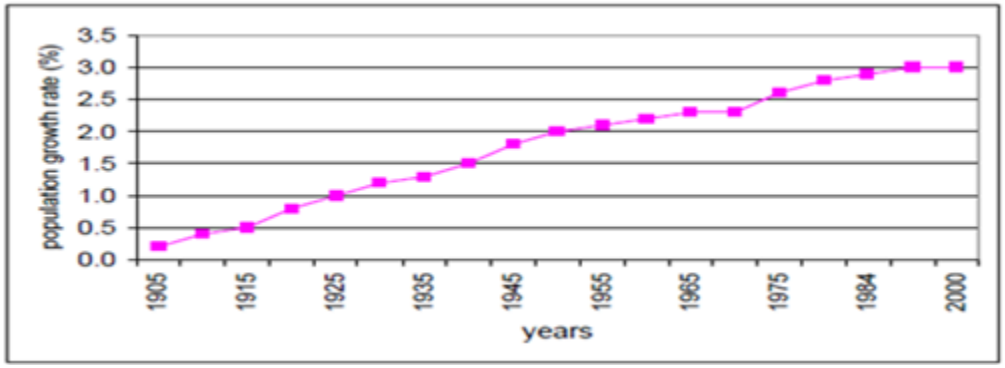

Figure 25 Population Growth Rate Over the Years

Source: MEDaC,1999 and CSA,1998

- **Forest Governance**

  Tree ownership & Enforcement

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

- **Livelihood income**
  - The local community to satisfy their economic demands and compensate the agricultural crises caused due climate change, exploited the market valuable

timber and lumber trees. Especially in Machishotimber valuable Podocarpus & Cordia completely removed for the good market price

- Converting forests lands has changed to market valuable agricultural crops.

- **Social security**

Due to the scarce of the natural resources and the consequence cooption larger families have better competitive advantage. Over the past 50 years poor rural families have not got sufficient social security support and turned therefore to various other kinds of social security net surrogates. These surrogates have been, for instance, ***large families***, which provided **sufficient household labor** for family livelihood. Secondly, the families in villages and town communities have to **support each** other during the difficult times. The third social security net surrogate has been **exploitable forests**, which could provide many goods and services free of charge such as wood energy, construction wood, food and fodder, new farm and housing land and drinking water.

➢ National and Local Pressures

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

Land use changes

The population continues to grow, accordingly the need to provide housing, agricultural land expansion and fuel wood consumption also increases. And these exerts pressure on Land use changes of forest ecosystem to agricultural, grazing and residences.

- Agricultural farming emission contribution is great
    - Land use change (CH_4 from deforestation)

- Crop production (N_2O emission from organic and mineral N imputes. Burning of crop residues, N_2O and CH_4 from manure handling (storage, etc.) and the application of mineral fertilizer is a significant material for agricultural products and productivity improvement.

Resettlement programs

According to FGD community's resettlement program is implemented by the government however it was one of responsible factors for the local climate variability that makes great stress on the forest through cutting the trees for agricultural purpose, wood consumption, household material, timber preparation and sells those cutting trees by making charcoals in order to satisfy their economic interests

Forest fire:

Intentionally combustion of the forest for different purpose. Expansion of agricultural activity mainly the local communities practice what is called shifting or slash and burn farming, better grass for grazing, charcoal making, to collect honey, were the main responsible factors for the expansion of the wild fire.

Charcoal and fuel wood production:

Charcoal and fuel wood production is cause of forest degradation as a result it hinders the carbon sequestration potential of the forest ecosystem. Deforestation and forest degradation as well as biomass energy emits carbon due to backward three stone stove which is not energy saving and wasteful.

Animal farm

- Animal populations were degrading the area and produced methane which is great contribution to greenhouse gas emission next to carbon dioxide with roughly 28 times the warming potential of CO2 over a 100-year time frame.
- Livestock generates greenhouse gases mainly in the form of methane emissions arising from digestion processes (mostly attributable to ruminant animals like a goat) and nitrous oxide emissions arising from excretions.

- Livestock emissions are estimated to amount to 65 MtCO2e-35% of Ethiopia's total emissions today (Ethiopian CRGE, 2011). In Ethiopia livestock emitted **methane** and **nitrous oxide** total of **65 Mt CO_2e**, which cover 42% of the total.

3.4.3. Impacts of Climate Change Machisho Forest Ecosystem

- **Global and National Impacts**

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

Forest distraction,
loss of habitat and biodiversity,
Soil erosion,
Air and water pollution,
Shrinking fossil fuel supplies,
Accommodation of toxic wastes and
Spread of tropical diseases
Malaria (vector Mosquito) ,
Schistomiasis (vector Water snail),
Filariasis (vector Mosquito),
Onchocerciasis/river blindness (vector Black fly),
African trpanosomiasis / sleeping sickness (vector Tsetse fly),
Dengue Fever (vector Mosquito), and
Yellow Fever (vector Mosquito).

- **Local Impact**

Deforestation and Forest degradation

It is well known that deforestation and forest degradation must be reversed if the country is to meet following economic and ecological advantages of:-

- Wood fuel accounts for more than 80% of household energy supply in Ethiopia and is particularly important in rural areas. Beyond wood fuel, forests provide other timber products and a host of valuable non-timber products, including livestock fodder, coffee and honey. Forests are also the source of essential ecosystem services, including carbon sequestration, crop pollination, conservation of agricultural soils and control of water discharge to streams and rivers.

Flooding

Due to the erratic character of the rainfall flooding frequency occurrence is very serious especially in downstream areas.

Biodiversity loss

For the cultivation of the economic and market valuable coffee & spices most of the biodiversity competing shrub & herbs are removed. This loss the biodiversity. **Coffee** management is widely practiced under a canopy of forest trees is a great economic resource for local farmers and the government. As a result, there is more interest in expanding forests with coffee plantations the forest ecosystem is increasing area coverage though there is loss of the biodiversity.

3.4.4. Response to Climate Change on the Koysha Forest Ecosystem

- **Global Response Efforts of COP 1 -28**

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

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

- **National Response Climate Change**

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

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

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

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

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

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

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

b) Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks

- Reduce demand for wood fuel through dissemination of more efficient wood and/or alternative-fuel stoves.
- Promote afforestation, reforestation and improved forest management activities to increase carbon sequestration in forests and woodlands.

c) Expanding electricity generation from renewable sources of energy for domestic and regional markets

d) Leapfrogging to modern and **energy-efficient technologies** in **transport**, industrial sectors, and buildings.

- **Local Response**

There is no any state or non-state intervention in rehabilitating the Machisho Forest Ecosystem starting from its declaration as Forest Ecosystem starting from the early 1980's

- No Past response measures from NGO
- No current response measures or practices of State

Response measures or practices by community

- Water shed management
- Soil and water conservation
- Afforestation and plantation

3.4.5. Outlook (2020 – 2050)

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

Temperature Projection:- Future temperature projections of the IPCC mid-range scenario show that the mean annual temperature will increase in the range of 0.9 to 1.1ºC by 2030, in the range of 1.7 to 2.1ºC by 2050, and in the range of 2.7 to 3.4ºC by 2080 in Ethiopia compared to the 1961 to 1990 normal (EEA, 2008), posing a sustained threat to the economy

Business us usual scenario:-Accordingly based on the available meteorological data in Machisho forest area temperature was increased. If this condition continuous without any strong mitigation, and adaptation measures in the coming 30 years temperature will increased, it will lead to increase climate-related hazards on the society and as well as on the Forest Ecosystem will **deforested completely** & changed to other land use. Because the nonbearing Kebeles will be more dependence on the Forest Ecosystem for compensating their loss income due to climate change will create a great pressure on it. Therefore the forest ecosystem will **disappear & changed** to other Land use for three reasons. First, agriculture is by far the dominant producer, employer, and main source of income. Second, the agriculture is highly susceptible to the causalities of climate change. Third, the agricultural population constitutes the significant majority

CRGE scenario:-The vicious triangle of climate, livelihood & Forest Ecosystem linkage is broken through the climate change **mitigation** & **adaptation** efforts through livelihood

improvement, reduce deforestation and degradation by adapting & enhancing participatory forest management practices of : -

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

In the **coming 30 years** the climate state and trend of forest ecosystem can be conserved the existing status and enhanced in quality and quantity benefiting the ecosystem and livelihoods.

3.4.6. Recommendation

Breaking vicious circle

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

Viscous circle of Climate change, Forest Ecosystem and livelihood is inter liked affects each other

- The climate variability's of rainfall and temperature affects the forest ecosystem and Livelihoods
- The degradation and deforestation of the Forest Ecosystem as carbon sink emitted CMC aggravate Climate change and Livelihoods negative impacts
- Livelihoods crises also enhance land use changes of degradation and deforestation and anthropogenic effects of Climate change

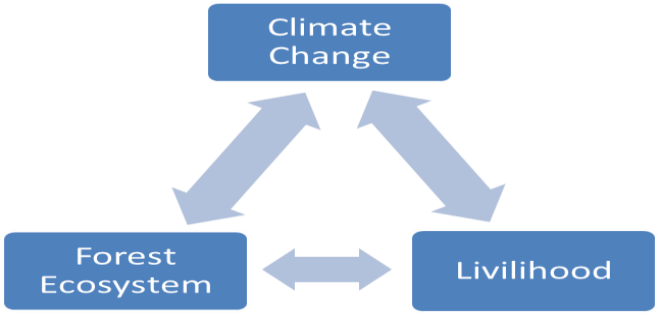

Figure 26 Viscous circle of Climate change, Forest Ecosystem and livelihood

Sustainable development

Among climate, forest & livelihoods:-

- **Climate Change**
  - Reduce carbon emission from deforestation & forest degradation
  - Promote climate change mitigation efforts
- **Forest Ecosystem**
  - Improved land tenure, conservation and restoration strategies.
  - Strengthening participatory forest management practices in coloration with the government, the society and by NGO.
  - Developing forest ownership/tenure law which is fair, stable and unambiguous with clear rights and duties (state, common, private).
  - Developing perceptive legal instruments (policy, law and regulation) that consider Participatory Forest Management as the main "pull" of forest management in the country and to develop or amend the forest law.
- **Livelihoods**
  - Promote adaptation strategies of wood and non-wood products utilization
  - Use alternative cooking stoves technology and improve electricity accessibility and bio-full gas instead use forest for fuel wood.
  - 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

- With land registration individual households get their rights overland and they can defend them from other households and outsiders coming to an area to cut trees
- Livelihood comprises capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from the stress and shocks and maintain or enhance its capacities and assets both now and in the future without undermining the natural resource base.

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