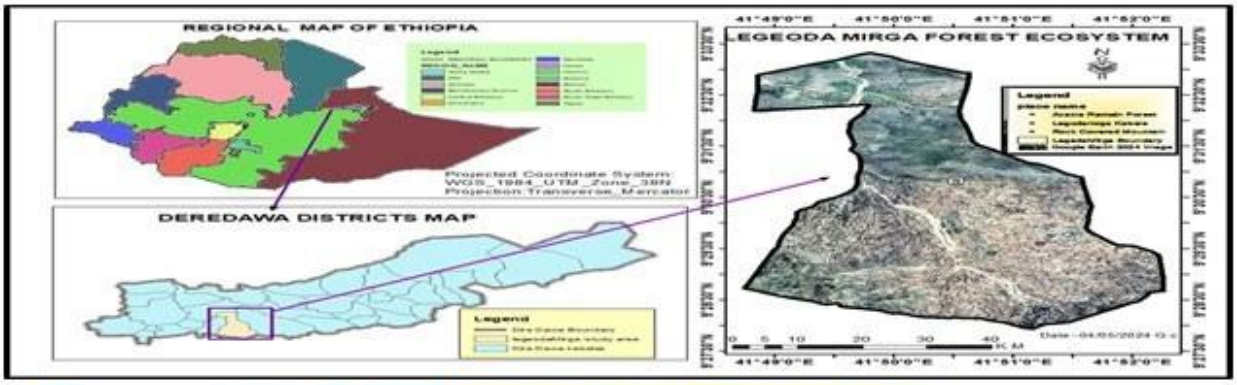
# ETHIOPIAN ENVIRONMENTAL PROTECTION AUTHORITY

# FACT SHEET OF

# LEGEODA MIRGA MOUNTAIN FOREST ECOSYSTEM

# DIRE DAWA CITY ADMINISTRATION






**Prepared by: State of Environment Data Study and Report Preparation Desk**

**JUNE 2024**
**Addis Ababa**

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## Acronyms and Abbreviation

AGP—Agricultural Growth Program

Avr – Average

CBD—Conventions on Biological Diversity

CH4 - Methane

CRGE-Climate Resilient Green Economy

$CO_2$ - Carbon dioxide

CO2e - Carbon dioxide equivalent

COP – Committee of Parties

CRGE – Climate Resilience Green Economy

CSA – Central Statics Authority

DDAC-Dire Dawa city Administration

DDWSSA-Dire Dawa Water Supply Sanitation Authority

DLUMDR- Department of Land use Management directorate report 2011

DPSIR- Driver, Pressure, State, Impact and Response

EPA – Environmental Protection Authority

FAO –Food and Agriculture Organization-

FGD – Focal Group Discussion

GDP- Gross Domestic Product

GHG – Green House Gas

GIL-Green Legacy Initiatives

GIS –Geographical Information system

GO-Government organization

GTP- Growth and Transformation Plan

IAPS-Invasive alien species

IPCC – Intergovernmental Parties for Climate Change

IPCC- Intergovernmental Panel on Climate Change

IUCN- International Union for Conservation Nature

IUCN-The International Union for Conservation of Nature

KI-Key informants

LULCC-Land use land covers change

LULC -Land use Land Cover Change

MAOD-Meteorology Agency office

Max – Maximum

Min – Minimum

MOWR---Ministry of Water Resource

Mt – Million tones

$N_2O$ - Nitrous oxide

NGO - None Governmental Organizations

NMA – National Metrology Agency

OCHA- United Nations Office for the Coordination of Humanitarian Affairs

RF- Rain Fall

SOE- State and Outlook of the Environment

SWC- Soil and water conservation

T-Temperature

UNFCCC - The United Nations Framework Convention on Climate Change

WMO-World Meteorological Organization

# 1. General Background

## 1.1. Environment for Green Economy Development

### 1.1.1. Green growth and sustainable development

***Green Growth*** means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. **Strategies for greener growth need to be tailored to fit specific country circumstances**. They will need to carefully consider how to manage any potential trade-offs and best exploit the synergies between green growth and poverty reduction. The latter include, for example, bringing more efficient infrastructure to people (e.g. in energy, water and transport), tackling poor health associated with environmental degradation and introducing efficient technologies that can reduce costs and increase productivity, while easing environmental pressure. Given the centrality of natural assets in low-income countries, green growth policies can reduce vulnerability to environmental risks and increase the livelihood security of the poor. Green growth strategies also recognize that focusing on GDP as the main measure of economic progress generally overlooks the contribution of natural assets to wealth, health and well-being. They therefore need to rely on a broader range of measures of progress, encompassing the quality and composition of growth, and how this affects people's wealth and welfare. The OECD is working to identify the policy mixes and measurement tools that countries in different situations can adopt to implement green growth in a way that contributes to poverty eradication, employment opportunities, and a strong and sustainable economy. Green growth is not a replacement for sustainable development**.** Rather, it provides a practical and flexible approach for achieving concrete, measurable progress across its economic and environmental pillars, while taking full account of the social consequences of greening the growth dynamic of economies. The focus of green growth strategies is ensuring that natural assets can deliver their full economic potential on a sustainable basis. That potential includes the provision of critical life support services – clean air and water, and the resilient biodiversity needed to support food production and human health. Natural assets are not infinitely substitutable and green growth policies take account of that. Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies.

The term “green economy” can be defined and understood in different ways and within different contexts. In their Green Economy Initiative, the United Nations Environment Program (UNEP) defines the term within a broad economic, social and environmental agenda: a green economy is “one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities”. Others, such as the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) define green growth as a policy focus that emphasizes “environmentally sustainable economic progress to foster low-carbon, socially inclusive development. (UNECE, 2011)

The role of Green Economy, Sustainable Consumption and Production and Resource Efficiency for Sustainable Development: Sustainable Consumption and Production aims to improve production processes and consumption practices to reduce resource consumption, waste generation and emissions across the full life cycle of processes and products – while Resource Efficiency refers to the ways in which resources are used to deliver value to society and aims to reduce the amount of resources needed, and emissions and waste generated, per unit of product or service. The Green Economy provides a macro-economic approach to sustainable economic growth with a central focus on investments, employment and skills.

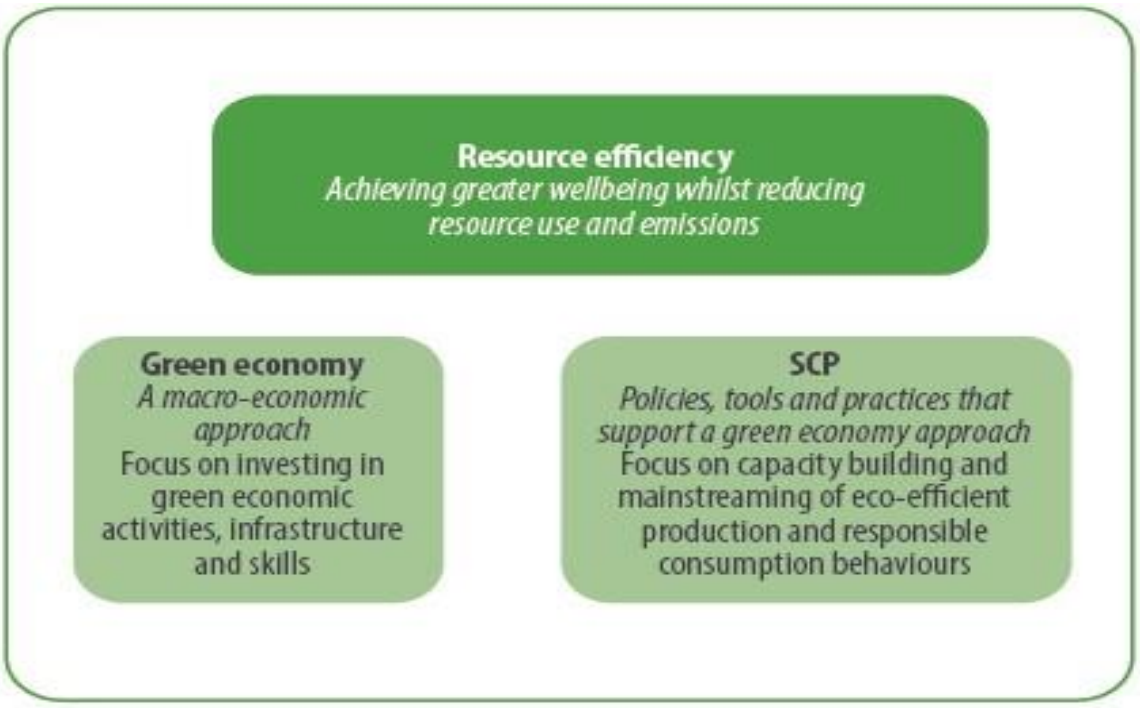



**Figure 1 Green Economy**

Multi-stakeholder partnerships for the promotion of a Green Economy are supported to accelerate and consolidate sustainable changes in both consumption and production patterns. In addition to Governments and not-for-profit organizations, UN Environment has increased its engagement with the private sector – which is a very important actor in promoting resource efficiency and green economy

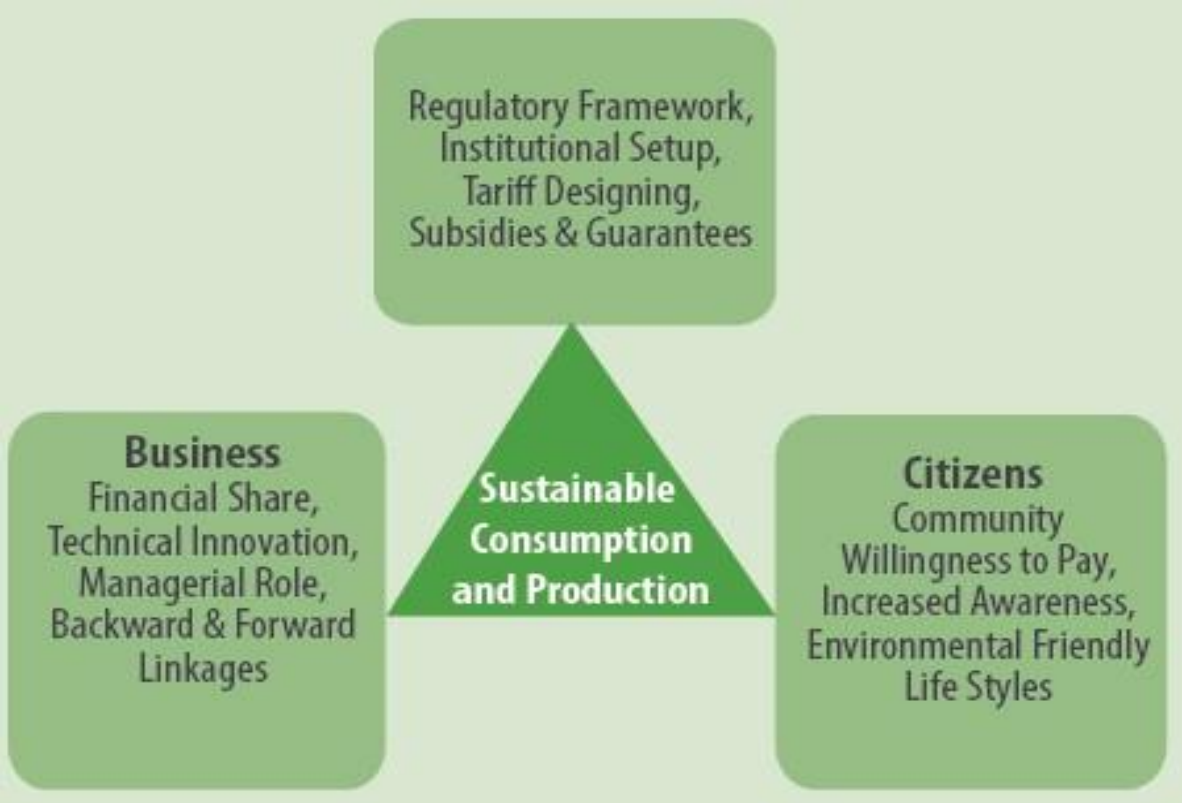



Figure 2 green economy for SD

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

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

sustainable development goals thus also establish a real link between the ecological system and the economic system. They also reinforce the need for a transition to a green economy, i.e., a fundamental transformation towards more sustainable modes of production and consumption.

### 1.1.2. The Driver-pressure-state impact-response framework

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

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

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

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

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

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

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

## 1.2. SOCIAL AND ECONOMIC ENVIRONMENT

### 1.2.1. Social Environment

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

Social and economic factors include factors such as income, education, employment, community safety and social support. The choices that are available in a community are impacted by social and economic factors. These choices include our abilities to afford medical care and housing and to manage stress. Our "environment" includes both social and physical determinants of health. Social impacts on health are embedded in the broader environment and shaped by complex relationships between economic systems and social structures. These systems and structures impact the distribution of resources, money and power in a community and around the world. This distribution, known as the socioeconomic environment, shapes how communities and individuals can gain the resources needed to meet their basic human needs.

In general, socio-economic impacts focus on how the activity affects human or societal well-being, as well as the use and benefit of any site. For example, the construction of a road may upset people living nearby due to noise and dust pollution, causing health impacts in some cases.

What is a social environment?

A person’s *social environment* is there **society** and all surroundings influenced in some way by humans. It includes all relationships, institutions, culture, and physical structures. The *natural environment* is the natural world around us: the ground, the trees, the air. The *social environment* is, collectively, all of the things that humans have overlaid on top of our world: our personal and societal relationships, our institutions, our cultures, and our physical surroundings—all of the aspects and products of human activity and interaction. Sociologists, health researchers, and others study how the *social environment* shapes who we are and how we live, especially how individuals are affected by such factors.

What is economic environment?

The term economic environment refers to all the external economic factors that influence buying habits of consumers and businesses and therefore affect the performance of a company. Economic environments are the foundation of growth. Economic environments are platforms where individuals trade goods, services, and money to grow their separate wealth. This in turn grows the general wealth of the environment. Generally Socio-economic development is the process of social and economic development in a society. Its purpose is to maintain the social and material well-being of the nation and its people with the aim of achieving the highest possible level of human development. Further Reading: Economic Growth and Development.

**Dire Dawa** (Somali: *Diridhaba*, meaning "where the Somali ancestor Dir hit his spear into the ground" or "The true Dir", Amharic: ድሬዳዋ, Harari: ድሬዳዋ, lit. "Plain of Medicine"; Oromo: *Dirree Dhawaa*, lit. 'Place of Remedy') is a city in eastern Ethiopia near the Oromia and Somali Region border and one of two chartered cities in Ethiopia (the other being Addis Ababa, the capital). Dire Dawa alongside present-day Sitti Zone were a part of the Dire Dawa autonomous region stipulated in the 1987 Ethiopian Constitution until 1993 when it was split by the federal government into a separately administered chartered city. It is divided administratively into two Woreda s, the city proper and the non-urban Woreda of Gurgura.

Dire Dawa lies in the eastern part of the nation, on the Dechatu River, at the foot of a ring of cliffs. The western outskirts of the city lie on the Gorro River, a tributary of the Dechatu River. It is located at the latitude and longitude of 9°36′N 41°52′E. The city is an industrial centre, home to several markets and the Dire Dawa Airport.

The projected population for 2015 was 440,000 for the entire chartered city and 277,000 for the city proper, making the latter the seventh largest city in Ethiopia. The present-day town of Dire Dawa (311 km by rail from Djibouti), however, is of very recent origin. It owes its foundation to a technical problem: when it became impossible to lay the Addis Ababa-Djibouti Railway via Harar because of the steep access to the town, Emperor Menelik II accepted (in a later dated 5 November 1896) that the first part of the line might finish at a village at the foot of the mountains, which should be named Addis Harar ("New Harrar").[18] The railway reached this location on 24 December 1902, a date which may be considered the day of Dire Dawa's foundation. The new name, however, did not win recognition. For financial and diplomatic reasons the railway was not continued until 1909 and the final inauguration of the whole line from Djibouti to Addis Ababa-again delayed by the revolution of 1916-only took place on 7 June 1917. During all this time, Dire Dawa was practically the town profited much and became a "boom city", attracting most of the trade which formerly passed through Harar. By 1902 the Ethiopian government, anticipating the future economic importance of Dire Dawa, had already transferred the customs station for trade with the Red Sea from Gildessa to Dire Dawa.

Dire Dawa developed into two settlements separated by the Dechatu River, which was dry for most of the year and became a torrent only when it rained. The north-western part of the town was planned and constructed very regularly, mostly by the engineers of the railway company. At first, this part of the town mostly housed the employees of the railway company, but it later attracted, besides the French, also Greeks, Armenians, other Europeans and Arabs, who opened shops and hotels and founded some industry as well. In 1909 the French Capuchin Mission settled in Dire Dawa. At that time Dire Dawa looked like a French town. The other part of the town, southeast of the river, concentrated around the market and was inhabited mainly by Ethiopian, Somali and a few Arab traders.

## 1.2.2. State and trend of social environment

**Population**

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

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

**Table 1: Population Trend in** Wahil rural cluster **200-2024**

| year (G.C) | Rural population | | |
|---|---|---|---|
| | male | female | total |
| 2019 | 24031 | 23792 | 47823 |
| 2020 | 24632 | 24387 | 49019 |

| | | | |
|---|---|---|---|
| 2021 | 25248 | 24996 | 50244 |
| 2022 | 25879 | 25621 | 51500 |
| 2023 | 26526 | 26265 | 52788 |
| 2024 | 27189 | 26919 | 54108 |

*Source*: - ERER WORWDA HEALTH OFICE (2024)

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

**Education**

Education is a powerful agent of change, and improves health and livelihoods, contributes to social stability and drives long-term economic growth. Education is also essential to the success of every one of the 17 sustainable development goals. Education is the most important factor that plays a leading role in human development. It promotes a productive and informed citizenry and creates opportunities for the socially and economically under privileged section of the society. When considering the enrolment of female students in all level of education primary education, from 2020-2024 is low as compared with male students. This shows that due to disaster problem female students are more vulnerable than male students and females are participated in other lively hood activates to cope the problem.

**Table 2: Students, teachers and number of schools in Wahil rural cluster in Academic year22020-024**

| No. | Level of School | Number of schools | Students Wahil rural cluster 2020- 2024 | | |
|---|---|---|---|---|---|
| | | | Male | Female | Total |
| 1 | Elementary schools | 15 | | | |
| 2 | Primary School ( 7-8) | 13 | 8555 | 6427 | 14982 |
| 3 | High School ( 9-12) preparatory | 1 | 705 | 616 | 1321 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | Number of teachers | 445 | 9260 | 7043 | 16303 |

Source: Dire Dawa education office

**Health**

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

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

In recent years, technology has revolutionized the healthcare sector, paving the way for innovative treatments, improved diagnostics, and streamlined patient care. From electronic medical records and telemedicine to artificial intelligence and wearable devices, these advancements have enhanced efficiency, accuracy, and accessibility within the industry. Medical professionals can now diagnose diseases more accurately, monitor patients remotely, and collaborate across borders for better patient outcomes.

While the healthcare sector has traditionally cantered on treating illnesses, there has been a notable shift towards preventive care. Recognizing the importance of early detection and lifestyle modifications, healthcare providers now emphasize wellness programs, health screenings, and educational campaigns. By focusing on prevention, the sector aims to reduce the burden of chronic diseases, enhance overall public health, and improve the quality of life for individuals.

**Table 3: Health Institutions in** Wahil rural cluster **f2020 -2024**

| No | Types of Health Institutions | Year | | | | | Remark |
|---|---|---|---|---|---|---|---|
| | | 2020 | 2021 | 2022 | 2023 | 2024 | |
| 1 | Governmental Health Center | 3 | 3 | 3 | 3 | 3 | |
| 1.1 | Primary Hospital | 0 | 0 | 0 | 0 | 0 | |
| 1.2 | Health center | | | | | | |
| 1.3 | Health post | 7 | 7 | 7 | 7 | 7 | |
| 2 | Private Health Centers | 0 | 0 | 0 | 0 | 0 | |
| 2.1 | Primary Health clinics | 0 | 0 | 0 | 0 | 0 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.2 | Number of health professionals' | 42 | | | | 7 | |

**Source: - Wahil rural cluster Health Report 2024**

As indicated on the above tables, the numbers of Governmental Health Institutions and health professionals has Constant number but the number of health professionals are relatively increasing year to year in **Wahil rural cluster**,

**Road and Transport**

Transport is a key component in the distribution of goods within and beyond a country's borders. Transport is a way to ensure stable prices in different markets and it allows traders to regulate the supply of goods at various locations based on areas, facilitates the export of agricultural products, and reduces the real cost of necessary imports. Moreover, transportation changing demands. Efficient and low-cost transportation expands market enables the movement of people and goods, supporting recreational and leisure activities, as well as employment opportunities. The total existing road in the *Woreda* is 69 kilometers. Most of the rural roads are seasonal and. The population who has access to Road infrastructure is around 65.5 % of the Woreda population. According to focal groups and key informant discussion Wahil rural cluster there is a great problem of road infrastructure.

**Table 4: Types and length of Roads, existing Wahil rural cluster in the year 2018**

| No | Road type | Length in km | % of population who has accessto Road |
|---|---|---|---|
| 1 | Asphalt | 15 | **22%** |
| 2 | All weather rood | 60 | 67% |
| 3 | Dry weather rood | 20 | 11% |
| 4 | Total | 95 k.m | |

Source: (Dire Dawa city administration transport office)

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

**Water Resource and Supply**

Access to safe water, sanitation and hygiene is the most basic human need for health and well-being. Billions of people will lack access to these basic services in 2030 unless progress quadruples. Demand for water is rising owing to rapid

population growth, urbanization and increasing water needs from agriculture, industry, and energy sectors. The demand for water has outpaced population growth, and half the world's population is already experiencing severe water scarcity at least one month a year. Water scarcity is projected to increase with the rise of global temperatures as a result of climate change. Investments in infrastructure and sanitation facilities; protection and restoration of water-related ecosystems; and hygiene education are among the steps necessary to ensure universal access to safe and affordable drinking water for all by 2030, and improving water-use efficiency is one key to reducing water stress. In, Wahil rural cluster from the total population 60% has access to clean water. Surface water resources and various springs were used as a water source. And provide considerable amount of water for domestic water use and even for all year round human, animal water consumption and for irrigation purposes. However, due to various environmental problems some streams and springs were dried, while the volume of existing small streams and river as well as the discharge rate of springs has been decreasing from time to time.

**Communication Services**

Communication helps you connect with others and share ideas. Effective communication clarifies information, reducing wasted time. Helps builds relationships, teamwork, and trust. Effective communication enables individuals and organizations to share ideas, collaborate on projects, and innovate more effectively. This can lead to the development of new products, services, and solutions that drive economic growth. In Wahil rural cluster, assess to the telephone services cover 30% of from the total population.

**Housing**

Our home provides us with a sense of protection and shelter from the outside world. We can be ourselves and let our guard down in the comfort of our homes. The feeling of safety and security that home provides is essential to our mental and emotional well-being. "A home is also a place of belonging. Housing is one of the three basic needs for human being; there is no problem of housing as mentioned during key informant, group discussion in the Wahil rural cluster.

**Electricity**

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

In today's era, can you imagine life without electricity for just a few minutes? A few hours without electricity wreak

havoc in our lives. Much of our work go to waste without electricity because humans depend on electronic items. These electronic items run on electricity or take electricity as an energy source. This 21st century is techno-savvy in which techno gadgets and electronic items like laptops, mobile phones, refrigerators, washing machines, television, computers, and electronic kitchen essentials like mixers, grinders, ovens, microwaves, heaters, etc., surround everyone. Even the construction of the home is incomplete without electric wiring. This is how electricity has impacted our life from birth to death.

*Electricity* is an essential infrastructure for a given area of economic and social development. In Wahil rural cluster the total coverage of Electricity is 15%. The other residents used fuel wood, charcoal as the source of energy and also they used kerosene as a source of light.

### 1.2.3. Drivers and pressure of social environment

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

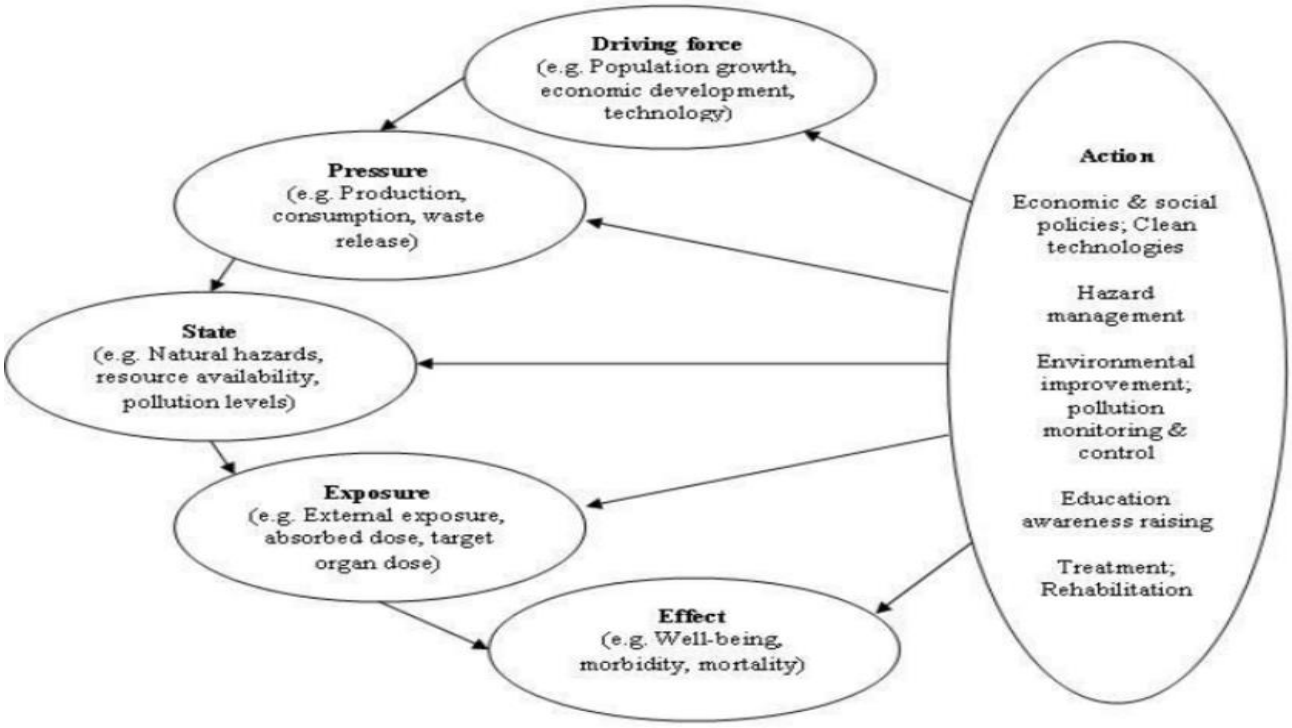



Figure 3: The drivers and pressure of change in the environment

- Important direct drivers include climate change, nutrient pollution, land conversion leading to habitat change, overexploitation, and invasive species and diseases. That happens intermittently. Changes in ecosystem services can feed back to alter drivers.

- Population growth and demographics, urbanization, economic development, new technological forces, and climate change

- Important direct drivers include climate change, nutrient pollution, land conversion leading to habitat change, overexploitation, and invasive species and diseases that happen intermittently. Changes in ecosystem services can feed back to alter drivers.

- Low educational background and less exposure to contraceptive technologies aggravate high birth rates among the rural population.

- Even though, currently much attention is given to the provision of primary healthcare in the households, the provision of family planning services are still low. As a result, there will be much more delivery and an

- The most significant drivers of environmental degradation are land use and land cover changes, resulting from agricultural farmland and settlement expansion.

### 1.2.4. Impacts due to social environment change

Humans impact the physical environment in many ways: overpopulation, pollution, burning fossil fuels, and deforestation. Changes like these have triggered climate change, soil erosion, poor air quality, and undrinkable water. Physical environmental compulsions such as famines, droughts, floods, earthquakes led to human migration to distant places with a consequence of disruption to settled human life. Physical environmental compulsions affect social life by producing new ways of living and set of social relationships.

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

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

students.

### 1.2.5. Responses to social Environment Change

There are many potential policy responses to the environmental challenges.

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

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

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

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

### 1.2.6. Outlook for Socio Environment of SMFE

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

## 1.3. Economic Environment

### 1.3.1. State and trend of the economic Environment

Agriculture is the most important economic sector in Wahil rural cluster 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 Dire Dawa Agricultural office report), Contribution of Agriculture sector for gross domestic product (GDP) is very high, which is: - Agriculture Sector 80 there is no industry or other sectors in the Woreda which can contribute for GDP

### 1.3.2. Drivers and pressures of the economy

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

### 1.3.3. Impacts due to the Economic Condition

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

Thus, the agricultural, sectors have a higher direct impact on the environment than other sector. Natural resources of Legeoda Mirga Mountain forest Ecosystem where degraded approximately 67%, based the discussions from different members of the community.

Soil fertility is declining every production season. Forest coverage is decreasing every year, due to intensive destruction of forests for charcoal, for construction and firewood production. Livestock's per capita production is very low and decreasing due to limited modern technique application and yield enhancing inputs. Therefore, the current livelihood strategy and pattern is a challenging task to promote sustainable development by protecting the environment. The population density around Legeoda Mirga mountain forest ecosystem is increasing. Hence about 60 percent of population is living under poverty rate according to the Woreda report and information gather during FDG.

### 1.3.4. Response Measures

What does response to the environment mean?

Organisms have the ability to adjust to changes in their environment through behavioral or physiological mechanisms. This ability is called responsiveness

**Environmental Response Measures** means any action necessary to comply with and ensure compliance with, or to reduce or eliminate liability under, Environmental Laws and/or any actions required under Environmental Laws and all applicable industrial standards to protect against and/or respond to, remove, remediate, investigate or monitor the release or threatened release of Materials of Environmental Concern at, on, in, about, under, within or near the air, soil, surface water, groundwater, or soil vapor.

- Replace disposal items with reusable items.
- The use of paper should be avoided.
- Conserve water and electricity.
- Support environmental friendly practices.
- Recycle waste to conserve natural resources.

The most common environmental emergencies are accidents involving shipments of chemicals or fuels. In such cases, an emergency response team needs to be called in to contain the leak, clean up the site and mitigate environmental impacts, thus avoiding soil, water and air contamination.

- Response measures are actions, policies, and programs that. Countries, as Parties to the UN Framework Convention on. Climate Change (UNFCCC), undertake in response to climate.

- Closing the gap between high population growth and low economic productivity through Planned reduction of population growth;
- improving the carrying capacity of the environment by taking appropriate environmental protection measures; and
- Improving the social and economic status of vulnerable groups (women, children and elderly).

A number of livelihood strategies were adopted by the communities at a grass root level to reduce their vulnerability to risk situations and recover from the unhealthy events. For instance, income diversification, engaged in off-farm activities, livestock fattening, and changing the cropping pattern from subsistence crop to perennial cash crops e.g., banana ,Coffee ,other spaces (Coro Rima, Jigger ) and to develop crop rotation practices from cereal crops to leguminous crops which facilitate soil development/increasing soil fertility to increase production and productivity. In addition, population policy, family planning policy, forest protection policy and health policy (family planning, human health), education policy and sector plan (quality education for all) has practically implemented at grass root level. To alleviate the problem and attain the Millennium Development Goals both the government and society are working together to achieve sustainable natural resource conservation. Apart from the above major responses by the Government of Ethiopia, a new plan has been coined and put into practice by different components of the government in this fiscal year Growth and Transformation Plan (GTP II). The planning year is between 2015/16 and 2019/20. GTP's vision in the economic sector is "to build an economy which has a modern and productive agricultural sector with enhanced technology and the economy; to sustain economic development and secure social justice; and, increase per capita income of citizens so that it reaches at the level of those in middle-income countries." an industrial sector that plays a leading role in

The major objectives of GTP are to:-

- Maintain at least an average real GDP growth rate of 11% and meet the Millennium development goals,
- Expand and ensure the qualities of education and health services there by achieving the MDGs in the social sectors,
- Establish favorable conditions for sustainable state building through the creation of stable democratic and developmental state.
- Ensure sustainable development by realizing all the above objectives within stable macro-economic framework.

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

- Sustaining faster and equitable economic growth
- Maintaining agriculture as a major source of economic growth
- Creating favorable conditions for the industry to play key role in the economy
- Enhancing expansion and quality of infrastructure development
- Enhancing expansion and quality of social development
- Building capacity and deepen good governance
- Promote women and youth empowerment and equitable benefit

### **2.2.1.** Outlook for Economy

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

### **2.2.2.** Options for future Action

The current policies, programs, strategies that are issued by the government are strong instruments for the management of natural resources however they need to be strengthened to cope with the changing situation such climate change and natural resources degradation and depletion. Implementations these

Policies and strategies should be ensured. Expansion of irrigated agriculture Introduction of drought tolerant crops environmentally friendly resettlement action plan should be in place, Income diversification such as engaged in off-farm activities, livestock fattening. Change the cropping pattern to cope up with the rain fall pattern variability due to shifting of seasons. Integrated and diversified agriculture need to be practiced for instance growing both subsistence and perennial cash crops by using additional technology to increase production and productivity.

- Applying integrated soil fertility management to improve soil organic compound
- Improve Livestock productivity and management
- Increasing agricultural productivity by practicing modern agricultural activates

# 2. Physical Environment

## 2.1. State of Land

### 2.1.1. State and Trends of LULCC and Land Degradation in Legeoda Mirga Mountainous Forest Ecosystem

Land use and land cover change is widespread, accelerating, and significant processes driven by human actions but also producing changes that impact humans (Agarwal, C., et. al, 2002). These changes alter the availability of different biophysical resources including soil, vegetation, water, animal feed and others. Consequently, land use and cover change could lead to a decreased availability of different products and services for human, livestock, agricultural production and damage to the environment as well.

In Ethiopia, steadily growing population pressure and agricultural expansion will inevitably increase the forest resources utilization (construction and fuel wood), and hence, different forms of unsustainable forest utilization will take place (fires, encroachment, logging, cultivation, urbanization) in coming decades ultimately leading to the total forest depletion. Based on the most recent estimates of the rates of deforestation, and assuming that 75 percent of forest losses are attributable to agricultural expansion, it is estimated that over the next 25 years the agriculture sector will require an additional 250 to 300 million hectares of new land to accommodate the demands of commercial farming, subsistence cropping, pasture and range development. Most of this increase in land will come at the expense of forests lands (Mulugeta, L. and Zenebe, M. (2011)).

Land use/land cover change (LULCC) is the modification of the Earth's terrestrial surface caused by human activities (Mengistu D. A., *et, al.,* 2012). The LULCC process has a negative impact on biodiversity, climate, soil, and air, as well as the ecosystem in general, and it has become the most serious environmental concern for humans in recent years (Hailemariam S. N. *et, al.,* 2016) LULCC can be used to assess ecosystem changes and their environmental implications at various temporal and spatial scales, making it useful for understanding environmental changes. Land use/land cover changes (LULCCs) are triggered by the interplay of socioeconomic and natural environmental factors. Inappropriate farming practices, overgrazing, rapid growth in the human population, and weak institutional setup are among the key anthropogenic driving variables of LULCCs (Assefa A., Singh K. N.2017). Rapid changes in the number of human populations initiate to the encroachment of farming and grazing on the fragile surface topography. Advances in technology and weak institutional response on the other hand promote uncontrolled lumber cutting and overuse of communal mountain resources that further encourage increased land degradation and LULCCs. Climate variability on the other way influences the succession of plant and animal species over

the fragile mountain ecosystems. Land cover refers to the observed biophysical cover on the earth's surface including vegetation, bare soil, hard surfaces, and water bodies. Whereas land use is the utilization of land cover type by human activities for agriculture, forestry, settlement, and pasture by altering land surface processes including biogeochemistry, hydrology, and biodiversity. Changes in land use and land cover are caused by direct and indirect consequences of human activities on the environment to have a better life.

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

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

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

The trend of land use land cover analysis shows that the city has been experiencing significant decrease in forest land with continuous concomitant increases in bare land and settlements through the study period. In response of land use changes, the trend of surface runoff showed continuous increasing trend. The result of focus group discussion confirms that land use change has significantly affected the trend of surface runoff generation. This is serious problem facing the city and also the rural Kebele. Land in the areas with unclear administration are exposed to informal development, deforestation and overall mismanagement. Dire Dawa city is located in the Great Ethiopian Rift Valley with an altitude of 1000–1200 m above sea level and

surrounded by mountainous districts of Oromia Regional States. These surrounding districts of Oromia Regional State are known for their dense population distribution. As a result people are forced to expand their agricultural lands to inaccessible, infertile and hilly areas located in the southern parts of the city. The study was conducted in Wahil cluster in Legeoda Mirga mountain forest ecosystem. Wahil Cluster, Dire Dawa CA is situated in the East and comprises of semi-arid highlands and moist highlands, an agro-pastoral livelihood zone. The main climate stress arises from moisture and water stress, and periodic failures of the rains and droughts in particular, which affect health, crops and livestock. However, flooding also occurs and there is soil erosion due to the terrain. Crop and livestock pests and disease also are a problem. Major climate induced disasters have been recorded in all Kebeles over the past five years, and around two thirds of households have reported crop or livestock damage The risk profile highlights the need for improved water access, as well as soil and water conservation. The area is a food deficit area, reflecting the low income levels (with the main source of income being agriculture), small land holdings and erratic rains. The effects of climate are compounded by wider stressors, including deforestation, inadequate access to water, poor agriculture management and information, lack of access to infrastructure (roads and energy), a shortage of health facilities and access, and low educational attainment levels, all of which increase the vulnerability of the community. 16% of households are female-headed. Household surveys reveal a large proportion have participated in food/cash for work programs and received food aid, and there is evidence of low recovery levels after shocks.

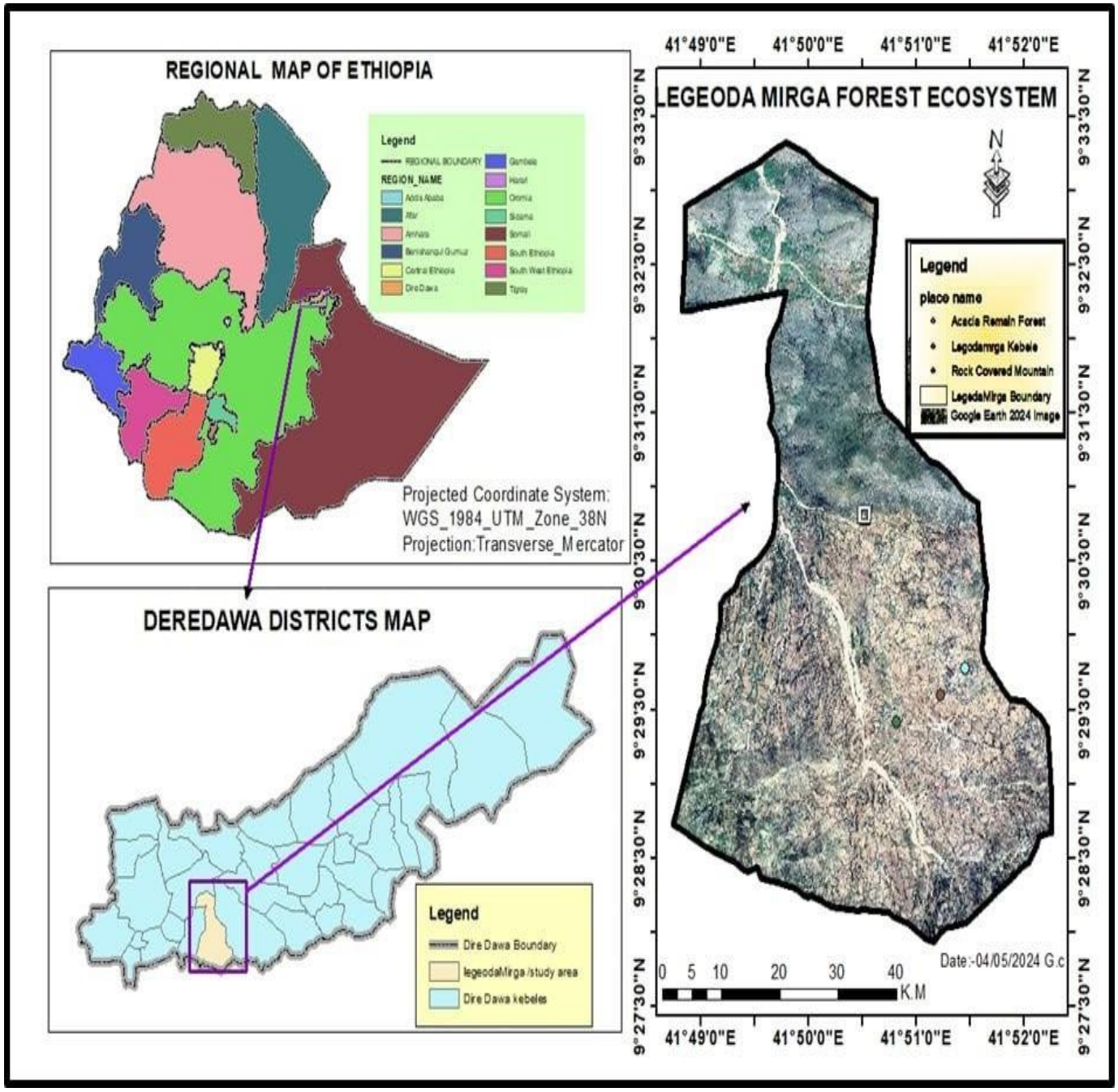



**Figure 4: Location map of Legeoda MirgaForest Ecosystem**

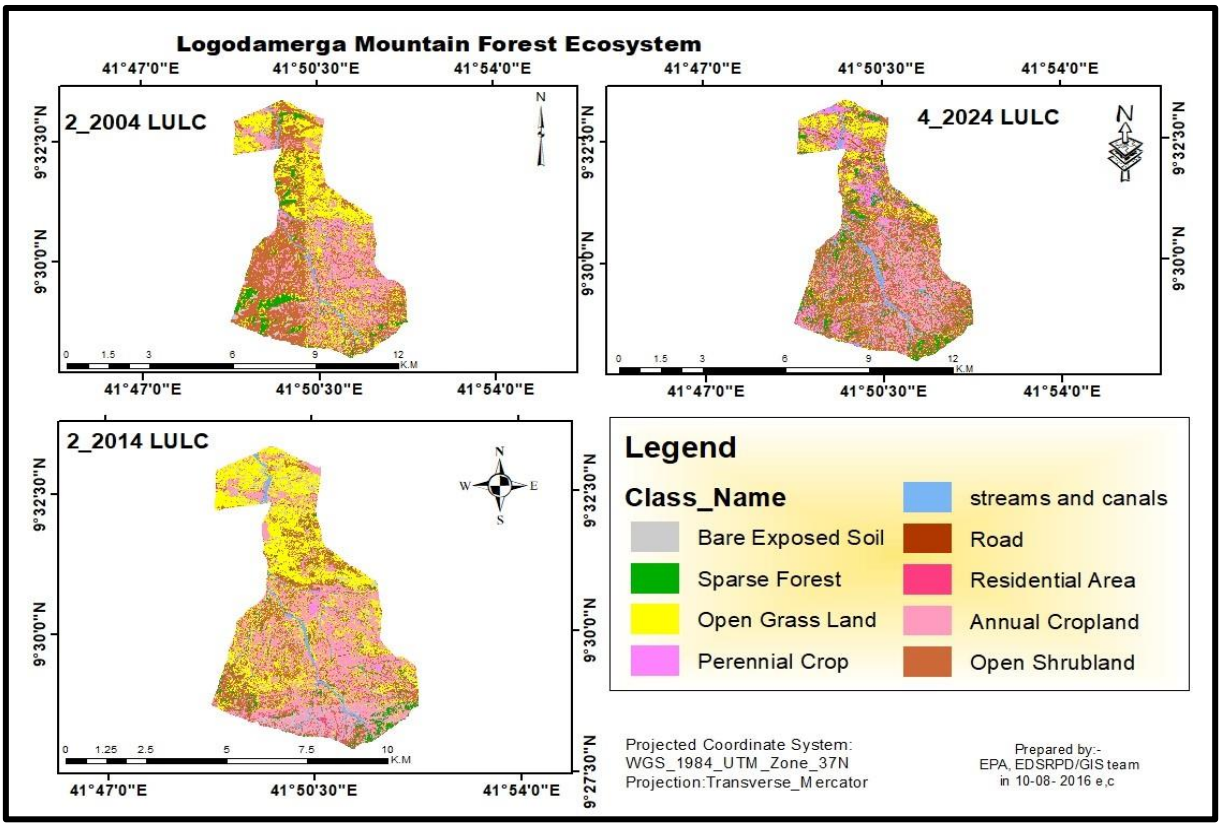



**Figure 5: LULCC map of Legeoda MirgaMountainous Forest Ecosystem**

**Table 5: Legeoda MirgaMountainous Forest Ecosystem LULCC Analysis**

| Class Name | year | | |
|---|---|---|---|
| | 2004_LULC | 2014_LULC | 2024_LULC |
| Road | 3.54 | 5.26 | 8.30 |
| Open Shrub Land | 1406.94 | 780.71 | 1379.10 |
| Streams & Canals | 81.37 | 107.30 | 140.43 |
| Perennial Crop | 116.40 | 54.65 | 375.80 |
| Sparse Forest | 168.78 | 113.38 | 271.78 |
| Open Grass Land | 924.27 | 1116.62 | 479.07 |
| Residential Area | 27.74 | 35.50 | 66.54 |
| Bare Exposed Soil | 72.22 | 173.85 | 181.81 |
| Annual Cropland | 757.88 | 1171.88 | 656.31 |
| Total | 3559.15 | 3559.15 | 3559.15 |

Source: - EPA GIS 2024.

As indicated in the classification scheme Stream & Channel, Road, Grass land, degraded land, Open shrub land, Annual Cropland, bare Exposed Soil, Sparse Forest and Residential Area are the major LULC classes for the GIS analysis. As it has been observed in the above table, road infrastructure was 3.54ha, 5.26 ha, and 8.30 ha in 2004, 2014 and 2024 respectively. This shows an increment due to the development of urbanization. The stream and canal branch was 81.37 ha, 107.3ha and 140.43 ha in the year 2004, 2014 and 2024 respectively, it shows an increment because of the geographical setting of the area as well as the expansion of flood in the study site. The analysis shows that shrub land in the year 2004 was 1406.94 ha and 1379.1 ha in the year 2024, the coverage of sparse forest in 2004 was 168.78 ha, in the year 2024 it covered 271.78 ha, perennial cropland in the year 2004 was 116.40 ha, 375.80 ha in 2024, Annual cropland in the year 2004 was 757.88ha, 656.3ha in year, residential area in 2004 was 27.74 ha, 66.54 ha in year 2024 and the bare exposed soil in the year 2004 was 72.22 ha and 181.81ha in the year 2024.

Generally, based on the LULCC analysis mentioned in the above table Stream and Channel, Road, Grassland Open Shrub land, Residential Area, sparse forest, Exposed soil, residential area and perennial cropland was increased from the year 2014 to 2024.Whereas Sparse Forest and Perennial Cropland was reduced from the year 2014 to 2024.Whereas open grass land and annual crop land was decreased from the year 2004 to 2024 because both of the was converted in to perennial crop and sparse forest land as well as settlement area.

According to Wahil rural cluster coordination office report, there was 941 ha of grazing land, ,5337ha of Agricultural land,9062 ha forest & woodland and 9274 ha of land used for other purposes.



**Figure 6: The partial view of Logoda Mirga mountainous Forest Ecosystem**

### 2.1.1.1. Land Degradation in Legeoda Mirga Mountainous Forest Ecosystem

Land degradation is a great threat for the future and it requires great effort and resources to ameliorate. Land degradation can be defined as long-term injury to ecosystem productivity and functioning initiated due to disturbances from which land and its components cannot recover [ELD Initiative, 2013]. The major causes of land degradation in Ethiopia are the rapid population increase, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production. Inappropriate land-use systems and land- tenure policies enhance desertification and loss of agro biodiversity. Utilization of dung and crop residues for fuel and other uses disturbs the sustainability of land resources. The supply of inputs such as fertilizer, farm machinery and credits are very low. The balance between crop, livestock, and forest production is disturbed, and the farmer is forced to put more land into crop production.

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

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

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

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

In Dire Dawa the land resources were highly degraded in both physically and chemically. Because of the topography of the city is highly suitable for flooding and easily eroded. According to Wahil cluster Agriculture office, 2024 the proportion of land affected by rill erosion was 10%, land affected by sheet erosion was 40%, land affected by gully and stream bank erosion was 15% and 10 % respectively. 25% of the land resource in Wahil cluster was affected by flooding.



**Figure 7: degraded land through Query extraction**

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

### 2.1.2. Drivers & Pressures of LULC and Land Degradation

The main drivers of LULCC and land degradation in Dire Dawa CA especially in Wahil cluster are mentioned here:

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

Based on the projection made by the Central Statistical Agency of Ethiopia (CSA), the population of Dire Dawa CA was increased highly from year to year. So this in directly affect the land use system of the area.

Table 6: Dire Dawa Administration population by Rural and Urban

Dire Dawa Administration Population by Rural and Urban

| Indicator | Regions | Periods | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| URBAN_Male | Diredawa | 130 000 | 134 000 | 139 000 | 143 000 | 147 000 | 152 000 | 157 000 | 162 000 |
| URBAN_Female | Diredawa | 129 000 | 134 000 | 138 000 | 142 000 | 146 000 | 151 000 | 156 000 | 160 000 |
| RURAL_Male | Diredawa | 78 000 | 80 000 | 82 000 | 84 000 | 86 000 | 88 000 | 90 000 | 93 000 |
| RURAL_Female | Diredawa | 77 000 | 79 000 | 81 000 | 84 000 | 86 000 | 88 000 | 90 000 | 92 000 |

**According to CSA, (2007) report, the number of population in Wahil cluster was 4,789**

**Deforestation**

Deforestation is the clearing or removal of tree from an area woody land or forest of tree an area woody land or forest for many reasons usually commercially. It is one of the major issues in this century since it is one of the many causes of prevailing land degradation. Tree cutting is common occurrence which has taken place for centuries. According to Wahil cluster rural coordination office report(2024), the proportion of land affected by deforestation was 10-15% and also the participants explained that the local community clear the forest land in to agricultural purpose as well as fuel wood consumption due to this the land resource was immediately prawn to flood.

**Query site extraction**

It is one of the main causes for environmental degradation especially land resources. Its harm-full effects on the major roads, power lines, built-ups, and water environment are considered to be frightening. As a result of quarrying, natural habitats and features such as; hedgerows and trees can be removed (Saha & Padhy, 2011). Habitats outside the quarry site can also be impact-ed indirectly by dust deposition, alteration of the water supplies, or as a result of run-off and siltation (Ogbonna etal., 2019).

In most of the African nations, the selection of quarry sites and their operations and management does not take into account environmental sustainability (Darwish et. al., 2011). Generally, the methods followed for resource ex-traction are poor and the site selection for quarrying is not made through systematic methods. This leads to land collapse, land conversion, environmental pollution and may also affect the people residing in the nearby localities (Pal & Mandal, 2017).

Based on our field observation the Wahil cluster is one of the nearest town to dire dawa, due to this reason most of the Dire Dawa city construction materials (stones) used for road and house construction were

Transported from Wahil cluster especially around legeoda Mirga mountainous forest ecosystem. Consecutively, the forest as well as land resource were highly degraded.



**Figure 8: extracted stones near to the forest ecosystem**

**Erratic Rain Fall**

Distribution, frequency, intensity and timing of rain fall energy produced by rain fall are among major factors affecting the land degradation. The severity of the land degradation dependent on those parameters when those factor are with higher degree, then severity of the degradation of land is also higher and the reverse is also true. Gentle rainfall distributed more over through the year cause of less land degradation than heavy rainfall concentrated only few month rain falls evenly distributed over water shed (Bekele, 2003). More frequent rain fall causes more degradation the less frequent one.

Rain of high intensity causes more land degradation than that of less intensity. According to the law state university extension web site during normal rain fall millions of rain drops from one to seven millimeter in

size fill pound the surface and splash soil particles three to five millimeter frequency from where they were before the rain and causes land and soil degradation. According to field observation as well as FGD participant explanation, Legeoda Mirga mountainous forest ecosystem is very suitable to flooding from the upper catchment and also the land as well as forest resources were easily degraded.

### 2.1.3. Impacts of LULC and Land Degradation on Legeoda Mirga mountainous forest ecosystem

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

**Flood**

Floods are often explained as excess flows exceeding the transporting capacity of the river channel, lakes, ponds, reservoirs, system, dam, and the other water bodies, whereby water inundates outside water bodies areas. A flood may be a continuous natural and recurring event in floodplains of rainfall areas like Ethiopia, where over 80% of annual precipitation falls within the four wet months (June, July, August, and September) (Getahun and Gebre,2015). The flooding is often caused by, heavy rain, snowmelt, and land subsidence; rising of groundwater, dam failures. The natural disaster associated with weather system variability, global climate change, and environmental degradation is frequently influencing citizenry and their impacts seem to possess greatly increased in recent decades (Getahun et al, 2016).

Dire Dawa city is identified as one of the most flood-affected cities in Ethiopia. Classifying village-level flood vulnerability using flood indicators is a new approach to Dire Dawa city. Flood is considered as the most recurring, widespread and harmful natural disaster causing devastating effects on the lives of millions of people and their properties, as well as infrastructure and the natural environment (EM-DAT 2015).

According to Daniel k,et.,al,(2007) 100% cultivated, 95.7% open land, 84.5% sand deposit, 83.4% built up area and 74.7% open shrub land faces low to moderate flood hazard. Besides (16%) of the built up area is categorized in to high to very high flood hazard.

**Loss of ecosystem service**

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. 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.

**Reduction of crop yield**

By diminishing soil organic matter and over soil quality soil erosion reduce biomass productivity in ecosystem ultimately this a profound effect on the diversity of plant, animal, microbes and other forms of life present in ecosystem .Plants, animals and microbes as well as other form of life present in the ecosystem are a vital component of the soil as mentioned and constitute a large measure of the soil biomass. Indirect effect of erosion on ecosystem frequently may nearly as damaging as the direct effect of reducing plant productivity. For example; the stability and biodiversity of grass land where significantly reduced when plant species reduction occurred

### 2.1.4. Response

The Climate Smart Integrated Rural Development Project select Wahil cluster to improve climate change, flood hazard as well as to minimize food shortage.

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

### 2.1.5. Outlook

The population of urban population in Dire Dawa city Administration in 2013 was 323,167.if it continuous as the existing situation the number of population the year will be 458,760. Due to this reason their demand for resource use will increased highly. As the population and deforestation rate increases as the existing rate not only Wahil cluster the whole Dire Dawa city administration was totally damaged by flood and also the fertile and productive part of the top soil will totally distracted and also weather condition totally changed into desert. So, the existence of animal and human life will under dangerous condition.

## 2.2. State Forest

### 2.2.1. State and Trend of Forest Fauna and Flora on Legeoda MirgaForest Ecosystem in Dire Dawa City Administration

Ethiopia is ecologically diverse with the chain of highlands, midlands and lowlands that encompass familiar biomes and more than 13 major vegetation types and various ecosystems with diverse flora, fauna and rich belowground and aboveground microbial diversity (NEA: EBI 2022) The topographic settings stretch over a

high altitudinal range between 125 m b.s.l. and 4533 m a.s.l. covering high mountains, flat-topped plateaus, gorges, valley bottoms and aquatic and wetland environments. Rangelands and agricultural landscapes where population centers occur and people engage in animal husbandry, crop cultivation and other livelihood systems are distributed within the wide agro climatic and spatial-temporal settings of the country (well established).

The Ethiopian mountains are among the unique centers of biodiversity, housing diverse endemic fauna and flora inhabiting this most sensitive and fragile ecosystem .Most of the mountains are well-known headwaters to major inland and Trans boundary Rivers, holding great cultural values for connecting people with nature and serving the purposes of recreation and tourism in addition to the usual material goods and services. Biodiversity and healthy ecosystems provide the essential resources and ecosystem services that directly support a range of economic activities, such as agriculture, forestry, fisheries and tourism. All food systems depend on biodiversity and a broad range of ecosystem services that support agricultural productivity, soil fertility, and water quality and supply. Ecosystem services and other non-marketed goods are estimated to make up between 50 and 90% of the total source of livelihoods among poor rural and forest-dwelling households (https://www.cbd.int/development/sdg1/). Healthy ecosystems help to mitigate the spread and impact of pollution by both sequestering and eliminating air, water and soil pollution. Forests, among other benefits, regulate water flow and improve water quality (https://www.cbd.int/development/). Many medicines have been derived from biological products and a substantial proportion of the world's population depends on traditional medicines derived from biodiversity. Ethiopia is one of mega diverse countries in terms of biodiversity. This is due to the presence of different geographical features with varying temperature and precipitation. These topographic features provide habitats for plant and animal species, which had formed assemblages and larger ecosystem hierarchies. Despite this rich endowment, biodiversity is being lost and ecosystem are degraded at an alarming rate due to habitat conversion, unsustainable utilization of biodiversity resources, invasive alien species, replacement of local varieties and breeds, climate change and pollution. Specifically, conversion of natural forests, grazing lands, woodlands, and wetlands to agriculture and settlement are growing, causing severe ecosystems degradation and biodiversity loss in different parts of the country. Consequently, many wild plants and animals including endemic species are at risk of extinction. According to EBI (2014), some 103 trees and shrub species, 31 bird, one reptile, nine amphibian, two fish, and fourteen other invertebrate species are known to be under threat. Farmers' crop varieties and indigenous animal breeds are slowly disappearing. There is more than ten ecosystems found but the major ecosystems include: agricultural eco system, forest ecosystem, mountain ecosystem, aquatic ecosystem and range land ecosystem (EBI: 2004).

Conservation paradigms, practices and policies have been variably successful. Traditional approaches in conservation have evolved awareness about biodiversity conservation. The diversity of life on earth is immense and comes in numerous forms, which is crucial to our continued survival. 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 GDP in the year 2012-13. Recent estimates indicate that about 26-30% of the total coffee production of the country originates from wild and semi-managed coffee forests and the value of wild coffee is estimated at USD 130 million/annum (Tesfaye, 2006; Lemenih, 2009). 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).

Biodiversity, which is significant to humans for a number of reasons, includes a diversity of genes, species, and ecosystems. This includes: sources of food, fiber, wood, medicine, and other essentials; support roles like regulating the climate, preventing flooding, and cycling nutrients; resilience to disturbances and changes in the environment; supply of pollinators and pest control in agriculture; carbon storage and sequestration; and economic, recreational, health-promoting, and social benefits. Ethiopia's landscape consists of a sizable highland region with mountains and isolated plateaus, split by the Rift Valley, which encircles lowlands, steppes, and semi-deserts and stretches from northeast to southwest. Because of the great diversity of the landscape, there are significant differences in the climate, soils, and native plants, which results in a unique biodiversity and high endemism. Between 6,500 and 7,000 species of higher plants are thought to make up Ethiopia's extremely rich flora, of which 15% are inborn to a region. According to some reports, Ethiopia is the fifth-largest country in tropical Africa with flowers.

The nation is rich in its fanatical variety as well. Larger mammals are primarily found at the country's southwest and south borders and in their surrounding regions. The northern mountain massifs are also home to numerous indigenous mammal species, including the Gelada Baboon, Semen Fox, and Walia Ibex. 861 bird species, 201 reptile species (including over 87 snakes, 101 lizards, and 13 species of tortoises and

turtles), 145 freshwater fish species—of which over 87 are from the Baro River and 16 from Lake Abay 324 butterflies, and 63 amphibian species are known to exist in Ethiopia.

The state of the ecosystems, which support all other species as well as ourselves as individuals, are declining at a rate never seen before. Globally, this condition deteriorates livelihoods, food security, health, and quality of life, and presents financial and economic hazards.

The major drivers of forest ecosystem deteriorations are proximate driving factors and basic 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/basic 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 and eradications of draught. The study was conducted in the Dire Dawa Administration Legeida Mirga forest ecosystem. The total forest ecosystem area is estimated to 9,062 ha shrubs and bushes 7,291 ha and the plantation of forests are 1,771 ha of land. And it contains different forest flora and fauna species.

The data was collected from primary sources, including field visits (FGD) surrounding Kebeles, key informants with Keble administrators and development agents (DA) while Secondary data was gathered from published documents, region and Woreda reports, and Landsat images to recognize the impact of forest cover change and deforestation.

## Definition Key terms

- ✓ Mountain ecosystem: this refers to the ecosystem on high mountains that support people who live within the mountain regions. The low land people also depend on mountain environments for a wide range of goods and services, including food, water, energy, timber, and other biodiversity resources as well as opportunities for recreation and spiritual renewal.
- ✓ ***Biodiversity:*** The Convention on Biological Diversity (CBD) defines 'biological diversity' as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems" (CBD, 1992).

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

- ✓ ***Drivers***: Drivers are external factors that affect nature, and, as a consequence, also affect the supply of Nature Contributions to People (NCP). Drivers of change include indirect drivers (all anthropogenic: here Drivers) and direct drivers (both natural and anthropogenic: here Pressures) (IPBES, 2019).
- ✓ Pressures- are human activities that induce changes to the environment, for instance, the discharge of chemical, physical or biological agents, or land use changes. The intensity of the pressures depends on the technology and extent of activities that vary across geographic regions and spatial scales (Bradley & Yee: 2015).
- ✓ State- refers to the physical, chemical, and biological components of the natural environment (i.e. the living and non-living components).
- ✓ Impacts- are the resulting changes in the quality and functioning of the ecosystem that influence living things including the production of ecosystem goods and services.
- ✓ Responses- are actions taken through policies and regulations to prevent, compensate, ameliorate, or adapt to changes in the state of the environment
- ✓ ***Threats:*** Following Salafsky et al. (2008), threats were defined as "the proximate human activities or processes that have caused, are causing, or may cause the destruction, and/or impairment of biodiversity targets (e.g. unsustainable fishing or logging)." Direct threats are the proximate human activities or processes that have impacted, are impacting, or may impact the status of a tax on.

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

  This forest definition differs from the definition used for international reporting to the Global Forest Resources Assessment (FAO) and from the forest definition used in the National Forest Inventory which both applied the FAO (2015) forest definition with the thresholds of 10% canopy cover, a 0.5 ha area,

and a 5 m height. The reason for Ethiopia to change its national forest definition is to better capture dry and lowland-moist vegetation resources. In specific, the reason for lowering the tree height from 5 to 2 m is to capture Termilania-Combretum dense woodlands found in Gambella and Benishangul Gumuz Regional States which in its primary state consists of trees reaching a height of around 2-3 m and above (MEFCC 2016).

**Benefits of forest flora and fauna in mountain ecosystem：** Mountains maintain rich biodiversity along with their ecological and geophysical heterogeneity. They include as many as half of all global biodiversity hotspots and support a great deal of inhabitants as sources of livelihoods (Dax 2002; Spehn et al., 2010). The high species and genetic diversity of mountain ecosystem contributes to human well-being in various ways. They provide humans with food, feed to their livestock, medicinal resources to combat diseases and provide other cultural services (Payne et al., 2017). In many parts of the world, mountains also exhibit well maintained agro biodiversity reflecting a rich history of human-nature interaction. This strong social- ecological interaction might have contributed to resilience of mountains to climate change and other disturbances. Mountains are important sources of vital ecosystem services and have a significant role in economic development, environmental protection, ecological sustainability, and human well-being (de Groot et al., 2002). Ecosystem services are the benefits people obtain from ecosystems (Diaz et al, 2015). They are the direct and indirect contributions of ecosystems to human well-being (TEEB, 2010). These include provisioning, regulating, and cultural services, which directly affect people, and supporting services needed to maintain the other services (MEA, 2005).Changes in these services affect human well-being through impacts on food security, materials required for a good life, health, social and cultural relations. These constituents of well-being are, in turn, influenced by an influence on the freedoms and choices available to people (Diaz et al., 2015). Biodiversity provides many valuable goods and services nature's contributions to people. Forests ecosystems are crucial for food security and sustainable livelihoods, providing ecosystem services like honey, coffee, gums, and timber. They also contribute to the economy through non-marketed products like soil erosion control, wood, climate change mitigation, and recreational services. Forests also serve as shelter for wild animals.

**The following categorization of ecosystem services has been used by the Millennium Ecosystem Assessment** (MEA TEEB 2004).

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 three capitals to produce flood control, storm protection, water regulation, human disease regulation, water purification, air quality maintenance, pollination, pest control, and climate control. For example, storm protection by coastal wetlands requires built infrastructure, people, and communities to be protected. These services are generally not marketed but have clear value to society.

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

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

### 2.2.2. State of Flora and Fauna in Legeoda Mirga Mountain Forest Ecosystem

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

**Table 7: Flora (plant) Species found in the forest ecosystem.**

| R.no | Scientific name | Amharic name | Remark |
|---|---|---|---|
| **1** | High land bamboo | ቀርቀሃ | **Threatened** |

| | | | |
|---|---|---|---|
| **2** | Croton macrostachyus | ብሳና | **Threatened** |
| **3** | Grevillea robusta | ግራቪሊያ | |
| **4** | Croton macrostachyus | ብሳና | |
| **5** | Accacia lbida | ግራር | |
| **6** | Olea European | ወይራ | |
| **7** | Accacia brevispica | ቀንጠፋ | |
| | Ficus sycomorus | ሾላ | |
| 8 | Prunus Africana | ጥቁር እንጨት | Threatened |
| 5 | Mill | ወፍቆሎ | |
| 6 | Carba edulis | ጫት | |
| 7 | Celtis Africana | አምላቃ | |
| 8 | Cordia Africana | ዋንዛ | Threatened |
| 10 | Cyperus digitatus | ፊላ | Grass spss |
| 11 | Diospyros abyssinica | ሰለቸኝ | |
| 13 | Ehretia cymosa | ኡላጋ | |
| 14 | Ficus Vasta | ዋርካ | |
| 15 | Eucalypptus amaldulensis | ቀይባርዛፍ | |

**Table 8: Fruits found in the forest ecosystem**

| No | Secntific name | Amharic name |
|---|---|---|
| 2 | Rhamnus prinoides | ጌሾ |
| 3 | Banana | ሙዝ |
| 4 | Mangifera indica | ማንጎ |
| 5 | Sweet orange | ብረቱካን |
| 6 | Coffee | ቡና |
| 7 | Lemon | ሎሚ |
| 8 | Psidium guava | ዘይቱና |
| 9 | Avocado | አቮካዶ |

Source from Woreda admin

**Table 9:** Faunal species are found in the area.

| No | Scientific name | Amharic name | Remark |
|---|---|---|---|
| 1 | Columbus Monkey | ጉሬዛ | Threatened |
| | Bush pig | ዓሳማ | Threatened |
| 2 | Hayena | ጅብ | |
| 4 | Tiger | ነብር | Threatened |
| 5 | Common Bush buck | ድኩላ | |
| 6 | Klipspringer | ሰስ | |
| | Wild Cats | የዱር ድመት | |
| 7 | Warthog | ከርከሮ | |
| 8 | Bush Duiker | ሚዳቋ | |
| 9 | Jackal | ቀበሮ | |
| 10 | Monkey | ዝንጀሮ | |
| 11 | Mangoose | ሸለሙጥማጥ | |
| 12 | Vervet Monkey | ጦጣ | |

**Table 10: Land use land cover Change of Legeoda Mirgamountain forest ecosystem**

| Class Name | year | | |
|---|---|---|---|
| | 2004_LULC | 2014_LULC | 2024_LULC |
| Road | 3.54 | 5.26 | 8.30 |
| Open Shrub Land | 1406.94 | 780.71 | 1379.10 |
| Streams & Canals | 81.37 | 107.30 | 140.43 |
| Perennial Crop | 116.40 | 54.65 | 375.80 |
| Sparse Forest | 168.78 | 113.38 | 271.78 |
| Open Grass Land | 924.27 | 1116.62 | 479.07 |
| Residential Area | 27.74 | 35.50 | 66.54 |
| Bare Exposed Soil | 72.22 | 173.85 | 181.81 |

| | | | |
|---|---|---|---|
| Annual Cropland | 757.88 | 1171.88 | 656.31 |
| Total | 3559.15 | 3559.15 | 3559.15 |

### 2.2.3. Drivers and Pressures of Forest Flora and Fauna on Legeoda Mirga Mountain Forest Ecosystem.

Drivers are those factors exerting pressure on natural ecosystems resulting in, often negative but also positive, changes in the functions and services of ecosystems. The changes could be triggered by natural and anthropogenic direct and indirect drivers. There could be causal linkages among the direct natural and anthropogenic drivers that aggravate the change process.

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

The Millennium Ecosystem Assessment identified five major drivers of biodiversity loss: pollution, invasive alien species, climate change, overexploitation, and habitat change. These drivers continue to be the main causes of biodiversity loss, with over 80% of vulnerable species threatened by habitat loss, 70% by overexploitation, and 30% by invading alien species. The analysis reveals that pollution affects 10% of threatened species and climate change less than 20%, despite these factors being relatively new. Direct and indirect driving Deforestation and forest degradation are caused by factors such as increased agricultural activities (tree removal and burning, overgrazing), fuel wood and charcoal, and resettlement expansion programs (Walle et al. 2011; Oljirra 2019).

Deforestation in Ethiopia is primarily caused by agricultural practices, logging, and urban resettlement. Factors like invading species, insect pests, new settlements, overuse of resources, and logging pose significant challenges to the country's forest fauna and flora ecology. The degradation of Ethiopia's forests is largely caused by the need for wood fuels. Even though the contribution of firewood to forest degradation is debatable, charcoal is the most popular energy source for cooking in cities, and it is commonly acknowledged that livestock grazing on forest flora and animals also contributes to forest degradation (Zerga & Gebeyehu 2016).




**Figure 9: Legeoda Mirga Mountain Ecosystem**

Source – filed photo 2024

**The main drivers and pressures of Legeoda MirgaMountain forest ecosystems**

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

### *2.2.3.1. Climate change*

Climate change alters the natural ecological process in the mountain forest ecosystem due to changes in the spatial and temporal pattern of temperature and precipitation gradients. The Ethiopian Academy of Sciences (2015) reported that human-induced climate change is a cause of the deterioration of biodiversity resources in mountain ecosystems due to temperature rise, droughts, natural fires, soil erosion, and invasive species.

Since forest Deforestation and degradation in the area are higher in vegetation and soils implies great losses in valuable genetic materials. There is the variability of rainfall and weather conditions. The impact of temperature regime change can likely cause migration of species (flora and fauna) towards the cold and dry plateau belt. These affect the structure and have an impact on the provisioning, regulating, cultural, and aesthetic values of the ecosystem.

#### *2.2.3.2. Drought*

Over the years, the frequency of these climate incidents has increased and resulted in high temperatures and moisture stress during dry years and or seasons. Although high mountain climates are cold and dry. There were animal and human diseases and also pest outbreaks.

Diseases and pests are often caused by changes in the climate pattern and human encroachment of wildlife habitats, agricultural intensification, and urbanization. Plant species are attacked by root rot bacteria, leaf rust fungus, and parasitic pests such as leaf scales, stem borers, and weevils. Human encroachment is also a cause of various types of zoonotic diseases in wildlife. Commonly known domestic animal diseases such as rabies, trypanosomiasis, and anthrax have been known to be transmitted from domestic animals to wildlife due to anthropogenic factors, with serious impact on wildlife populations.

#### *2.2.3.3. Agricultural expansion and wood extraction*

The economic growth in the agricultural sector, on the other hand, is partly attributed to yield increment and partly to the expansion of agricultural land (EBI, 2014a). Agriculture is recognized as the most important direct driver of ecosystem change (Mezgebu and Workineh, 2017). Agricultural land expansion, demand for fuel wood and construction materials as well as overgrazing have contributed to ecosystem degradation in Ethiopia (FAO, 2010).

In the Logide Mriga mountain ecosystem range, there is extensive agricultural activity up to the highest sloping area. These results of intensive cultivation are accelerating deforestation, soil erosion, and land degradation of the fragile ecosystems in the mountains. The LULC indicated that from 2004 to 2014 G.C. annual Cropland increased from 757.88 ha to 1171.88 ha while Perennial Crop 2014 to 2024 increased from 54.65 ha to 375.80 ha. But shrub land and sparse Forest land from 2004 to 2014 G.C declined by 55%, and 67.17% respectively. Overgrazing by livestock and unsustainable fuel wood and timber extraction are also major problems in the mountain forest ecosystem.

#### *3.2.2 4 Overgrazing*

In the Ethiopian highlands, overgrazing is one of the major drivers of land degradation and accounts for 20% of the country‘s annual soil erosion (Aregu et al., 2015), and vital flora and faunal species are disappearing from pastures mainly because of open-access grazing. Due to livestock grazing and browsing, palatable species are gradually replaced by non-palatable species. There are Excessive free and overgrazing,

browsing, unmanageable cut-carry schemes of grass use, and trampling pressure on the legida meriga mountain forest ecosystem. human settlement, agricultural expansion, pastoralist movement, illegal cutting of trees, human-wildlife conflict, habitat fragmentation, scarcity of water, migration of wild animals, and illegal hunting of wildlife as threats to biodiversity and the ecosystem.

#### *3.2.2.5 Population pressure*

Population growth is the most important human factor driving ecosystem change in Ethiopia as it generally is the case in developing countries (Hurni, 1993; Mortimore, 1993). The highlands were inhabited by humans in the earlier times and hence, ecosystem changes are more severe in the highlands than in the lowlands (Eshetu and Hogberg, 2000). 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). Human overpopulation is a major driver of biodiversity loss and a key obstacle to fairly sharing habitat and essential resources with other species (Crist, 2019). Population growth is a major cause of forest decline, as it leads to increased deforestation and demand for land for agriculture and fuel wood. This growth affects the forest ecosystem reducing land productivity, gully formation, loss of groundwater, draughts, variability of rainfall, community conflicts, and rapid urbanization. Population pressure has pushed farmers onto steeper slopes in the Legeoda Mirga mountain forest ecosystem which can only give yields for a few years before the soil is washed away. In such inhospitable environments, farmers could hardly produce crops with the same amount and rate. It leads to a decrease in forest flora and fauna. This is because of high population pressure and repeated cultivation without fallow. Legeoda Mirga mountain ecosystem is under increasing threat from a growing human population, and rapid illegal and unrestricted settlement. The demographic trend shows an increase year to year from the last 24 years population trend indicated in 2000 both male and female populations 29,785 know2024 reached 54,108 increased by 55.04% and 2.5% per year as a result of driver new perennial crop areas increased from116.4 ha to 357.8ha by 259.8 ha and residential areas from 27.74 ha to 66.54 ha by 38.8 has Many FGD and key informant respondents indicated population growth as the main factor of change in Legeoda Mirga mountain ecosystems.

***3.2.2.6 Land tenure system and weak land use policy*:** land privatization is a topic of considerable disagreement in Ethiopia. The government owns all forest and agricultural land, granting usufruct rights to citizens in the case of farmland and maintaining all management authority in the case of forestlands (Guillozet et al. 2011). Uncertain land tenure systems leading to low investment, including lack of ownership, trigger illegal logging, and the so-called tragedy of the commons (Assefa & Bork 2014). Likewise, weak policy implementation on land use, low capacity of forest institutions, land use conflict, and policy discrepancies aggravate forest cover loss in Ethiopia (Moges et al. 2010). There is no responsibility

among local populations for common forest resources and the mountain ecosystem leads to unenforced laws and regulations. There is no clear ownership over mountain resources has caused irreversible changes in forest flora and fauna mountain ecosystems.

Invasive alien species (IAPS): Expansion of alien plant species, namely Prosopis juliflora, Lantana camera, and Parthenium spp. it resulted from the displacement of native vegetation and fauna, affecting rangeland quality and human livelihoods. Are rapidly reproducing, out-competent native species, and are major drivers of forest biodiversity loss, altering ecosystem services and socio-economic conditions through various mechanisms. They reproduce rapidly, out-compete native species for food, water, and space, and are one of the main causes of global biodiversity loss.

***3.2.2.7 Urbanization***: The majority of Ethiopia's unprotected and protected forest ecosystems are seeing an increase in urbanization. Through habitat degradation, fragmentation, obstruction of migration corridors, and disturbance, it directly impacts wildlife (IBC, 2005; Tessema et al, 2019). Regarding the legidea Mirga mountain ecology, the rate at which rural settlement is replacing forest areas with cleared land is frighteningly high. Furthermore, regular interaction between people (and the cattle they own) and animals is facilitated by human presence in and around protected areas. This subsequently impacted the ability of numerous kinds of wild animals to reproduce and survive, disrupted the rate at which flora regenerates, and increased the susceptibility of these creatures to extinction.

***3.2.2.8 Household fuel energy demand***: the FGD participants explained that the forest ecosystem is one of the energy sources for rural as well as urban communities. Logging/Tree Cutting: is a major threat to biodiversity where people practice it for charcoal making, timber production, and household fuel wood consumption and also for income generated or as a source of income.

### 2.2.4. Impact of the Degradation of forest fauna and flora in Legeoda Mirgaforest ecosystems

After analyzing both the primary data and secondary data the following findings Impacts were observed

1. Habitat destruction and fragmentation

In mountain ecosystems, most flora and fauna species are degraded due to deforestation, agricultural expansion, overgrazing, population growth, and invasive alien species. These pose significant threats to local species extinction, shortage of groundwater, soil erosion, shortage of animal forge, variability of rainfall, outbreak of draught, and economic impact on local communities.

Wild animals like lions, tigers warthogs, and the forest flora Podocarpus falcatus, Cordia africana, and Juniperus procera, high land bamboo are highly threatened in the area.

2. Climate change: as a result of deforestation and land degradation forest clearance is high on the site leading to rainfall variability, shortage of rainfall, reduced productivity, draught, occurrence of animal diseases, malaria, and soon .generally as result of loss of habitat forest flora and fauna is threatened.

3. over exploitation: also known as overharvesting, renewable resources for household consumption, income generation, timber, and construction, charcoal, and fuel wood purposes resulting from the coverage of forest ecosystem is decreased to the point of diminishing return flora and fauna species, threatening /declining the mountain ecosystem.

4. Direct loss in the form of the removal of trees: due to the pressures and drivers of activities' approximately 626.23 ha or 55.48% ha of trees and shrubs removed from 2004 G.C to 2014 G.C, 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.
- Loss of such large numbers of trees shrubs and bushes may affect the ecosystem severely in the form of a change in the microhabitat.
- Loss of diversity in agroecosystems increases their vulnerability and thus reduces the sustainability of many production systems.

5. Expansion of Invasive Alien Species: the rapid expansion of invasive alien species in the mountain ecosystem like Prosopis juliflora, Lantana camera, and Parthenium and Steragia spp. results loss of Indigenous plant and animal species: Currently plants such as highland bamboo, cordial Africana, croton, and Zegba, whereas animals like Leopard, keye kebero, dekula, wild pig, kerekero, and lion are also extinct from the mountain ecosystem.

6. The variability in amount and distribution of rainfall: with the impact of deforestation and change in forest ecosystem services. FGD participants perceive that the distribution of rainfall decreased from year to year. Due to this problem, the growing season was changed and correspondingly the temperature was raised highly. Increased vulnerability to natural and anthropogenic disasters: Healthy, diverse ecosystems can help protect human communities from natural disasters, such as floods, storms, and landslides. Biodiversity loss can reduce the ability of ecosystems to buffer these events, increasing the vulnerability of human settlements to natural disasters and the influence of human beings on the degradation of natural resources and inappropriate farming practices over stocking, over-cultivation, cultivation of steep slope area and deforestation is easily observed in the area. More fertile and productive land found at the foot of the mountain is covered by sand from the steep slope area of the mountain ecosystem. As the area of suitable agricultural land is limited, people have started to cultivate on steep slopes and hilltops with resulting negative impacts on the environment in-adequate agricultural production techniques have particularly led to an increase in soil erosion, surface run-off, and loss in soil fertility and no groundwater recharge. All mismanagement of the resources available in the mountain ecosystem which includes

inappropriate cultivation methods, deforestation, overgrazing increased surface concentration, and run-off creates new gullies or enlarges old ones. Different soil and water conservation were constructed previously to reduce soil erosion but due to lack of maintenance and ownership, most of the structures were destroyed by animal or human movement. The effects of livestock grazing on ecosystems include grass cover degradation; soil compaction; bush invasion; prevention of tree regeneration in the forest; and changes in natural ecological succession, such as the replacement of forests by grass.



**Figure 10: Partial View of Legeoda Mirga Mountainous forest Ecosystem**

**Source- filed photo 2024**




**Figure 11** over degradation ecosystem in Legeoda Mirga mountainous Forest Ecosystem

Source- from filed photo 2024




**Figure 12 Acacia and shrubs plants In the Legeoda Mirga mountions Forest Ecosystem**



Figure 13 Focus Group Discussion with the community

Source photo 2024 ecosystem afforestation

### 2.2.5. The response is taken to improve the status of Legeoda Mirga mountain forest ecosystem.

Therefore, if the state has to conserve and develop natural resources in study areas to improve their production and productivity, the development of the mountain ecosystem for resource conservation and flood control is inevitable. So the following practice should be implemented monitored and evaluated based on the standards.

- Fencing the mountain ecosystem or protection is usually required when livestock are present. Fencing can be used to protect other sensitive ecological resources. Area closure/protection is the best option for the rehabilitation of bare land to protect the steep slope from further erosion and conserve the natural forest from further encroachment.
- Development should be human-centered, at the local level the ideas for the plan should come from the people of the people, by the people, and for the people that increase the participation of different stakeholders (farmers, GO, and NGO) especially farmers who believed to live with the result (positive or negative).
- Awareness Generation: for the reason that for human capital to function effectively, both knowledge and technical skills are prerequisites. Therefore, it is recommended that residents and other stakeholders be given access to information about the various plant and animal species found in the ecosystem, their significance to human society, the environment, and the economy, as well as the ecological processes necessary for maintaining ecological balance at the site, threats to their survival, and appropriate packages of practices for biodiversity conservation
- 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 the ecosystem.
- Providing appropriate legal and institutional mechanisms.
- Biodiversity mainstreaming -involves integrating biodiversity considerations into policies, strategies, and practices of public and private actors, ensuring its persistence across entire landscapes and also livelihood improvements.
- Providing ecosystem-based adaptation includes the sustainable management/watershed management-based approach, conservation, protection, and restoration of ecosystems to provide services that help people adapt to the adverse effects of climate change.
- Expanding electric power generation from renewable sources of energy to reduce the reliance of people on forest resources.

- Reducing deforestation and forest degradation from smallholder agricultural expansion via the introduction of agricultural intensification assisted by improved technologies and irrigation systems by subsidizing critical inputs for poor farmers should be considered.
- Ensure that forest-dependent communities, women, and the poor are particularly supported in forest entitlement, and participate in decision-making.
- Adoption of CRGE and GIL strategy prioritizing forestry as one of the pillars of building a green economy.
- Communities, governmental and non-governmental organizations, farmers, and private sectors must take an inclusive responsibility.



Figure 14: **Nursery site**

**source- from filed 2024**

### 2.2.6.Outlook

Scenario 1 business is usually

According to the data obtained from LULCC 2024, primary and secondary data from 2004 to 2024 indicate an increment of Perennial Crops, annual Cropland, open grassland area, and residential area by 30.9 %, 64.72%, 82.77 % respectively while shrubs and open grasslands decreased by 55.48%and 51.83%. This will in turn contribute to livelihood and food insecurity among people living in the mountain ecosystem.

Therefore, the current management and use of the ecosystem, i.e. population increase, deforestation, ecosystem degradation, and urban expansion; if this continues, the ecosystem will be destroyed in the next 10 years.

There for all concerned stakeholders and actors should be**:**

- Strengthening Green Legacy Initiative:

The „green legacy" initiative contributed to the planting of billions of trees across the country and is growing to an annual activity.

- They have to work with integration
- Continuation of the integrated soil water conservation activities
- Maintaining the sustainability of what has been done
- Using police and strategy option
- Public awareness of ecosystem services

## 2.3. Deterioration of Water Bodies around Legeoda Mirga Mountainous Forest Ecosystem in Wahil Cluster, Dire Dawa Administration

### INTRODUCTION

Water is one of the natural resources, which are found in an adequate amount vital for life, development and the environment. It is an essential source for the existence of life on the planet earth. It is widely used for various purposes such as drinking, washing, bathing, cleaning, cooking, irrigation, and other industrial and domestic uses. There are various sources of water. About 97% of the water on the Earth's surface is covered with water. The three main sources of water are: Rainwater, Ground water – This includes water bodies like Wells and springs. Surface water – This includes different water bodies like Reservoirs, Rivers, Streams, Ponds, Lakes and Tanks.We all need water for different daily activities including: I). Domestic Purposes include bathing, cleaning, cooking, drinking, and washing. III). Agricultural applications include irrigation, farming, gardening, and frost control.,III).Other Industrial Applications

Access to safe water and sanitation to meet human and livestock needs is a prerequisite for sustainable development. However, when inadequate in quantity and quality, it can rather serve as a limiting factor in poverty reduction and overall national development, resulting in poor health and low productivity, food insecurity and constrained economic development. It is therefore imperative that the linkages between water development initiatives in the agriculture, food, energy, health, education and decentralized governance sectors be clearly understood and carefully managed to benefit from the inherent synergies and to minimize or avoid negative cross-sectorial impacts.

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

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

This study focus on water resource of Dire Dawa City Administration found Legeoda Mirga Mountainous forest ecosystem. The water supply of Dire Dawa City is from groundwater (including boreholes, dug wells, and springs). Recently, groundwater cause corrosion and scale problems to water distribution systems due to its content of dissolved ions that can cause public health and economic issues.

### 2.3.1. State and Trends of fresh Water resource around Legeoda Mirga Mountainous Forest Ecosystem

Ethiopia has abundant water resources and contains the headwaters of numerous trans boundary rivers, including the Nile. Key water stress metrics suggest Ethiopia is water stressed. Total annual renewable water resources per person are 1,162 m3, which is below the Falken mark Water Stress Index threshold for water stress and just above the water scarcity threshold. The ratio of water withdrawals to supply is 32 percent, which exceeds the SDG i.e. threshold for water stress. Water stress is most evident at the sub- national level and seasonally in some locations. There are also eleven major lakes with a total area of 750,000 ha. The biggest is Lake Tana found in the Northwestern part of the country while the rest of the lakes are found in the Rift Valley. Although Ethiopia's water resource is large, very little of it has been developed for agriculture, hydropower, industry, water supply and other purposes. To date only about 160, 000 ha (about 4%) of the potential irrigable land has been developed. National coverage of potable water supply stood at 26% by 1992 while coverage of sanitation services is only 7%, which is low by even the Sub-Saharan standards (MoWR, 2001).

The country can only be a water tower in terms of receiving ample water and donating it to neighboring countries but not in terms of ample water resources that is readily available for use**.** This is because, most of the major rivers have created deep gorge in the country and the water they contain passes to neighboring countries, thus constraining development and utilization of the water resources in the country. In addition, 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.

Water is an essential life-supporting medium for fish and other aquatic organisms. It essentially provides all fish needs, such as food, oxygen, and other helpful environments for breathing, feeding, reproduction, and growth of fishes The water quality parameters such as water temperature, turbidity, watercolor, dissolved oxygen, BOD, $CO_2$, pH, alkalinity, .hardness, calcium, ammonia, nitrite, nitrate, phosphorus, $H_2S$, primary productivity, and plankton are essential factors to be considered when planning for high fish production.

Ethiopia gets more than 80% of the drinking water supply from groundwater (Seifu et al., 2018). In the case of Dire Dawa, which is arid part of the country, there are no perennial rivers and streams. For the last 12 years, almost 100% of the water for the urban and rural population of Dire Dawa Administrative Council (DDAC) gets its water supply for domestic, industrial, and irrigation purposes exploited from boreholes, dug wells, and springs. Besides, the increasing water demands, there are other related issues from the source point to the distribution system from public health and economic aspects. Naturally, water contains dissolved hardness-causing ions, iron, sodium, potassium chloride, sulphate, bicarbonate which cause corrosion and scale problems to the water distribution systems. Corrosion and scale add to the cost of water selling price because of high pump operation costs; replacement of failing pumps, pipes, and fittings; short life of water heaters, boilers, and cookers in-house and industries. Corrosion may cause the leaching of contaminants such as lead and copper into the water distribution network that would have hazardous concerns for community health (Mahmoud et al., 2012). It also rises customer complaints and loss of public trust due to water quality, low water pressure there are a public drinking water distribution system and several private bottled water companies in Dire Dawa City which are facing problems related to corrosion and scale forming. According to the technical report (Antonaropoulos and Associates, 2017 unpubl. Data) on the incrustation problems of the city water distribution system stated an average of 2000 m long pipes damage each year. In the 2014-15 year annual reports of the city Water Supply and Sanitation Authority (DDWSSA), it was also presented that the pipe loss estimated 1% of the total distribution network length. The actual production capacity of the existing water sources is estimated at 415 l/s, which corresponds to approximately 70% of their design yield (DDWSSA, 2015 unpubl. data).

Water pollution is an immense set of unwanted effects upon water bodies such as lakes, rivers, oceans and groundwater that caused by human activities. This matter requires urgent attention, since water is scarce. This important resource needs detailed scientific research all over the world in order to sustain and keep the

water resource from pollution and for its wise utilization. However, no water in nature is absolutely clean. Even as it rains, the precipitation is interact with solid dissolved salts and aerosols in the air prior to reaching the ground, running on the surface and finally percolating through the ground.
At present, almost 100% of the water supply for the urban and rural population of Dire Dawa administrative council gets its water supply for domestic, industrial, and irrigation purposes from boreholes, dug wells, and springs.

Legeoda Mirga mountainous forest ecosystem is one of the degraded forest ecosystem in Wahil Cluster. The native residents around forest ecosystem states that Legeoda Mirga mountainous forest ecosystem was degraded from year to year in highly rate due to these reason there was shortage of water in the local area. The FGD participants that exist in the surrounding area of those forest ecosystem explained that most of the water sources was spring. The participants also explained that three water pumps and also bore holes provide benefit to the surrounding community of the forest ecosystem. Based on the GIS analysis the stream order map of Legeoda Mirga mountain forest ecosystem is explained in the figure below. A watershed is the area of land from which runoff (from rain, snow, and springs) drains to a stream, river, lake, or other body of water. The watershed is made up of networks of tributaries, each of which flows into a larger stream. They are identified by stream order, determined by the order of other tributaries that have contributed to their flow. First-order streams are those which have no tributaries, second-order streams are those which receive as tributaries only streams of the first order etc. However, the main stream is denoted by the same order number all the way to its headwaters, and hence one of the first-order streams (normally either the longest or the one which seems the most direct upstream continuation of the main stream) has to be renumbered as second order. In the study area below the delineated watershed contained many stream orders, in the legend number one explained first order, legend number two explained second order/largest river and also the main river is mentioned in legend number three. As shown in the field the upper catchment of the study area was developed through different conservation practices but the lower catchment of the watershed was not developed through conservation practice. So it will better to develop both the upper and the lower catchment equality to conserve the watershed suitably.

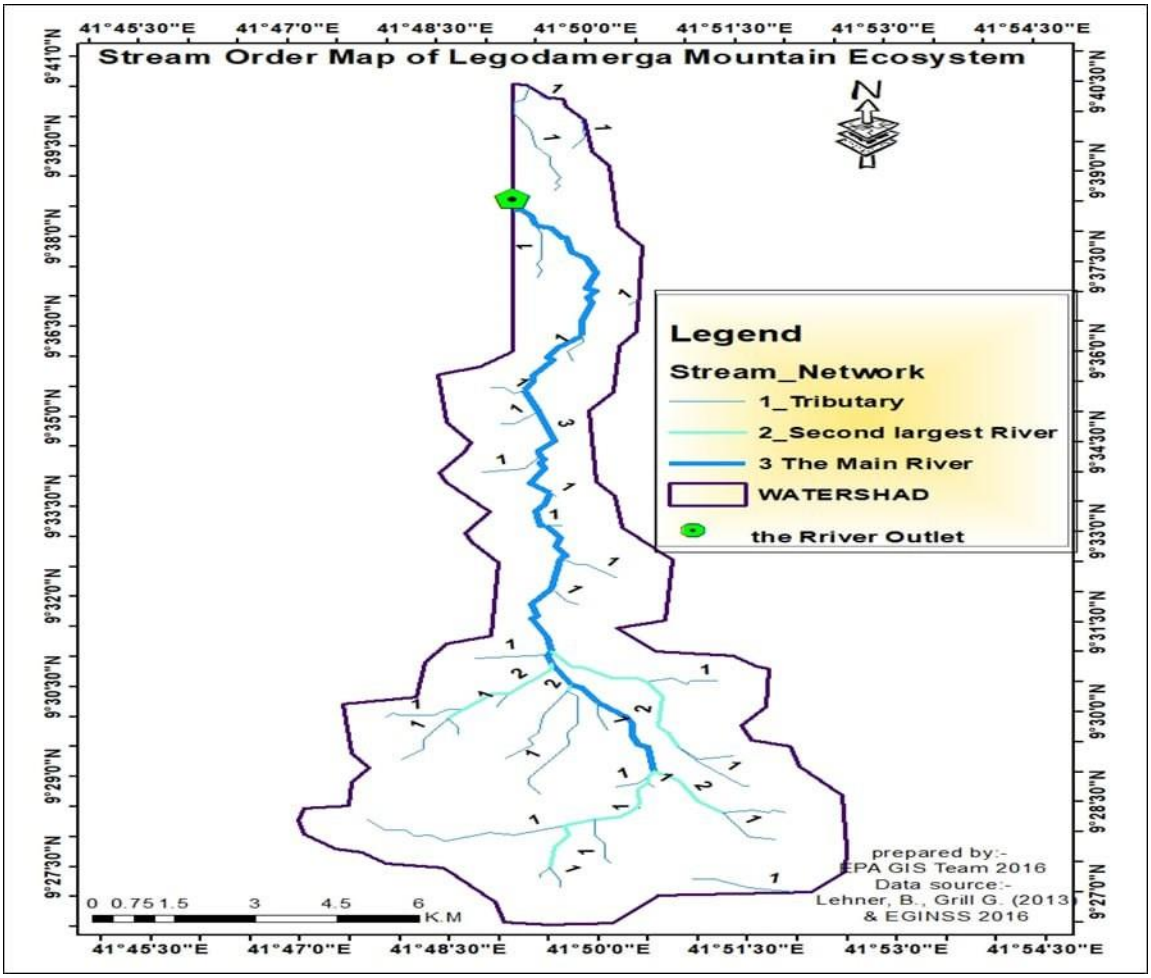



**Figure 15: Stream Network in Legeoda Mirgamountainous forest Ecosystem (Source: EPA GIS Team, 2024)**

**Water Supply and Coverage around Legeoda Mirga Mountainous Forest Ecosystem**

Safe domestic water supply is an essential component of primary health care and plays a vital role in poverty alleviation. Inadequate water supply and sanitation services impact upon the lives of billions of poor people in the developing world (World Bank, 2004). Two in every ten persons lack access to safe water supply, five have inadequate sanitation, and nine do not have their wastewater treated. Yet, these estimates are believed to underestimate the extent of the drinking water supply problem. In many countries where water supply systems have been installed, the quality of the services provided is poor. Many consumers who are connected face unreliable water supply and when available, it is often not safe to drink (World Bank, 2004). Unprotected water supply sources are one of the most important problems related to water supply quality. Consequently, a majority of the Ethiopians use unsafe and polluted water and are, as a result, exposed to a large variety of water-borne diseases. This is especially the case for the rapidly growing urban population. Besides limited protection of water supply sources, financial constraints also play an important

role in the current state of water supply in Ethiopia. Investment and operation costs of domestic water supply facilities are only partly covered by the consumers (15%). The central government contributes more or less the same as the consumers, but the majority of the costs (70%) are funded by financial sources from outside Ethiopia, primarily through international aid (Teshome, 2007). There exists a huge gap between the finance required to maintain and operate the existing water supply system.

Dire Dawa city entirely depends on groundwater resources for its supply. Remote-sensing analysis revealed significant and rapid urban expansion of the city. Current water supply sources of the city do not meet the future water demand. Hydraulic performance of the existing water distribution system is insufficient**.** Apart from periodical floods, there is a low supply of water in Dire Dawa. According to the Water Supply and Sewerage Authority, the current supply coverage is only 56 percent (UN HABITAT, 2008).

According to Dire Dawa Agriculture, Water Mines and Energy Bureau, 2020 the main water sources of the city and its rural area are well and spring water, on the other hand the quantity, development capacity and number of beneficiaries are mentioned in the table below.

**Table 11: Distribution of water point in rural area (functional) 2019/2020**

| Water source | Quantity | Development Capacity | Used for Irrigation Development | Development land in ha | Number of Beneficiaries |
|---|---|---|---|---|---|
| Well | 2 | 45 | 15 | 25 | 115 |
| Spring | 7 | 142 | 142 | 145 | 1453 |
| Total | 9 | 187 | 187 | 170 | 1568 |

As there is no perennial river, the whole drainage system in the DDA is intermittent streams (i.e. carrying water only after heavy rain events). They are thus, dry wadis with sand beds. These wadis are highly erosive in nature at the southern and south eastern escarpments of the region. The main rivers of the Administration are Kelaad, Dechatu, LegeOda and Kalcha and their catchment areas are stated in the table below. Within the respective river catchments, there are smaller rivers and streams which are draining towards them. It is to be noted that all the above rivers and their tributaries are draining towards the Awash River and are sub- basins (DDSA Regional state and outlook of the Environment, 2022). The surface runoff potential in the Administration has been estimated for the entire watersheds as well as for project sites by (Dire Dawa Integrated Natural Resource Master Plan Study, 2005). Accordingly, the total surface water potential of all the watersheds is estimated as 211.2 $Mm^3$ per annum. It is important to note that in some of the watersheds, particularly those on the Eastern part of the Administration; most of the runoff comes from parts of the

watersheds, which lie outside the boundary of the Administration in the South. The existing annual recharging is estimated to be about 38.8$Mm^3$/ year (1233 Lt/sec).

The Administration is also endowed with groundwater resources abstracted mainly from upper sandstone and Hamanelei limestone aquifers that act as reservoir of the groundwater of the Administration (major aquifer) and it is essential for the urban supply of Dire Dawa (Sabiyan field) and Harare (Haseliso field). The current utilization of this resource is by far less than the estimated annual recharge. The abstractions from all type of water schemes (deep and shallow boreholes including dug well, springs) are 18.85 $Mm^3$/year (597.8 l/sec) while existing annual recharge estimated is 38.8 $Mm^3$/year (1233 l/sec). However, the aquifers have problems of over exploitation and pollution (DDSA Regional state and outlook of the Environment, 2022).

The FGD and key informant interview explained that the decline in the coverage of water in around Legeoda Mirga mountainous forest ecosystem prawn to water shortage in the recent time and also females' travel long distance to fetch water.

### 2.3.2. Driver and Pressures of Deterioration of Water Bodies in Legeoda Mirga Mountainous Forest Ecosystem in Wahil Cluster

#### *2.3.2.1. Population Growth*

The city of Dire Dawa, Ethiopia is experiencing rapid urbanization, making it the second largest city in the country (Feyissa, 2018). One of the reasons for this growth is the rural to urban migration, which accounts for 30% of the city's population. As population increases in an area, groundwater consumption increases due to over-abstraction and this must be properly managed for sustainable water supply (Foster, 2022). An increase in population also leads to an increase in the consumption of other resources, which in turn affects the economic development of a country. Groundwater can be considered as an urban self-supply system when it is appropriately managed and supported by strong policy (Foster, 2022). In response to population growth and accelerated urbanization, developing cities are becoming increasingly dependent on groundwater for their water supply needs.

However, the existing water supply system in Dire Dawa is struggling to keep up with the increased demand. The water quality and quantity are inadequate and there are frequent cases of over-exploitation and degradation of groundwater resources. The unbalanced supply and demand, caused by a growing population and infrastructure development, is further exacerbating the issue. The challenge of ensuring a stable water supply in the face of urbanization is made even more difficult by insufficient resources and inadequate city

design. Failure to act on this issue can lead to water supply crisis, water pollution and loss of water supply accessibility (Foster et al., 2022).

#### 2.3.2.2. Urban Expanisition

Urbanization in Ethiopia is increasing rapidly, leading to environmental changes and necessitating improved urban infrastructure. Dire Dawa, the second most populous city in Ethiopia, has a high rate of urban growth. The current and future water demand and supply analysis found that the water supply is three times less than the water demand, indicating that existing water sources are not adequate for the future expansion of the city (Seble A, *et al* 2023). Overall, the study conducted by Seble A, *et al* (2023). showed that high urbanization rate together with the population growth has put pressure on the existing water supply source and existing water distribution system calling for feasible water management strategy for the city.

3.3.4.3 Industrial Expansion:

Dire Dawa has remained the main fast growing city in Eastern Ethiopia. Its fast growth rate as an industrial and commercial center, lack of proper sewers and other waste disposal facilities, presence of about 20,000 open pit latrines, favorable geological, morphological, climatological and conditions have facilitated pollution of the hydrologic system. In this city there has been shortage of water and population increases at a higher rate.

### 2.3.3.Impacts of Water Resource Deterioration on the local Community

Deterioration of water bodies are many impacts on the local community as well as the country as a whole. According to the FGD and Key informant interview declining of water bodies' cause varies impacts on their living environment.

#### *2.3.3.1. Pollution*

Dire Dawa has remained the main fast growing city in Eastern Ethiopia. Its fast growth rate as an industrial and commercial center, lack of proper sewers and other waste disposal facilities, presence of about 20,000 open pit latrines, favorable geological, morphological, climatological and conditions have facilitated pollution of the hydro geologic system. In this city there has been shortage of water and population increases at higher rate. Sewage related pollution already has manifested itself in drinking and food processing water and with increasing volumes of water use and pollutant disposal, it is likely to occur at increasing amounts in the future.

#### *2.3.3.2.Exapanistion of Water born disease*

From records found from the Out Patient Department of Dire Dawa Hospital, 10 out of 15 most common diseases are directly or indirectly related to water. Among the top 15 diseases, duodenitis and gastritis and kidney infection ranks 4th and 13th respectively. The presence of the methemoglobinemia or blue baby

disease, a killer disease caused by drinking water with high nitrate concentration and that affects infants, case is unknown. The health workers are unaware of water pollution in the city. In fact the public water source is safe for domestic consumption, but still people might use sources outside the public water supply. The source of contamination of the hydro geologic system is two types. The first and dangerous one is the point source contamination, which is caused by more than 20,000 unprotected pit latrines found in the city. These latrines carry the human excreta to the hydro geologic system through the loose formation. The second source of contamination is the line source contamination caused by the discharge of enormous amount industrial and domestic waste water into the sandy stream channels. This effluent percolate within few hundreds of meters distance from their sources.

#### *2.3.3.3. Flood*

According to OCHA report in 2006 flood has inflicted severe direct and indirect damages on social; infrastructure and economic sectors of Dire Dawa. It caused the death of 256 people, 244 missing and 15,000 people displaced from their dwellings. Number of fatalities was large because floods hit the city in the middle of the night while people were in deep sleep and absence of early warning system that alerts the residents before the flood hit the city. The total fatalities, the proportions of women fatalities were 134 as compared to 83 men fatalities; and the remaining 39 fatalities were children.

### 2.3.4.Response

In order to reduce excessive flood soil and water conservation activities was done by the local community as well as land closer activities was done by land of Dire Dawa city environment office experts like Mr.Hussain.

### 2.3.5.Outlook

Degree of pollution is directly related with population density and groundwater flow direction. While the most precious natural resource, water, is polluted in such a way no state measure is taken to protect the hydrogeologic environment. The 2006 flood impact on the socio-economic sector of Dire Dawa was worst that the extent of its impact is incomparable with other flood disasters occurred in the flooding history of Dire Dawa city. Total direct and indirect impacts of flood disaster in all sectors are about 15 million USD.

The increasing intensity of rainfall accompanied by forest resource degradation particularly in the upland areas of the catchment has potentially caused floods in the Dire Dawa city. Unless the government of Ethiopia, private sectors and other concerned bodies will take any action to reduce water shortage as well as flood hazard both human and natural resources in the city administration will devastated within a few years later

## 2.4.Baseline State and Trends of Climate for Dire Dawa City (1960-1990)

**Baseline Climate**

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

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

***Temperature variability and trend***

In Ethiopia year-to-year variation of annual maximum and minimum temperatures expressed in terms of normalized temperature anomalies averaged over 40 stations the country has experienced both warm and cool years over the last 50 years. Years like

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

It has also revealed that there has been a warming trend in temperature over the past 50 years. The average annual minimum temperature over the country has been increasing by about $0.25^0$C every ten years while average annual maximum temperature has been increasing by about $0.1^0$C 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***. (NMA, 2007)

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 10ºcover the central high lands to more than 35º.c over Northeastern and Southeastern low lands

The figure below clearly reveals that there has been a warming trend in the annual maximum temperature over the past 30 years. It has been increasing by about $0.67\ ^0$ C every ten years. On the other hand, the trend of the minimum temperature in past 30 year has been gradually dropping by $0.01\ ^0$ C per decade. Annual maximum temperatures over the last 30 years (between 1980 and 2008) show upward trend

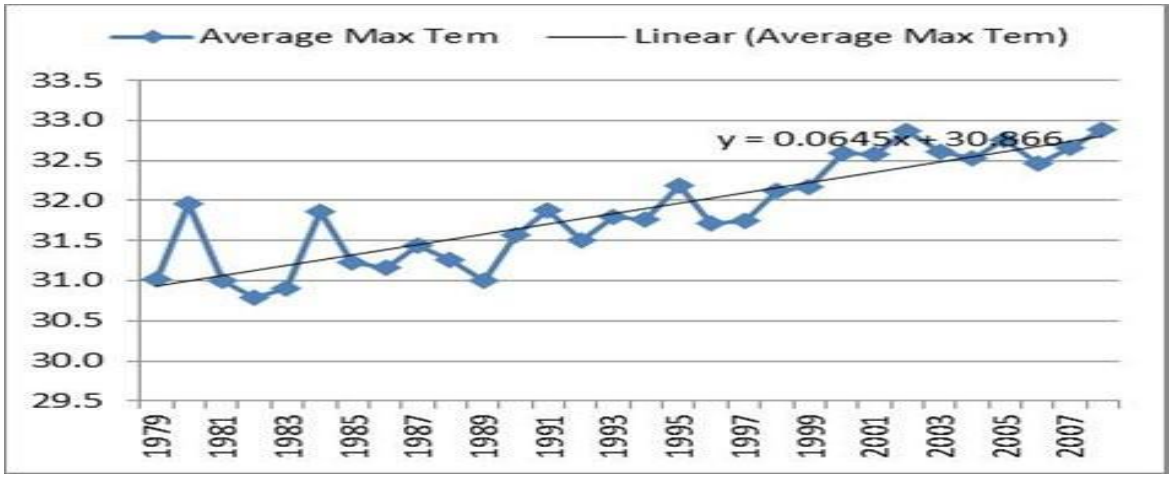



**Figure 16: Annual Maximum Temperature Trend of Dire Dawa ( from 1980-2008)**

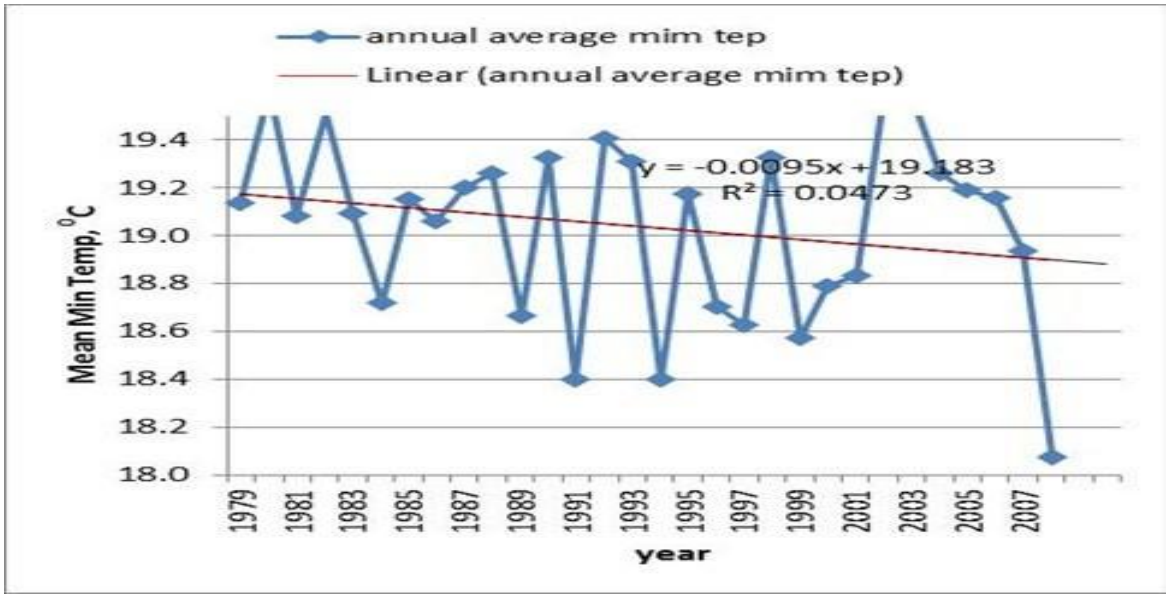



Figure 16:- Minimum Temperature Trend of Dire Dawa (Period: 1980-2008)

***Rainfall variability and trend**:*

At country level mean annual rainfall shows large spatial and temporal variation. It is characterized by large spatial variation and ranges from about 2000 mm over some pocket areas in Southwest to about less than 100 mm over the Afar lowlands in the Northeast.(source national metrology agency 2001 )

March and April rain originate from the Indian Ocean and are brought by the Easterly Wind; while the heavy rains in the wet season come from the Atlantic Ocean by wind known as Equatorial Westerly Wind. The mean annual rainfall varies from 410 millimeters to 800 millimeters and above. The average duration of the dry season is 6 to 7 months. However, the rainfall pattern has recently become much

more unpredictable with some areas/zones receiving extremely minimum and maximum rainfall per year; that is, some areas receiving smaller than their usual rainfall, while other areas receiving higher than their usual rainfall.

Analysis of the average annual rainfall trend in the past three decades in Dire Dawa Administration shows a more or less constant trend. However, the trend of the last 30 years shows a slight increase

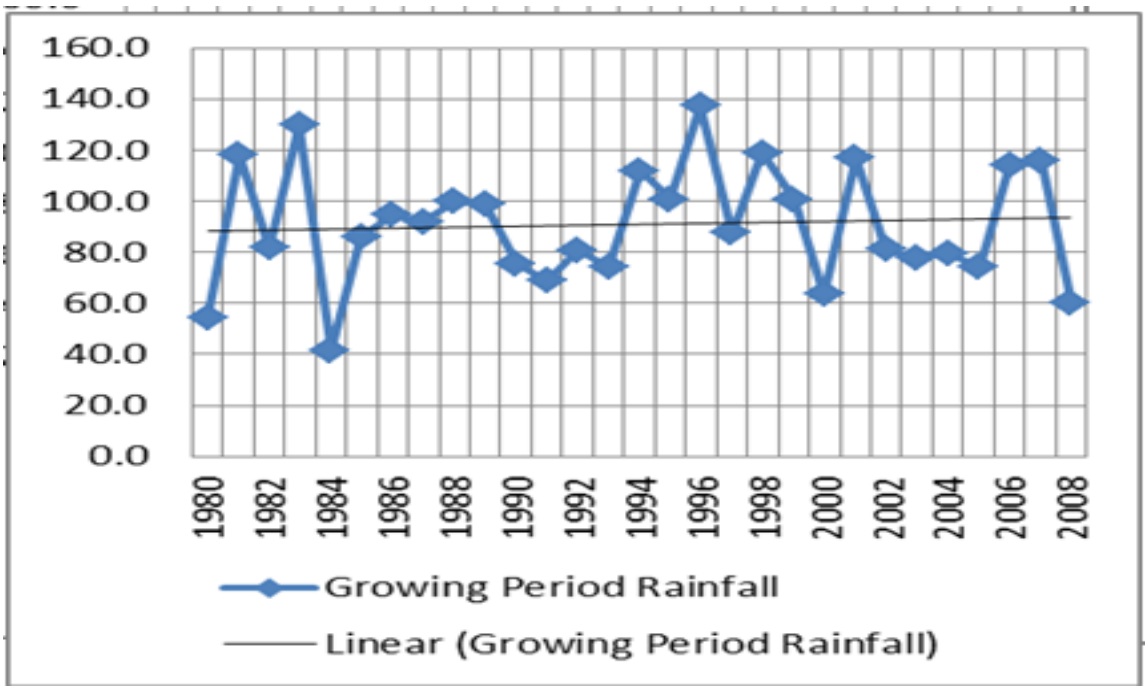



**Figure 17: rainfall trend of Dire Dawa City State**

### 3.4.1. State and Trends of Climate for Legeoda MirgaForest Ecosystem (1990– 2020)

State and Trend of Rainfall on Legeoda Mirga Forest Ecosystem

#### *3.4.1.1 Rainfall*

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

Table 12 Legeoda Mirga Average Monthly **rainfall from**

| MONTHLY | RF |
|---|---|
| January | 17.99406 |
| February | 12.12174 |
| March | 51.83384 |
| April | 83.96677 |
| May | 56.6629 |
| June | 33.35071 |
| July | 86.90858 |
| August | 126.8598 |
| September | 85.38229 |
| October | 41.31839 |
| November | 23.03997 |
| December | 11.9309 |
| Avr Sum RF | **631.3699** |

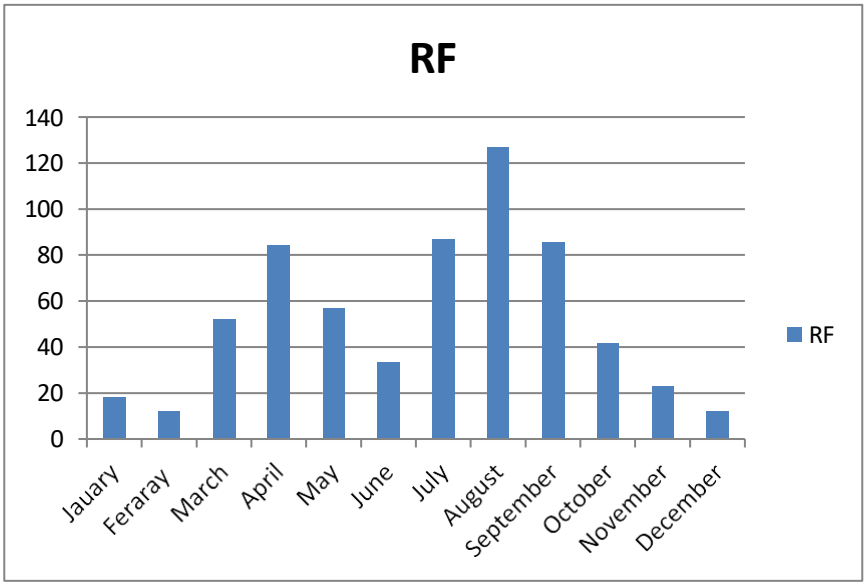



Figure 18: Legeoda Mirga Average Monthly **rainfall from 1990-2020**

One can observe that the peak average monthly sum of rainfall was recorded during August, it reached around 127 mm. The positive rainfall anomaly was recorded in April & July up to September months. The positive sign was an implication that the monthly averages were higher than the 30-year normal. On the other hand, all the other eight months have a negative anomaly which means the monthly average rainfall was recorded lower than the 30-year average normal.

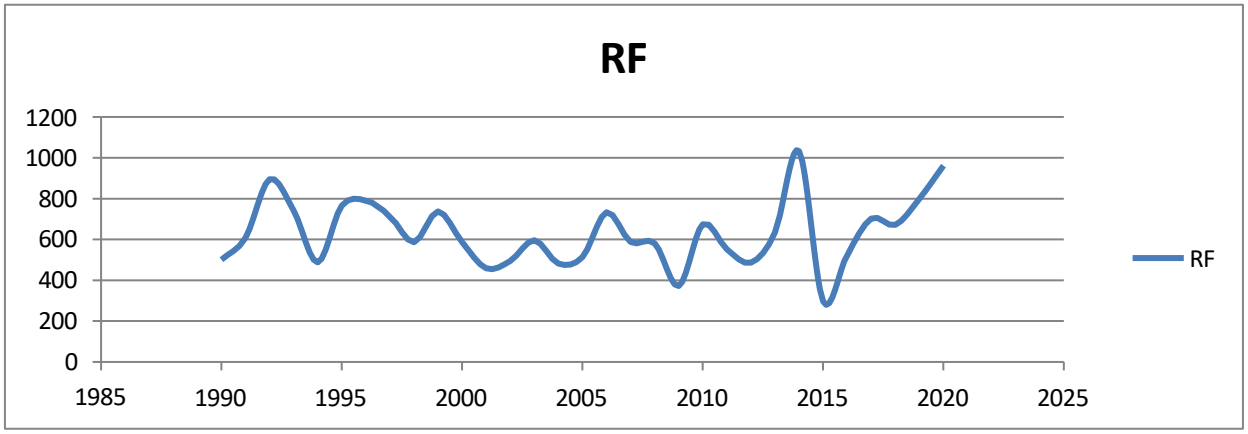



Figure 19: **Legeoda Mirga** annual **Rainfall from 1990- 2020**

The amount of annual sum of rainfall was highly variable from year to year. The highest Rainfall was recorded around 1032 mm in 2014 and the lowest rainfall was recorded in 2009 which was 372 mm. From the available data annual average rainfall was 631 mm rainfalls were recorded.

The highest negative anomaly was -259 mm in **2009** which indicate that in these years the average rainfall received was far below the reference normal. On the other hand, the highest positive rainfall anomaly was recorded in **2014** which is **+401** mm above the reference normal as illustrated above.

#### *3.4.1.2. Temperature*

Legeoda Mirga forest ecosystem have has been experienced a warm pattern classified as the long warm season (February –September) and cool (November - January) locally referred as Meher respectively.

**Table 13 Legeoda MirgaAverage Monthly Maximum Temperature from 1990-2020**

| MONTHLY | Avr Max Temp |
|---|---|
| January | 24.67152 |
| February | 26.05155 |
| March | 27.2768 |
| April | 27.44613 |
| May | 27.73492 |
| June | 28.02654 |
| July | 26.68523 |
| August | 26.55485 |
| September | 26.65641 |
| October | 26.9999 |
| November | 25.59005 |
| December | 24.46945 |
| Avr Sum Max Temp | 26.51361 |

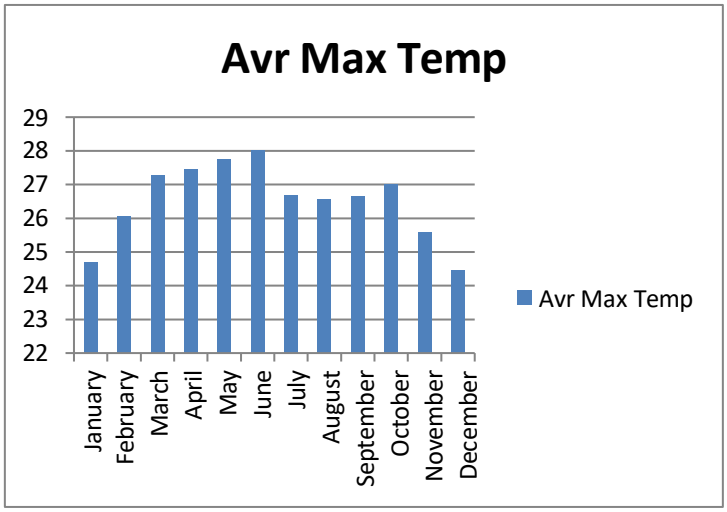



**Figure 20:Legeoda MirgaAverage Monthly Maximum Temperature from 1990-2020**

**Table 14 Legeoda Mirga Average Monthly Maximum Temperature from 1990-202**

| MONTHLY | Avr Mi Tem |
|---|---|
| January | 12.08063 |
| February | 13.08964 |
| March | 14.4292 |
| April | 15.5646 |

| | |
|---|---|
| May | 15.20936 |
| June | 15.48757 |
| July | 15.14631 |
| August | 15.19205 |
| September | 14.81469 |
| October | 13.58723 |
| November | 12.32112 |
| December | 12.20821 |
| | |
| Avr Sum | 14.09422 |

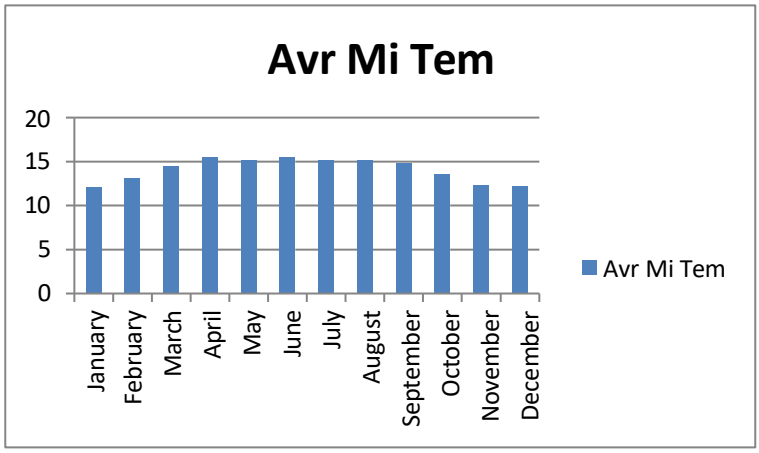



Figure 21: **Legeoda Mirga Average Monthly Maximum Temperature from 1990-202**

The hottest month for the 1990 - 2020 period was the months of June with an average maximum temperature of 28.02 °C against the normal reference of 26.51 °C an increase of 1.51°C while the coldest month was the months of December with a maximum average of 24.7 °C against the normal reference of 26.51 °C decreases of - 1.81 °C as well. The overall total average anomaly for the 1990 - 2020 periods was 3.32 °C. {Range }

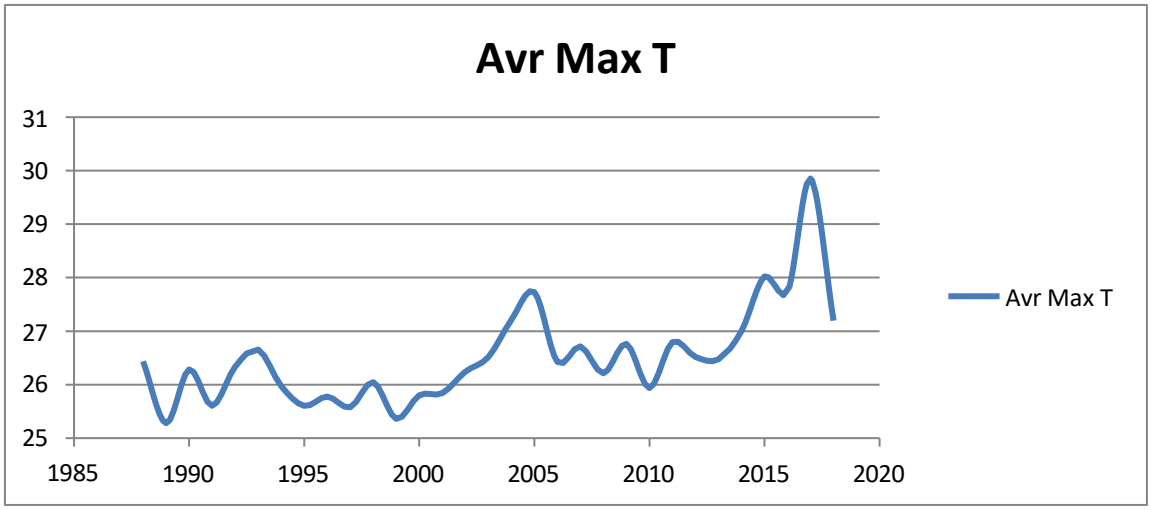



Figure 22: **Legeoda Mirga Average Annual Maximum Temperature from 1990-2020**

Within the period of between 1990 - 2020, the considering the reference normal of 26.51 °C average annual **maximum** temperature recorded

- Highest recorded was 29.85 °C in 2017 with the highest anomaly +3.34 °C of. While
- Lowest average annual maximum temperature was 25.28 °C in 1989 with an anomaly of - 1. 23°C

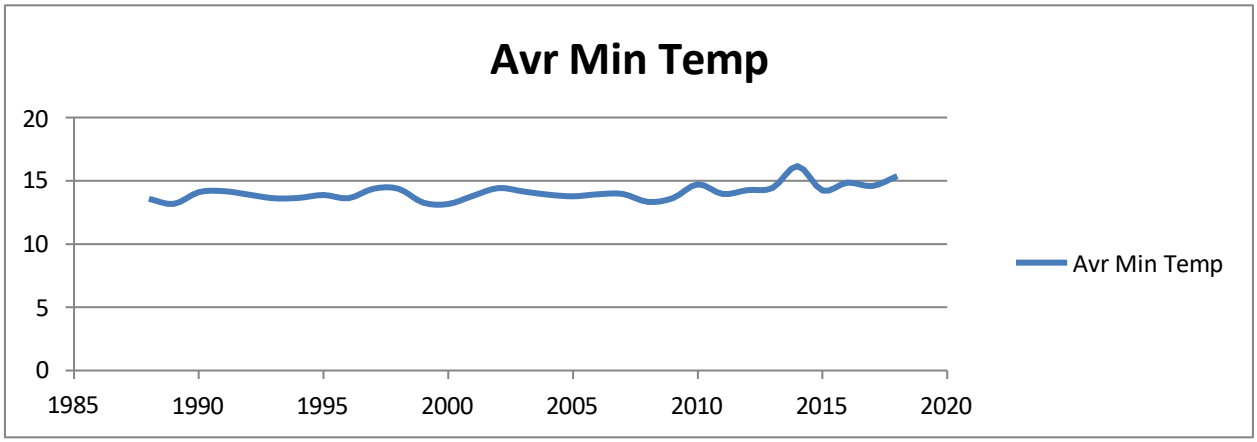



Figure 23: **Legeoda Mirga Average Annual Maximum Temperature from 1990-2020**

Within the period of between 1990 - 2020, the considering the reference normal of 14.07 °C average annual **minimum** recorded

Highest recorded was 16.16 °C in 2014 with the highest anomaly +2.09 °C of. While
Lowest recorded was 13.16 °C in 2000 with an anomaly of - 0. 91 °C

**Climate variability and anomalies observation from FGD**

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

- Rainfall is highly erratic and typically falls in the form of intensive convective storms such variability causes
    - Severe flooding effects to the downstream areas of the city. Flooding is a sever and frequent phenomena to Dire Dawa ( like the 1998 E.C. flooding Hazards )
    - If not like the 1998 flood hazard flooding is a common phenomenon in the city occurring frequently every three years.
    - increases the number of extreme events
- Shift of crop season
    - rainfall starts in may but now it is changed its pattern earlier or later
- Pests and Disease
    - Plant disease: - Sorghum warm pest.
    - Animal Disease :- Livestock foot swelling
- Droughts affecting agricultural productivity and livestock feed
- Drying of former springs ( up to six springs dried in the locality )
- Species have shifted their geographic range envisage the area

- Invasive species " Bekertea and Yeferenje Biskut' occurrence and spread in the locality

- Extinct plant species from the Forest Ecosystem
  - Tree and Shrubs species : - Jejeba, Diressa, Bakka, Hamessa, Hagamssa
  - Herb species :- Serdo, Bolbolessa, Sembeleatte

### 3.4.2. Drivers and Pressure the Changed Climate

***Vicious circle***

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

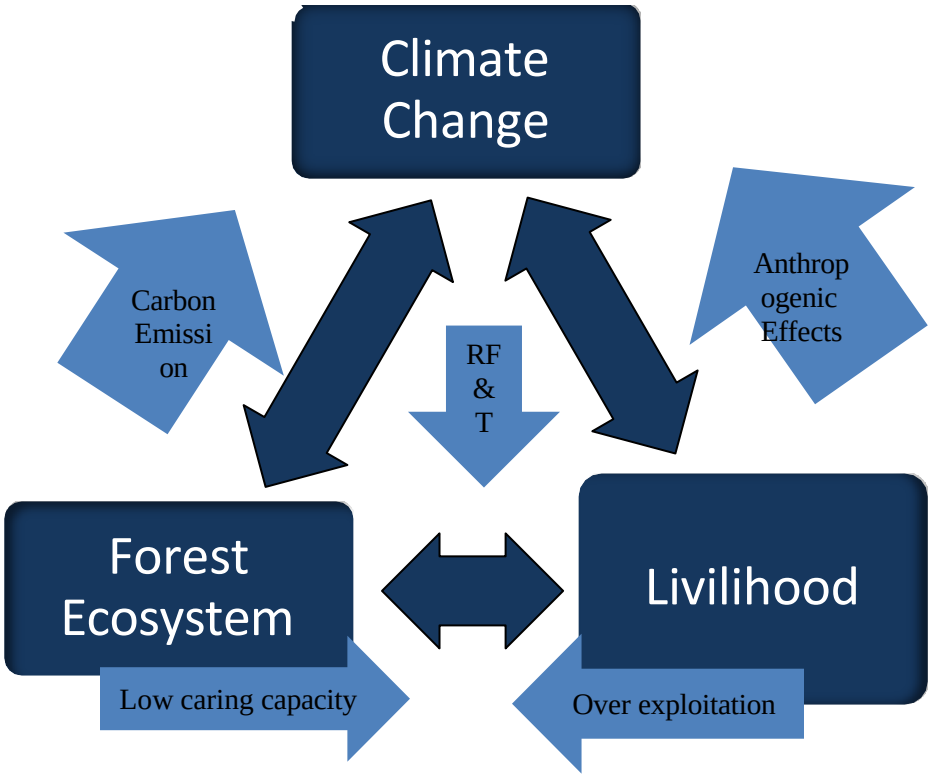



**Figure 24: Vicious circle of Climate, Forest and Livelihoods**

***Global Drivers and Pressures***

Drivers: - The Western Materialistic Philosophy

According to the Western philosophical believes of Christianity **nature** is given for human beings them to own and use right GIVEN by GOD. The Holy Bible states that:"Be fruitful, and multiply, and replenish the earth, and subdue it; and domination over the fish of the sea, and over the fowl of the air, and over every living thing that move the upon the earth. (Genesis 1: 28) .The Bible gives human beings to exploit nature as a gift. Accordingly their way of life HAPPINESS is an accumulation of wealth and owning more matter. This enable them to exploit the natural resources and develop veracious apatite of exploiting the natural resources unsustainable and generate more toxic wastes beyond the recycling capacity of Mather earth.

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

**Pressures: GHG Emission**

The unprecedented increase in global energy uses of fossil has given rise greenhouse gas emission. The main natural GHGs are **carbon dioxide ( $CO_2$ )** , **methane ( $CH_4$ ) , nitrous oxide ($N_2O$ ) , water vapor ( $H_2O$) , and ozone ( $O_3$)** in the troposphere and stratosphere. Further human activities in recent decades add new **halocarbons** (HFCs) as GHG. On the whole if the rise of GHG's takes place in the current rate the overall rise of each pollutant gases that contribute the greenhouse effect will be somewhat in fair higher side with **doubling point sometimes in 2030**. Thus the corresponding temperature changes from 1850 to 2050 at the magnitude of $0.25^0$C to $3.5^0$C.. Thus it is **very urgent** to restrict the current rate of GHGs emission. Most scientists agree that if the pollution continues at present rates, the result will be irreversible damage to the ecological cycles which all life depends. They warn that fundamental, and perhaps drastic, a change **in human behavior is** required to avert the ecological crisis and assure sustainable development.

**National and Local Drives and Pressures**

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

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

The mainly Drives & Pressures are:-

A. Population growth and anthropogenic effects

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

**B. Land tenure**

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

**C. 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 exert pressure on Land use changes of forest ecosystem to agricultural, grazing and residences.

- Agricultural farming emission contribution is great
- Land use change (CH4 from deforestation)
- Crop production (N2O emission from organic and mineral N imputes. Burning of crop residues, N2O and CH4 from manure handling (storage, etc.) and the application of mineral fertilizer is a significant material for agricultural products and productivity improvement.

**D. Resettlement programs**

According to FGD community's resettlement observed nearby the forest in response 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

**E. 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. Wood & biomass fuel accounts for more than 80% of household energy supply in Ethiopia and is particularly important in rural areas.

**F. Animal populations**

- Animal populations were degrading the forest vegetation 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 CO2e, which cover 42% of the total.

### 3.4.3. Impacts of Climate Change

**Global and National Impacts**

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

- Forest distraction,
- Worldwide loss of habitat and biodiversity,
- Soil erosion,
- Air and water pollution,
- Shrinking fossil fuel supplies, and
- Accommodation of toxic wastes
- Human Health major tropical diseases spread with changing climate
    - Malaria ( vector Mosquito) ,

- Schistomiasis ( vector Water snail),
- Filariasis ( vector Mosquito),
- Onchocerciasis/river blindness ( vector Black fly),
- African trpanosomiasis / sleeping sickness ( vector Tsetse fly),
- Dengue Fever ( vector Mosquito), and
- Yellow Fever (vector Mosquito).

**Local Impacts**

**A. Drought**

The intergovernmental panel on climate change predicts a decrease in world food production of 5.11% by 2020 and 11.46% by 2050. The shortfall in the world's staple foods supply is estimated to be from 400 to 600 million tons by the 2080s and it will naturally increase hunger and poverty, particularly in poor countries like Ethiopia. Dire Dawa population is one of the victims of the frequent droughts. Generally Dire Dawa Administration is a semiarid region with an average annual rainfall of 604 mm, the evapo-transpiration exceeds the rainfall. Only in July and August rainfall exceeds half the potential evapo- transpiration.

**B. Impact on Agricultural Productivity**

Three-quarters of the people who are at risk of hunger as a result of climate change are in Africa. It is also known that agriculture is the dominant sector in Ethiopian economy. Agriculture contributes about 52 percent to the gross domestic product (GDP), it generates more than 85 percent of foreign exchange earnings, and it employs about 80 percent of the population (Ministry of Economic Development and Cooperation (MEDaC, 1999). The contribution of the agricultural sector to the total economy, however, is challenged by its vulnerability to climate change.

Vulnerability could best be measured by a change in income or livelihood attributed only to climatic factors. For instance, the monetary impact of climate change on agriculture can be measured by modeling the relationships between climatic variables and farm income. Similarly, the yield impacts of climate change can be analyzed by modeling the relationships between crop yields and climatic variables

**C. Feed Scarcity**

Natural pasture and bush/shrub is the major feed sources for the pastoralists and agro-pastoralist households in the Administration. The main source of animal feed resources in the area is natural pastures (herbaceous vegetation composed mainly of grasses and forbs and browses (shrubs, tree leaves and pods).

As a result, the pastoralists are always forced to migrate seasonally from place to place in search of feed and water. Feed shortage is the primary reason for migration. The pastoralists migrate on average for 78 days away from the residential areas they relatively consider as their permanent address. Generally, pastoralists and agro-pastoralists believe that shortage of feed has resulted in long calving period, weak physical condition and less yields (milk, meat, lower market values) and reduced reproductive capacity.

**D. Impact on Settlement and Infrastructure**

**Extreme weather events** such as storms, floods, have already marked impacts on settlements and infrastructure. Indeed, for urban planners, the biggest threats posed by climate variability and change to localized population concentrations are often expected to be from little-characterized and unpredictable rapid-onset disasters such as storm surges, For instance, the devastating flood on August 5, 2006, caused the death of 256 people, displaced 9956 and 244 people were unaccounted for. The flood has made 2685 households homeless. Out of the displaced people, 5524 lived in temporary shelter while 4432 stayed with their relatives and friends. The flood has inflicted huge damages on urban infrastructures. Roads, bridges and houses were destroyed. Electric poles, water pipes and sanitation facilities were also damaged

**E. Land degradation**

The root causes of the problem of land degradation in Dire Dawa Administration are climate change and manmade factors. To begin, the soil loss rate of 04-21.8 tons /ha/yr/ is by far higher than the annual soil formation rate of 0.4 -05 ton/ha/yr. resulting in continuous soil erosion and thus about 75% of the region is severely degraded by soil erosion (DDA Integrated Resource Development Master Plan, 2006).

**F. Deforestation**

Beyond wood fuel, forests provide other timber products and a host of valuable non-timber products,. 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

Forests are the second largest stores of Carbon next to Oceans. Forests have a great role for climate change as a carbon sink. However, agriculture, forestry and other land uses are responsible for nearly a quarter of all man-made greenhouse gas emissions to the atmosphere

Forests are a great contribution in determining the accumulation of greenhouse gases in the atmosphere. As well as being critical to slowing or even stopping climate change, forests are important for reducing their current and future effects on people.

In the study area forest coverage is decreasing from time to time mainly due to agricultural activities, Deforestation is one of the most important causes of climate change. An increasingly numerous population needs more and more resources, which speeds up the increase in greenhouse gas emissions from all production processes.

**G. Invasive species**

The pasture lands have seriously been infested by Prosopis julifiora (locally called yeferenje biscut) - an alien invasive species – a species so aggressive and dominant that it has displaced almost all desirable indigenous plants or grasses because they could not withstand the aggressive competition with it.

The introduction of exotic species has contributed to bush encroachment and the fast disappearance of the Acacia woodland of the region. This has resulted in plant genetic erosion in the last three decades (Dire Dawa City State Conservation Strategy, 2001).

**H. Pest and Disease Epidemics**

Climate variables affect the geographical distribution of pests and diseases, and, therefore, expand their distributions to new areas. In most of the rural Kebeles of Dire Dawa Administration, for example, **tick** borne diseases have been reported.

Climate change induced escalation in the epidemics of **pests** and **diseases** were reported across the rural Kebele for both livestock and crops as being the major causes of low productivity. According to Dire Dawa Administration INRMPS (2003) 25% of the crop loss in the DDA is because of pest and diseases.

**I. Impact on human health**

Over the last few decades, Dire Dawa Administration has experienced an increase in the frequency and intensity of extreme weather events with serious consequences on the health sector. For example, in recent years, there have been outbreaks of water-borne and water-related diseases such as malaria and malaria-like disease called **dengue** in Dire Dawa City and its environs.

**Cholera out break**

The floodwaters caused destruction of homesteads, latrines, and land sites leading to outbreaks of cholera. The situation was similar in 2006 and 2010 where poor sanitation led to increase in cholera. For example, on average Malaria, ADD, poor hygiene and sanitation accounts for 20 % of the health issues from 2005 to 2009. Severe droughts resulted in drying up of water sources leading to serious water shortages especially in the lowland ecosystems. The acute shortage water leads to the worsening of personal hygiene which in turn resulted in the escalated fecal oral transmission of diseases.

**Malaria**

There was a general increase of malaria incidences throughout Dire Dawa City state. According to Dire Dawa Administration Health Office malaria is the first killer disease together with Tuberculosis. According to the Malaria Prevention and Control Service, malaria causes more illness and death than any other single disease. Malaria transmission is said to be at its peak during high temperatures and humidity, after the rainy season. As a result of change in temperature and rainfall regimes, malaria epidemic has been observed to extend to some parts of Legeoda mirga, Belewa and Hulul Mojo highlands (non-traditional malaria areas) where the disease was not prevalent. As more areas receive more rains, it will in turn attract more malaria vectors, leading to increased incidences of malaria diseases across the Administration.

### 3.4.4. Response to Climate Change

**Global Response**

**Efforts of COP 1 -28**

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

The **United Nations Climate Change Conferences** are yearly conferences held in the framework of the United Nations Framework Convention on Climate Change (UNFCCC). They serve as the formal meeting of the UNFCCC parties – the Conference of the Parties (COP) – to assess progress in dealing

with climate change, and establish legally binding obligations for developed countries to reduce their greenhouse gas emissions.

**National Response Climate Change**

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

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

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

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

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

- Improving crop and livestock production practices for higher food security and farmer income while reducing emissions. Intensification of agriculture through use of improved inputs and better management of crop and animal residues, resulting in a decreased requirement for additional agricultural land that would be taken primarily from forests. Expand agricultural activities on degraded lands through increased irrigation.
- Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks. Reduce demand for wood fuel through dissemination of more efficient wood and/or alternative-fuel stoves. Promote afforestation, reforestation and improved forest management activities to increase carbon sequestration in forests and woodlands.

- Expanding electricity generation from renewable sources of energy for domestic and regional markets
- Leapfrogging to modern and **energy-efficient technologies** in **transport**, industrial sectors, and buildings.

**Local Response Climate Change**

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

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

### 3.4.5. Outlook

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). The trend made by NMA (2007) reported that in case of IPCC mid-range (AIB) emission scenario, the mean annual rainfall is likely to increase along Dire Dawa by 3.4% by 2030, 6.4 % by 2050 and 10.5% by 2080 compared to the 1961 to 1990 normal.

**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

The assessment made by NMA (2007) reported that in case of the IPCC mid-range (A1B) emission scenario, the mean annual temperature in Dire Dawa Administration will increase up to 1 °C by 2030, 1.8°C by 2050 and 3°C by 2080 compared to the 1961-1990 normal.

**CRGE Scenario**

Accordingly based on the available meteorological data in Legeoda Mirga 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.

Unless, the Vicious circle of climate, livelihood ad Forest Ecosystem linkage is broken through the climate change mitigation and adaptation efforts of :-

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

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

**Business us usual Scenario**

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

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

### 3.4.6. Recommendation

Sustainable Development: Climate, Forest and Livelihoods

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

- **Climate Change**
  - Reduce carbon emission from deforestation and forest degradation
  - Promote climate change mitigation efforts
  - Addressing the issue of ground water and flood hazard is the issue of alpha and omega to the Dire Dawa Administration
    - Flood hazard and ground water depletion many hamper all development endeavors in the Administration and of course its adverse impact will be catastrophic.
  - So to reverse the would be expected evil consequence of flooding and ground water depletion due attention should be given to the above mentioned emerging issues to ensure sustainable development and of course the very existence of the city of Dire Dawa at large
- **Forest Ecosystem**
  - Promote adaptation strategies of Participatory Forest Management
  - Enhance area enclosures to protect ecological degradation and loss of biodiversity.
    - Rehabilitee forest ecosystem through afforestation, reforestation,
  - Strengthening participatory forest management practices in coloration with the government, the society and by NGO.
  - Developing forest ownership/tenure law which is fair, stable and unambiguous with clear rights and duties (state, common, private).
    - Legalizing or recognizing customary rights of communities over forests and woodlands and enhance the capacity of informal institutions to the extent possible.
    - Developing perceptive legal instruments (policy, law and regulation) that consider Participatory Forest Management as the main “pull” of forest management in the country and to develop or amend the forest law.
- **Livelihoods**
  - Promote adaptation strategies of wood and non-wood products utilization
    - Substitute house construction material by others instead use forest for construction.

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

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