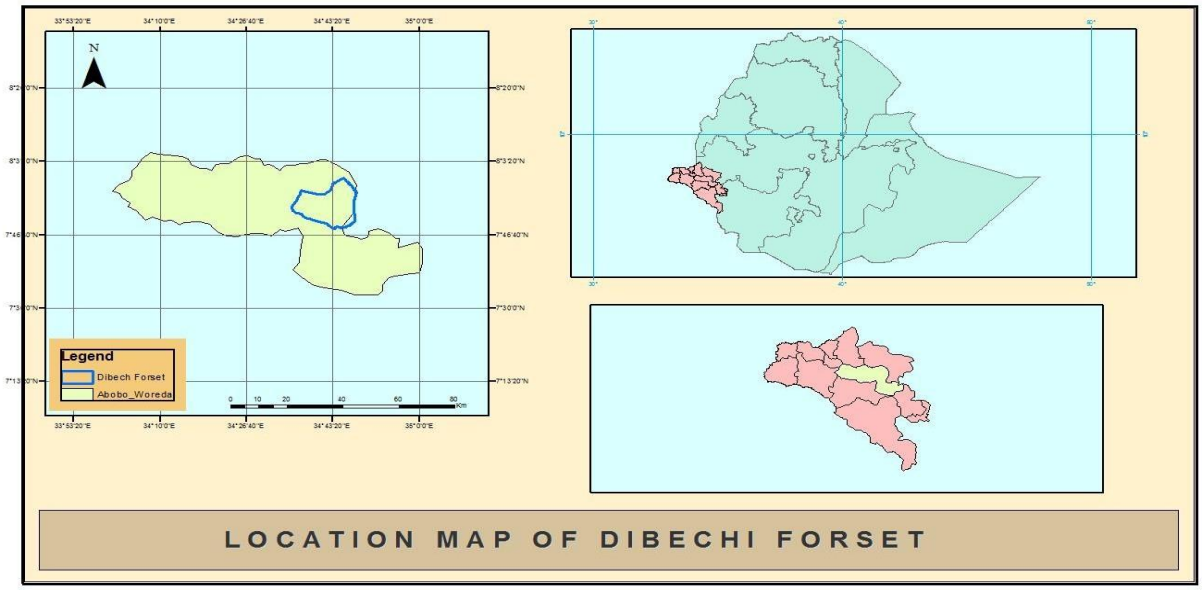
THE FEDERAL DEMOCRATIC REPUBLIC OFETHIOPIA ENVIRONMENT, FOREST AND CLIMATE CHANGE COMMISSION





FACT-SHEET OF DIBECHI FOREST ECOSYSTEM

ADDIS ABABA,

2019

Contents

Table of contents i
List of Figure… iii
List of Table iv
Acronyms and Abbreviations v
1. General Background 1
1.1. Environment for Green Economy Development 1
1.2. Frameworks /Approaches 6
1.2.1. The Driver-Pressure-State-Impact-Response Framework 6
2. Social and Economic Environment 7
2.1. Social Environments 7
2.1.1. State and trends of Social Environment 7
2.1.2. Drivers and Pressure of Social Environment Change 14
2.1.3. Impacts of Social Environment Change 16
2.1.3. Responses to Social Environment Change 16
2.2. Economic Environment 17
2.2.1. State and Trend of the Economic Environment 17
2.2.2. Drivers and Pressures of the Economic Condition 18
2.2.3. Impacts due to the Economic Condition 19
2.2.4. Response of Economic Environment 19
2.2.5. Outlook for Socio-Economic Environment 22
2.2.6. Implementing sector programs including policy Reform 23
3. Physical Environment of Dibechi Forest Ecosystem 23
3.1 Lland use land cover change of dibchi forset ecosystem 23
3.1.1. State and Trend of Land Use land cover Change of Dibechi Forest Ecosystem 26
3.1.2. Drivers and pressures for land Use Land Cover Change 32
3.1.3. Impacts of land use land cover change of Dibehi Forset Ecosystem 33
3.1.4. Response measures in improving the status of land use land cover change 34
3.1.5. Outlooks 34
3.2. Land Degradation in Dibechi Forest Ecosystem 35
3.2.1. State and Trend of Land Degradation in Dibechi Forest Ecosystem 35

3.2.2. Drivers and pressures for land degradation 41
3.2.3. Impact of land degradation on livelihood system of local community 42
3.2.4. Response measures in improving the status of land degradation 44
3.2.5. Option for future action /outlooks/ 44
3.3. Forest and Woodland Degradation in Dibechi forest ecosystem 45
3.3.1. State and Trends of forest and woodland degradation 46
3.3.2. Driver and pressures Dibechi forest degradation 50
3.3.3. The Impact of forest degradation on the livelihood of local communities 55
3.3.4. Response of deforestation and forest degradation 56
3.3.5. Outlook 56
3.4. Dibechi Forest Biodiversity 57
3.4.1. State and Trend of Biodiversity on Dibechi Forest ecosystem 57
3.4.2. Drivers and Pressures of Biodiversity Degradation on Dibechi Forest ecosystem 62
3.4.3. Impact of Biodiversity Degradation on Lively Hood System of the Local People of Dibechi Forest ecosystem 65
3.4.4. Responses to Biodiversity Degradation on Dibechi Forest ecosystem 66
3.4.5. Outlook 67
3.5. Climate for Dibechie Forest Ecosystem 67
3.5.1. State and Trend of Climate 67
3.5.2. Driver of Climate Variability and/or Change to Dibechi Forest Ecosystem 71
3.5.3. Impact of climate change and/or variability in Abobo Woreda 75
3.5.4. Response to Climate Change and/or variability in Gambela region Abobo Woreda Dibechi Forest Ecosystem 78
3.5.5. Outlook for Climate Change and/or Variability of Dibechi Forest Ecosystem 79
Reference 81

List of Figure

Figure 1: The three Dimensions of sustainability 2
Figure2: Population projection of Abobo Woreda from 2007 to 2019 within six years Period… 7
Figure3: Total number of primary and secondary school in Abobo Woreda 8
Figure 4: Total number of students both at primary and secondary education level in Abobo Woreda 9
Figure 5: Total number of teachers both at primary and secondary education level in Abobo Woreda 10
Figure 6:Type of health institutions in Abobo Woreda 11
Figure 7: entry of Dibechi Forest ecosystem ..... ……..22
Figure 8: Figure FDGs were
Figure 9: Location map of Dibechi Forest Ecosystem 25
Figure 10: Land use land cover classification in the year: 1999, 2009 and 2018 27
Figure 11: Photos which shows burning of forests (field survey, 2019) 30
Figure 12: Summary of land use land cover extent by percentage (from 1999-2018) 32
Figure 13 shows acidification and fertility depletion through burring of plant spps by resettlement 37
Figure 14 Indigenous forests like cordia Africana/wanza/ spps were destroyed by investors 38
Figure 15: clearly showed that, how dense natural forests are devastated by community 39
Figure 16: The Dibechi forest has cleared by burring of fire for investment 40
Figure 17: shows burning of indigenous forest species and deforestation for tradition ship 41
Figure 18: Farmers delebrately divastated natural forest by fire 42
Figure 19: Population growth rate at Abobo district between 3 consecutive years. 43
Figure 20: Dense Forest in Dibechi Forest Ecosystem 50
Figure 21: Degraded forest ecosystem in Dibechi 50
Figure 22: Forest land converted in to investment farm 51
Figure 23: Illegal charcoal choking by investors 51
Figure 24: Population growth versus forest coverage (ha) 50

Figure 25: Resettlement around Dibechi forest ecosystem 53
Figure 26: Forest burned for cultivation purpose 54
Figure 27: Boat Made From Dibechi Forest 54
Figure 28 Dibechi forest destructed by fire 58
Figure 29: Activity of burning Dibechi forest (field survey, 2019) 63
Figure 30 :Deforestation processes on Dibechi forest by Dozen (field survey, 2019) 64
Figure 31: FGD 68
Figure 32: Monthly total rainfall of Gambela from the year2006 to 2018 in mm 69
Figure 33: Gambela Annual R.F in mm 70
Figure 34: Average Annual Min. and Max. Temprature of Gambela 71
Figure 35: Monthly Average Min. and Max. Temprature of Gambela 71
Figure 36: Resettlement area in Abobo Woreda 72
Figure 37: Deliberate Forest Fire with farmer, ... 73
Figure 38: Large scale cultivation of Mango, and currently cleaned investment land 74
Figure 39: Acceleration of forest fire leads to Air pollution. (Source: Field photo, 2019) 76

List of Table

Table 1: Selected Definitions of Green Economy 3
Table 2: Ratio of students to teachers, selection and textbooks in the Woreda 10
Table 3: Adult ten top diseases of Abobo Woreda in 2015… 11
Table 4: Children ten top disease of Abobo Woreda in2015… 12
Table 5: Number of health professionals, Health center to people ratio and Health coverage in the Woreda 12
Table 6 Land use and land cover classes considered and their descriptions 28
Table 7 Land use land covers distribution for (1999, 2009 and 2018) in Dibechi Forest 28
Table 8 Land use lands cover change detection in the year 1999, 2009 and 2018. 29
Table 9 The Proportion of land owned by community at district level 35
Table 10 Land use land cover change of Dibechi forest ecosystem 48
Table 11: List of tree species found in Dibechi forest ecosystem 49
Table 12: List of Shrubs found in the study area 49
Table 13: List of fruits 49
Table 14 Extinct and Endangered forest species 55
Table 15: Extinct and Endangered wild animals 55
Table 16: Identified plant species of Dibechi forest ecosystem 57
Table 17: Medicinal plant species 58
Table 18: Identified mammal species in Dibechi forest ecosystem 59
Table 19: Identified bird species in Dibechi forest ecosystem 59
Table 20: Reptile species in Dibechi forest ecosystems 62

Acronyms and Abbreviations

AIDS: Acquired Immune Deficiency Syndrome

AWANROR: Abobo Werede Agriculture and Natural Resource Office Report

BMP: Biodiversity Management Program

CBD: Convention on Biological Diversity

CSA: Central Statistical Agency

DPSIR: Driver Pressure State Impact Response

FAEDOAW: Finance and Economic Development Office of Abobo Woreda

FDRE: Federal Democratic Republic of Ethiopia

FGD: Focus Group Discussion

FGD: Focus Group Discussion

GDP: Growth Domestic Product

GRSEBESAA: Gambela Regional State Education Bureau Education Statistics Annual Abstract

GTP: Growth and Transformation Plan

IGAD: Inter Governmental Authority for Development

KI: Key Informant

NBP: National Biodiversity Policy

SDGs: Sustainable Development Goals

1. General Background

1.1. Environment for Green Economy Development

Human societies of different interests and values, with the objective of using resources, have interacted with the environment throughout history and, in the process; they have altered it. Most African economies depend highly on natural resources, aim to achieve industrialization and economic diversification, and face challenges of poverty and unemployment. Therefore, a pathway to a green economy requires action on three fronts: capitalizing on Africa's natural capital, exploiting opportunities for industrial growth and establishing enabling policies and institutions.

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

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

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

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

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

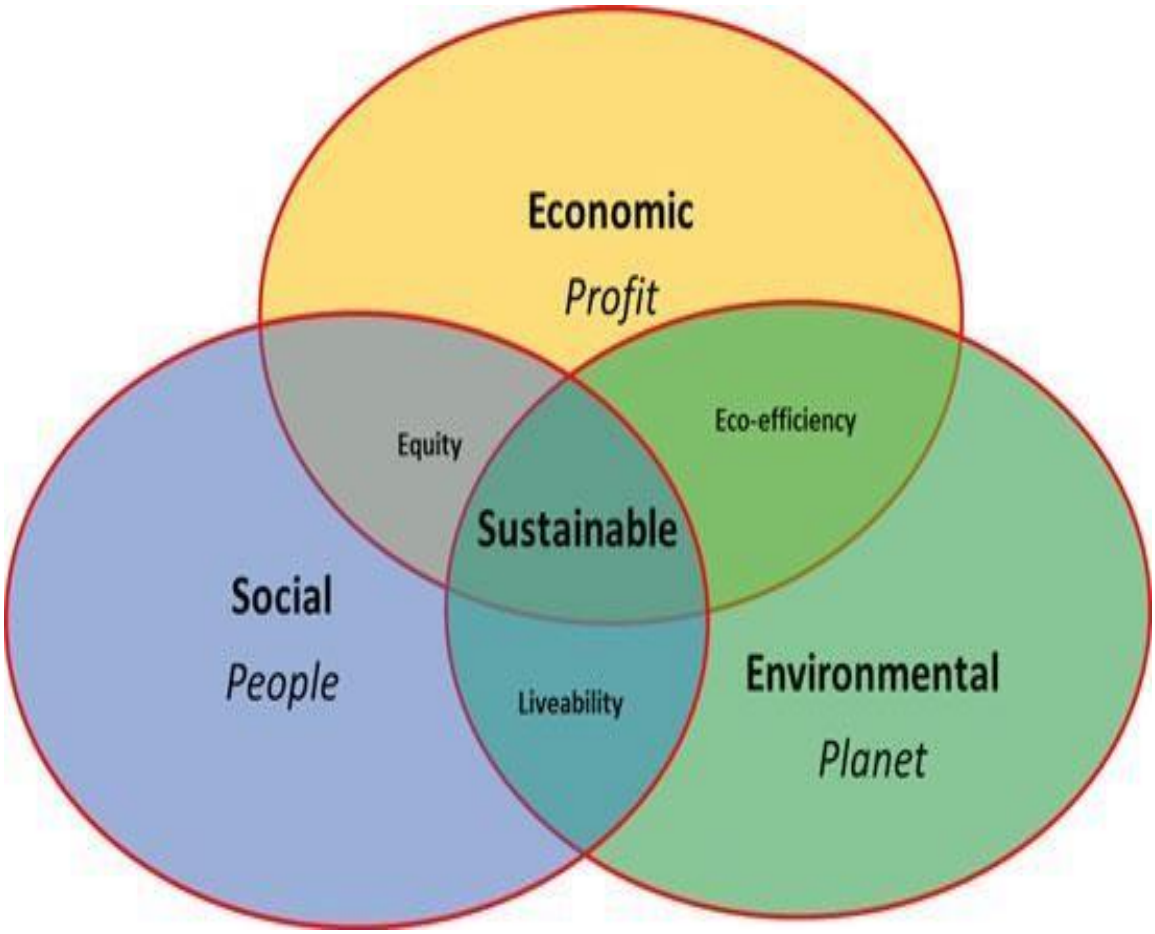


Figure 1**:** The Three Dimensions of Sustainability

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

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

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

Table 1: Selected Definitions of Green Economy

Source	Definition
UNEP's working definition (UNEP, 2010b)	"…A system of economic activities related to the production, distribution and consumption of goods and services that result in improved human well- being over the long term, while not exposing future generations to significant environmental risks or ecological scarcities…"
Green Economy Coalition, 2010	"…A resilient economy that provides a better quality of life for all with in the ecological limits of the planet…"
The UNEP-led Green Economy Initiative (UNEP, 2011)	Economy "that result in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient, and socially inclusive."
International Chamber of Commerce, 2012	"…An economy in which economic growth and environmental responsibility work together in a mutually reinforcing fashion, while supporting progression social development…"
Diyar*et al.*, 2014	"…The economy where the growth of the people's welfare and employment increase are provided owing to the state and social investments ensuring reduction of emissions and environmental pollution and stimulating effective use of energy and resources as well as preventing from any harm to biodiversity and ecosystem"

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

In practical terms, in a green economy investing in ecological resources and services, such as a stable climate, bio-diversity and clean air and water, can be an opportunity for profit, employment and growth rather than cost and burden on economy. Green Growth is the process of greening conventional economic system and a strategy to arrive at a green economy. Thus, pursuing a Green Economy and Green Growth means more than just investing in ecological resources and green technologies, such as renewable energy technologies.

Green Economy/Green Growth is a new strategy in a sense that it focuses on greening economic systems through a system change, while sustainable development as defined in Agenda 21 describes the need for incorporating environmental sustainability into economic policies without providing guidance on "how". It evolved into a new development paradigm illustrating how economic development and environmental sustainability can reinforce each other and create a win-win synergy to overcome the trade-offs of the conventional paradigm. The idea that the ecological crisis can provide new opportunities for greening the economic growth has also emerged recently. Green Economy/Green Growth can be a leapfrogging strategy for developing countries to pursue economic development without repeating the conventional "grow first, clean up later" path. Today, the concept of green economy has evolved to consider also social issues. Some individuals and firms have been implementing environmentally responsible practices for over a decade or more; however, currently the green sector of the development industry is experiencing rapid growth. Innovative firms have embraced principles of sustainable design, creating projects having a minimal impact on the environment. Governments have encouraged expansion of the green sector through policies promoting green development practices.

The Government of the Federal Democratic Republic of Ethiopia, the Regional State and city administration are striving to fulfill their responsibilities to their citizens. They strive to provide Social services and securities ensure adequate functioning of infrastructure, provide a climate Conducive employment and pay their debts. They are promoting development, and achieve their national aspirations using the resources available at their disposal in sustainable manner. To be able to achieve the desired social and economic development, the government has already started to pursue its development endeavors following the green growth path.

Accordingly, the country's second 5 years Growth and Transformation Plan (2015/2016-2019/2020) that aims at improving the livelihoods of its people is being implemented. The GTP, which aims at sustaining the rapid and broad-based growth of the country, hinges on seven pillars and four of these (i.e. 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, and enhancing expansion and quality of infrastructure development). Furthermore the environmental sector plan is also mainstreamed into the GTP II of the country. One of the activities outlined within the environment sector plan of the GTP II is the preparation of Fact sheet of the country through undertaking fast assessment and third

Ethiopian environment outlook. To this end, The Environment, Forest and Climate Change Commission of the Federal Democratic Republic of Ethiopia have conducted assessment of debch forest ecosystem in an integrated approach to study the status of the forest.

1.2. Frameworks /Approaches

1.2.1. **The Driver-Pressure-State-Impact-Response Framework**

The current study tried to use the DPSIR framework/approach. This approach put emphasis on understanding the trends and cause–effect relationships of the social, economic and environmental conditions in a given geographic setting.

The DPSIR framework 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 feedbacks in terms of environmental change, or could be an intentional or un-intentional by-products of other human activities (i.e., pollution);

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

IMPACTS: Environmental change may positively or negatively influence human wellbeing (as reflected in international goals and targets) through changes in environmental services and environmental stress. Vulnerability to change varies between groups of people depending on

their geographic, economic and social location, exposure to change and capacity to mitigate or adapt to change Human well-being, vulnerability and coping capacity is dependent on access to social and economic goods and services and exposure to social and economic stress;

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

2. Social and Economic Environment

2.1. Social Environments

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

Abobo is one of the Woreda in the Gambela Region of Ethiopia Part of the Anuak Zone. It is bordered on the southeast by the Mezhenger Zone, on the south by Gog, on the southwest by Jor, on the northwest by Itang special Woreda, on the north by Gambela Zuria, and on the northeast by the Oromia Region; part of its northern boundary is defined by the Alwero River. The capital town in Abobo is Abobo. It has total of 19 Kebeles, which is 17 rural and 2 urban Kebeles.

2.1.1. **State and trends of Social Environment**

2.1.1.1. **Population**

Population in urban areas has growing more rapidly than rural population worldwide, particularly in developing countries including Ethiopia. According to 2007 national census of Ethiopia population annual growth rate within the study area is expected to be nearly 3.53%.

Based on the 2007 Census conducted by the CSA, Abobo Woreda has a total population of 15,741, an increase of 12.65% over the 1994 census, of whom 8,184 are men and 7,557 women; with an area of 3,116.17 square kilometers, Abobo has a population density of 5.05, which is greater than the Zone average of 4.83 persons per square kilometer. The census reported 4,090 or 25.98% are urban inhabitants. A total of 3,867 households were counted in this Woreda, which results in an average of 4.1 persons to a household, and 3,663 housing units. The majority of the

inhabitants said they were Protestant, with 71.41% of the population reporting they observed this belief, while 10.77% were Catholic, 9.98% of the population practiced Ethiopian Orthodox Christianity, and 6.12% were Muslim.

According to the 1994 national census, the Woreda population was reported to be 13,973 in 3,597 households, of whom 7,223 were men and 6,750 women; 1,222 or 8.75% of the population were urban inhabitants. The five largest ethnic groups in Abobo were the Anuak (44.05%), the Kambaata (20.1%), the Amhara (12.57%), the Oromo (6.31%), and the Mezhenger (5.99%); all other ethnic groups made up 10.98% of the population. Anuak is spoken as a first language by 44.08%, 20.45% speak Kambaata, 13.5% Amharic, 5.93% Majang, and 5.65% speak Oromiffa; the remaining 10.39% spoke all other primary languages reported. The largest group of the inhabitants said they were Protestant, with 32.2% of the population reporting they practiced that belief, while 29.66% professed Ethiopian Orthodox Christianity,13.71% were Muslim, and 6.46% were Catholic.

As shown from figure 2 below, the population of the Woreda was 23,869 in the year 2019.The details of the population data of year 2007-2019 the population trend of the Woreda shows rapid growth from 15,741 to 23,869 (figure 2 , Population Projection of Abobo Woreda). With an area of 3,116.17 square kilometers, Abobo Woreda has a population density of 7.66 persons per square kilometer.

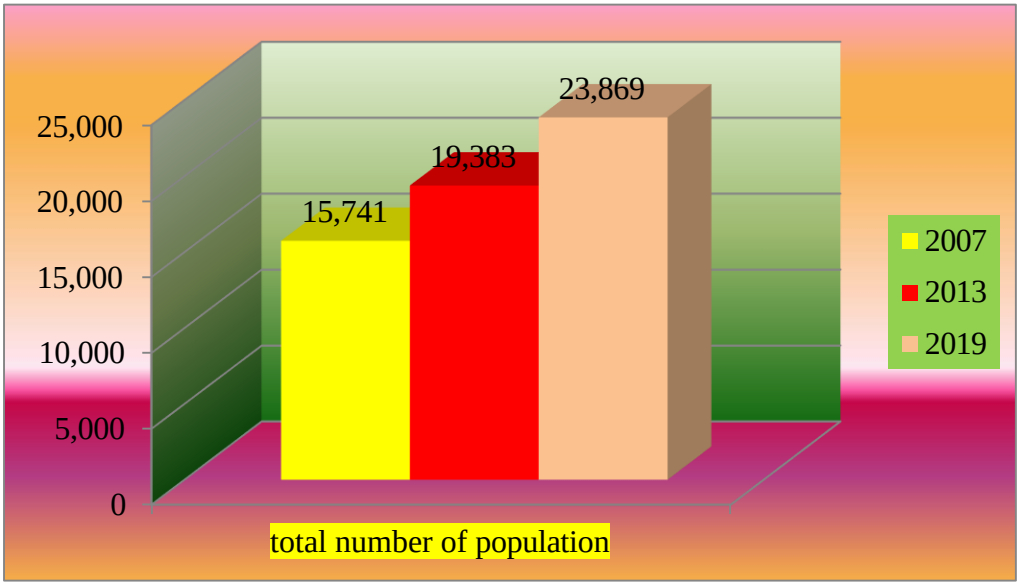


Figure 2: Population projection of abobo Woreda from 2007 to 2019 within six years period

Source: 2007 Census and finance and economic development office of Abobo Woreda

2.1.1. 2. **Education**

Education is the most important factor that plays a leading role in Human development. It promotes a productive and informed citizenry and creates opportunities for the socially and economically under privileged section of the society. One of the primary goals of Ethiopia Ministry of Education is promoting primary education in every corner of the country, based on the motto “quality education for all". Accordingly, regions are working in line with this objective.

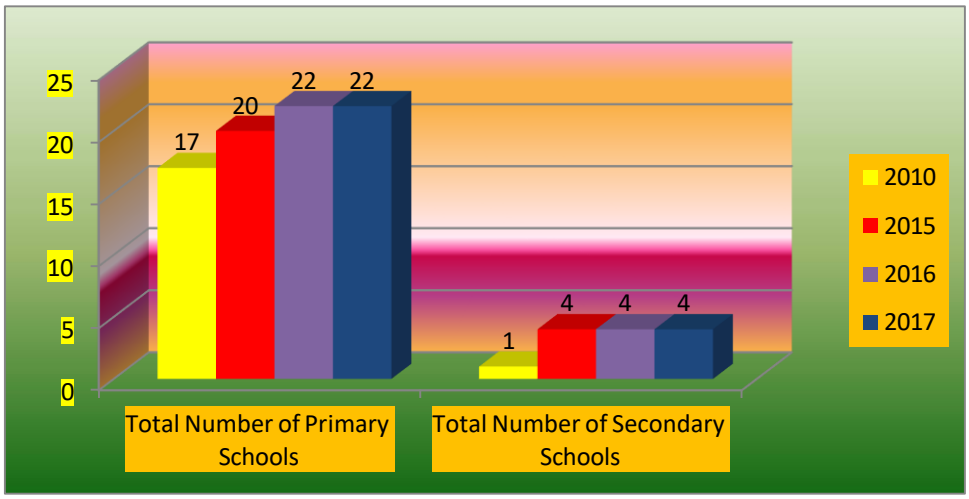


Figure 3: Total number of primary and secondary schools in abobo Woreda

Source: Finance and economic development office of Abobo Woreda (2010-2017)

Figure 3 indicated that total number of primary and secondary schools in the Woreda from 2010 to 2017. It shows the number of primary schools in 2017 has been increased by 22.73% when compared to in the year 2010. And also the number of secondary schools in 2015 has been increased by 75% when compared to in the year 2010.

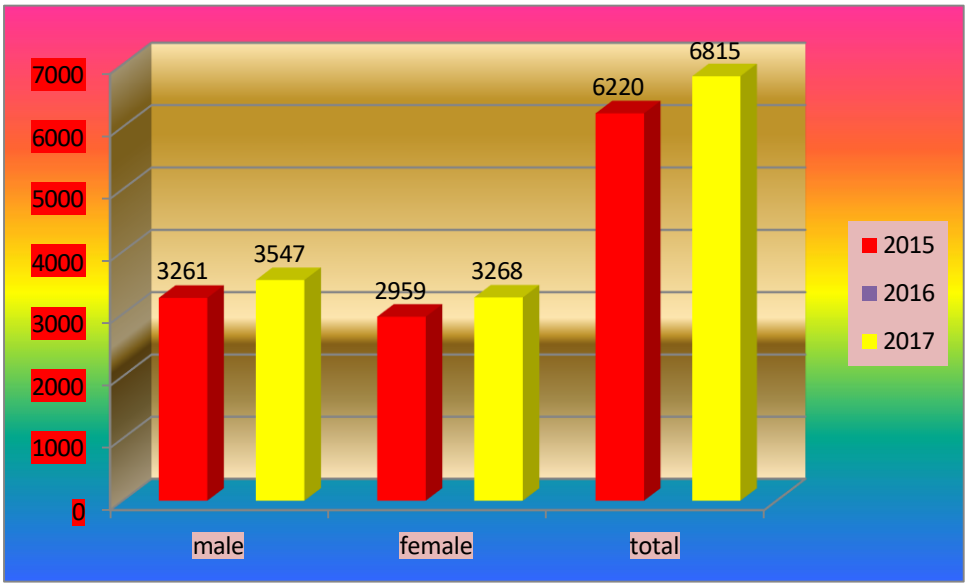


Figure 4: Total number of students both at primary and secondary education level in Abobo Woreda

Source: Finance &economic development office of Abobo Woreda (2015-2017)

Figure 4 indicated that total number of primary and secondary students in the Woreda from 2015 to 2017. The number of students in both sexes shows an increase between 2015 and 2017. In line to this fact, the number of students both male and female in 2017 increased by 8.06 and 9.46% respectively when compared to in the year 2015. But, in the year 2016 we can't get efficient data. In general, total number of students in 2017 has been increased by 8.73% when compared to in the year 2015.

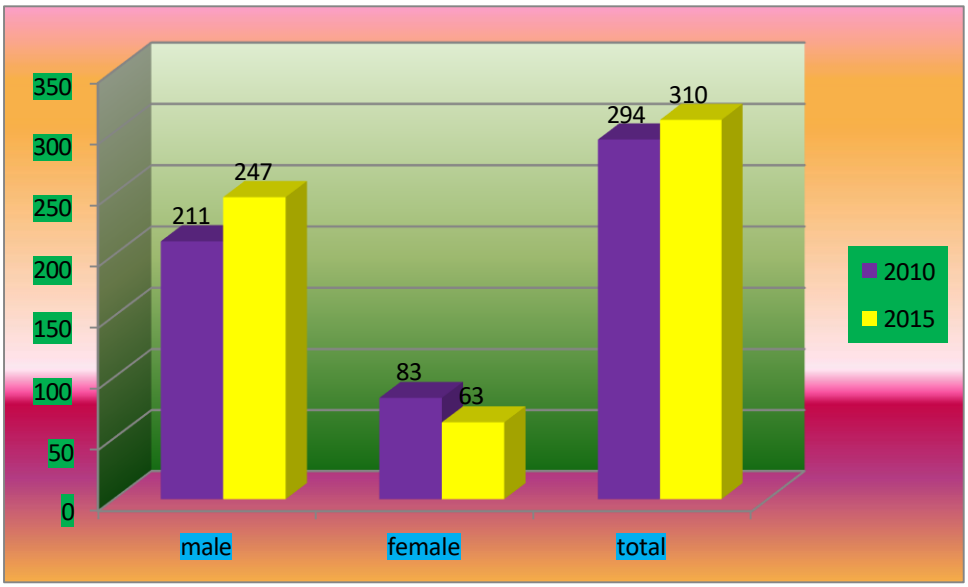


Figure 5: Total number of teachers both at primary and secondary education level in Abobo Woreda

Source: Finance &economic development office of Abobo Woreda (2010-2015)

Following the increase in number of schools and students in the Woreda, the number of teachers has also shown a similar increasing trend, which was 5.16% between the year 2010 and 2015 (Figure 5).

Table 2: Ratio of students to teachers, sections and textbooks in the Woreda

Year	Ratio of students to teachers	Ratio of students to sections	Ratio of students to textbooks
2010	18:1	108:1	4:1
2015	22:1	32:1	1:1

Source: Finance &economic development office of Abobo Woreda (2010-2015)

Table 2 indicated that ratio of students to teachers, sections and textbooks between 2010 and 2015 in the Woreda. The national standard for student-teacher ratio is 50:1 for primary and 40:1 for secondary schools (GRSEBESAA, 2017). The lower student-teacher ratio the higher the opportunity of contact between the teacher and students, however, very low student-teacher ratio indicates inefficiency of the education system or underutilization of the resources. As indicate above in table 2, in 2010 and 2015 the student-teacher ratio for Abobo Woreda is 18:1 and 22:1 respectively, which indicates a very low student-teacher ratio with compared to the standard. This shows underutilization of resources/teachers.

And student-section ratio has similar standards with that of student-teacher ratio. Then, in 2010 and 2015 the student-section ratio for Abobo Woreda is 108:1 and 32:1 respectively, which shows above and below the standard. Therefore, in 2015, it has lower student-section ratio indicates underutilization of the resources while in 2010, it has a higher student-section ratio indicates overcrowding of class and hence less interaction between students and teachers as well as among students themselves.

With regarding to student- textbook ratio in 2015, it has 1:1 ratio, which improves the quality of education. But, in 2010, it has 1:4 ratios, which affects the quality of education in the Woreda (GRSEBESAA, 2017).

2.1.1. 3. **Health**

Health is one of the most preeminent social sectors. It can be broadly defined as the state of being well physiologically and psychologically. It also has overarching effect on sustainable socio economic development. Health is a fundamental prerequisite for the successful achievement of any work which has significant importance for family, organization and for the country in general.

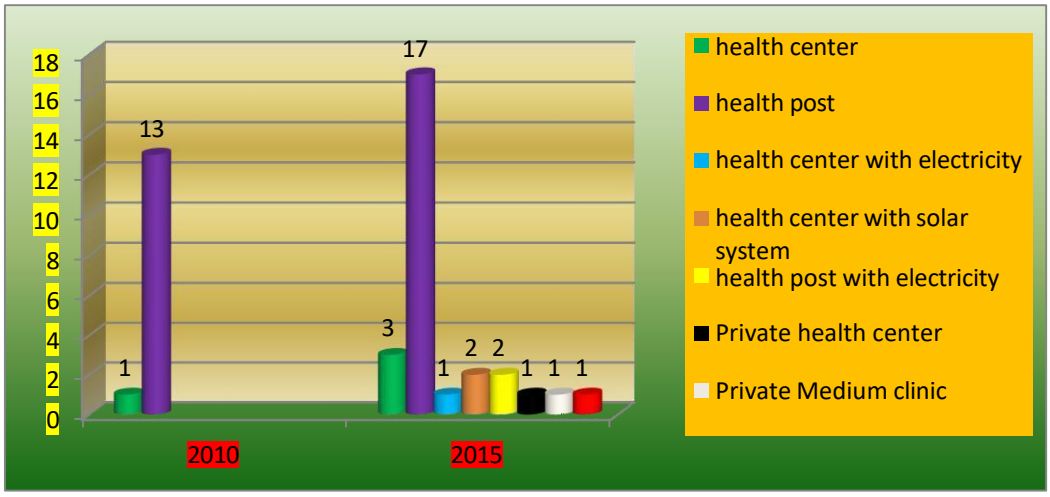


Figure 6: Type of health institutions in Abobo Woreda

Source: Health office of Abobo Woreda (2010-2015)

In the Woreda different health facilities, such as health center and health post were constructed between the year 2010 and 2015 (figure 6). However, their functionalities vary in providing the required services such as electricity.

Table 3: Adult ten top diseases of Abobo Woreda in 2015

Number	Adult ten top diseases
1	Malaria
2	Respiratory tract infection
3	Diarrhea with dehydration
4	Ischemic heart diseases
5	AIDS
6	Cirrhosis of liver

7	Diarrhea non blood
8	Rheumatic heart diseases
9	trauma
10	Infection of eye

Table 4: Children ten top diseases of Abobo Woreda in 2015

Number	Children ten top diseases
1	Malaria
2	Acute respiratory tract infection
3	Diarrhea non blood
4	Infection of skin
5	Meningitis
6	Pneumonia
7	Acute fiber infection
8	Un specified diseases of eye
9	Acute bronchitis
10	Malaria without clinical

Source: Health office of Abobo Woreda in 2015

According to the assessment made by the health office of the Woreda on patients, the most prominent diseases are Diarrhea non blood, Malaria, and infection of eye. Table 3 and 4 above shows the top ten diseases observed in adults and children for the Woreda.

Table 5: Number health professionals, Health center to people ratio and Health coverage in the Woreda

Year	Number health professionals	Health center to people ratio	Health coverage
2010	68	1:17,408	-
2015	92	1:5713	92%

Source: Health office of Abobo Woreda (2010-2015)

Table 5 indicates the number of health professionals, health center to people ratio and Health coverage of the Woreda between 2010 and 2015. The number of health professionals in Abobo Woreda has been increased by 26.09% in 2015 when compared to 2010.And health center to people ratio indicates in 2015, coverage of health center has been increased with compared to 2010.Thus, an increase in the number of health facilities has improved the health coverage in 2015 by 92%.

2.1.1.4. **Infrastructures**

The length of dry and all weather roads in Abobo Woreda is 202.3 km. All of them are gravel/rural roads (FAEDOAW, 2015). The main gravel road of the Woreda is a road that connects Abobo-Gambela. All Kebeles have a road network that provides service mainly in winter, but some Kebeles doesn't provide service in summer.

The water supply source of the Woreda is mainly from both ground and surface water through hand Dug wells, shallow wells and spring development. Total number of water institutions in Abobo Woreda in 2010 was 81, but, in 2015 the total number of water institutions was 119 (FAEDOAW, 2015). In 2015 the number of water institutions has been increased by 31.93% when compared to 2010.

The Woreda capital has 24hrs electric service from the national grid hydropower source of energy. But, 1 rural and 2 urban Kebeles which have 24hrs electric service from hydropower source of energy among 19 Kebeles. And 1 rural Kebeles use solar system. However, the rest of 15 Kebeles doesn't have electric service. Instead, it uses fire wood and charcoal for cooking and lighting purpose from the forest. The fire wood used in the house is release carbon mono oxide in the air. Due to this reason, there is high household pollution caused by the energy used for food cooking. With regard to communication the Woreda has post office, digital telephone, & mobile telephone services in the Woreda capital & satellite telephones and mobile networks in the rural Kebeles (FAEDOAW, 2015).

Drivers and Pressure of Social Environment Change

The causes of environmental change are complex and there are numerous factors that lead to change ecosystems of water resources, and land.

- **Population growth:** The driver of environmental change is mainly the results of population growth. In the last two decades basically due to a number of reasons the populations of the Woreda increase with an average annual growth rate of 3.53 percent. Some of the following are the important ones,

(i) In the rural areas, due to high labor demand, the community prefers to have large number of children. Thus, the need for more labor force in the agrarian economy is among others the major cause aggravating pressure on natural resources.

(ii) Lack of awareness on contraceptive methods contributes to high birth rates in the rural population.

(iii) Even though, currently much attention is given to the provision of primary health care in the households, the provision of family planning services are still low. As a result, there is much more delivery and an increase to the existing population.

(iv) The current high fertility rates and youthful population affects adversely the quality and distribution of schools and health facilities and major infrastructural amenities.

- **Gender inequality:** there is gender inequality in the Woreda as well as in the region. Due to the fact that, the role of females in the protection of natural resources is very low (FGD). And also the participation of females in different sectors is very low. For instance, the percentage of qualified female teachers in preparatory schools in the Woreda as well as in the region is zero in 2017 (GRSEBESAA, 2017). Moreover, in 2010 all number of health post workers are males, the number of female workers is zero in the Woreda. This leads to the problem of work implementation in the institution. Due to this problem, the Woreda tried to participate female workers in some extent in 2015 (FAEDOAW, 2015). In any aspect the participation of females is very low in the Woreda.
- **Increasing the rate of poverty:** the rate of poverty is increasing year to year in the Woreda (FGD). Because, the source of income in the Woreda is mainly agriculture. Due to the fact that, the farmer follows traditional farming system it can't use an oxen or any other modern farming system mechanisms. But, it has been harvested different crops by digging the land every year. It leads to livelihood of the community is Vulnerability to food crisis referred as people's inability to secure a regular supply of food from their own farmlands. And also unwise use of natural resources, crop diseases and pests such as army worms, animal diseases and drought are aggravating the rate of poverty in the Woreda.

Impacts of Social Environment Change

Two hundred years ago, Malthus predicted that the power of population is indefinitely greater than the power of the earth to produce subsistence for man (Bilsborrow, 1991). In a latter period Ester Boserup (1981) forwarded contrasting views to the Malthusian theory and emphasized innovation and land use intensification as a response to population growth or resource scarcity. They focus on "population density" as a driving factor for innovation and the expansion of carrying capacity.

With high population growth rate of 3.53 percent, there is a very high demand over the available natural resources to satisfy the increasing demand by cultivating ecologically fragile and marginal hill sides, which exacerbated the condition of environmental degradation. Population growth cause over cultivation, increased the demand of fuel wood and constructional materials, settlement which ultimately resulted in soil nutrient depletion and dwindling proximate environmental resources and, there by resulted in declined food security.

Vulnerability to food crisis referred as people's inability to secure a regular supply of food from their own farmlands of through off-farm incomes. Thus, it is the product of shock or drought and low resilience due to poverty, conflict over scrambling of natural resources, climatic variability, crop failure, traditional farming system, dependency of food aid, and lack of off-farm employment opportunity. These are the perceived causes of vulnerability to household livelihood in Abobo Woreda.

Farm production in the Woreda is unsatisfactory and it resulted in low nutritional intake, where children are stunted and adults are prone to sickness and poor rate of recovery. This is usually happened in the Woreda, because of traditional farming system, pests on crop and climatic variability in every year. Moreover, poverty and poor nutrition has also contributed to low health status.

Responses to Social Environment Change

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

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

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

(iii) Improving the social and economic status of vulnerable groups (Women, Children and Elderly).

In line with the policy document, Ethiopia set out a national population program in accordance with national priorities as stated below:

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

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

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

2.2. Economic Environment

State and Trend of the Economic Environment

Ethiopia's economy is highly dependent on Agriculture. At present the economy of the country is growing at fastest rate. The economy uses natural and environmental resources as essential inputs in the production process. During the production process, resource material and energy are

transformed from one state to another. Economics and the environment are inextricably linked, as natural resources are the basis of production, manufacturing, and waste disposal.

The study area is characterized as agricultural economy where by the main social, and economic aspects are expressed in terms of traditional and backward features. The agricultural production system is mainly mixed farming, including crop and livestock productions. Major harvests are maize, sorghum, ground nut, sesame and rice, whereas, cotton and rice are cultivated by state farms and investors operating in and around the study area. And also vegetables, onions, and potatoes have produced in the Woreda. From FGD, pests and rats were reduced different crop products such as maize.

Similarly, animal husbandry is another major source of livelihood in the area i.e. Such as: cattle, sheep, goat, and donkey. In addition, fishing and apiculture are another source of livelihood.

Drivers and Pressures of the Economic Condition

- **Population growth**: The driving force behind economic policy-making lies in the macro-economic objectives. The macro-economic objectives should be environmentally and socially sustainable. The concept of studying population dynamics and economic environment is that its interlinked nature. As there are high rates of population growth in the study area, the demand to satisfy the increasing new comers increases in over exploitation of the available natural resources.

  According to Abate (2010), the study area has been experiencing vegetation degradation processes under the stress induced by both climate change and increased human activities. Forest cover change is the direct reflection of the dynamics of socio-economic development. Likewise, several factors stimulated by the activity of man are responsible for massive conversion of forest cover land into other land cover and land use units, All the factors of deforestation such as the prevalence of various types of agricultural activities, fire wood and charcoal production, cutting trees to fulfill the demand of constructional materials, settlement expansion and income generation are directly or indirectly related to population growth (Abate, 2011).
- **Reduction in labor force:** The farmer follows traditional farming system in the Woreda, and then it needs higher labor force. But, the temporary rural-urban migration in search for off-farm employments in urban centers labor forces were decrease in the Woreda.

Moreover, there are high school dropouts in the area due to labor shortage during harvesting seasons.

Impacts due to the Economic Condition

The nature of economic growth can be analyzed according to economic sectors. Three indicators of environmental pressure, namely sectorial composition, sectorial rate of growth and a change in sectorial production methods and techniques can be considered to understand the economic growth. Thus, the agricultural, and industrial and service sectors are used. The first two are to have a higher direct impact on the environment than the third sector.

The rate of deforestation and degradation of forest has been increased due to resettlement expansion, agricultural land expansion, fire wood and charcoal production, cutting trees to fulfill the demand of constructional materials, shifting cultivation and income generation. The living standards of the household are hand to mouse due to traditional farming system, and unwise utilization of natural resources. As a result, the households couldn't able to buy an oxen and farming by it.

FGD said that, crop failure due to pests such as army worms, animal diseases, increasing poverty, conflict over scrambling natural resources and climate variability were major problems in the Woreda. Livestock's per capita production is decreasing due to limited modern technique application, yield enhancing inputs and animal diseases. Therefore, the current livelihood strategy and pattern is a challenging task to promote sustainable development by protecting the environment. There is a higher risk and vulnerability to food insecurity.

Response of Economic Environment

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

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

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

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

GTP-I's (2010/11-2014/15) vision in the economic sector is "to build an economy which has a modern and productive agricultural sector with enhanced technology and an industrial sector that plays a leading role in 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."

The major objectives of GTP-I (2010/11-2014/15) are to

- Maintain at least an average real GDP growth rate of 11% and meet the Sustainable Development Goals,
- Expand and ensure the qualities of education and health services there by achieving the (SDGs) in the social sectors,
- Establish favorable conditions for sustainable state building through the creation of stable democratic and developmental state
- Ensure growth sustainability by realizing all the above objectives within stable macroeconomic framework. This broad social and economic aspect of the GTP-I are hanged 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
    - Promote women and youth empowerment and equitable benefit

Objectives of GTPII (2015/2016-2019/2020)

The overarching objective of GTP II is to sustain the accelerated growth and establish a spring board for economic structural transformation and thereby realizing the national vision of becoming a lower middle-income country by 2025. To this end, GTP II has set out the following specific objectives:

- Achieve an annual average real GDP growth rate of 11 percent within a stable macroeconomic environment and thereby contribute towards the realization of Ethiopia's vision of becoming a lower middle income country by 2025, while pursuing comprehensive measures towards narrowing the saving-investment gap and bridging the widening trade deficit.
- Develop the domestic engineering and fabrication capacity and improve productivity, quality, and competitiveness of the domestic productive sectors (agriculture and manufacturing industries) to speed up structural transformation;
- Further solidify the on-going public mobilization and organized participation to ensure the public become both owners and beneficiaries from development outcomes.

The pillar strategies of GTPII are built on that of GTP I complemented by additional pillar strategies that serve as foundation for sectorial plans. Therefore, in order to achieve the objectives of GTP II set out above, the following pillar strategies will be pursued.

- ✓ Sustain the rapid, broad based and equitable economic growth and development witnessed during the last decade;
- ✓ Increase the productive capacity and efficiency to reach the economy's production possibility frontier through concurrently improving quality, productivity and competitiveness of productive sectors (agriculture and manufacturing industries);
- ✓ Accelerate human development and technological capacity building and ensure its sustainability;
- ✓ Promote women and youth empowerment, ensure their participation in the development process and enable them equitably benefit from the outcomes of development;
- ✓ Build climate resilient green economy.

- ➢ Pesticides and herbicides were given by the government for the farmers.
- ➢ Awareness creation by the government to use natural resources wisely.

Outlook for Socio-Economic Environment

If everything continues as it is practiced as present, population growth within the study area nearly 3.53% will continue. In year 2018, there are 23,055 people living in the Woreda. Then, the coverage of settlement and crop land were increased by 0.24 and 9.51% respectively, but forest land were decreased by 14.3% from 1999 to 2018 in the Woreda (Land classification of land sat images of 1999, 2009 and 2018).

In the year 2037 population figure of Abobo Woreda would be beyond the carrying capacity of the environment. There will be nearly 44,568 people living in the Woreda. If everything continues as present, the coverage of settlement and crop land were increased by 0.48 and 19.02% respectively, but forest land were decreased by 28.6% from 2019 to 2037 in the Woreda. It indicates the subsistence mode of economic situation that based on farming land expansion will pressurize the limited natural resources. Then, natural environment could not be able to provide the environment service.

Implementing sector programs including policy Reform

If different interventions are taken to leverage the imbalance of over population to that of natural resource base, such as demographic programs incorporating family planning, health and education services are properly implemented, the demographic trend would be stabilized and change of the environment could be checked by 2037. Moreover, diversification of activities will generate income and minimized impact on a given natural resources that is instead of depending on forest for different purpose could be engaged in other activity such as api culture, poultry production and irrigation etc.

3. Physical Environment of Dibechi Forest Ecosystem

3.1 Land Use Land Cover Change of Dibch Forset Ecosystem



Figure 7: Entry of Dibechi Forest Ecosystem

Source field survey, 2018

Dibechi Forest ecosystem is located in Abobo district; Gambela peoples Regional State, Ethiopia. Abobo Woreda is one of the five Woredas of Agnwa zone in Gambella regional State. It is located 813 Km Southwest of Addis Ababa, Ethiopia. It is about 45 km south of Gambella (the capital of the region). (Brhanie et *al*, 2018). Geographically, the district is found between

$7^0$32’52”N to $8^0$54’7”N latitude and $34^0$7’4” E to $35^0$6’35”E longitude and the forest ecosystem is also found between $7^0$48’2”N to $7^0$59’32”N latitude and $34^0$35’22”E to $34^0$47’51”E longitudes. The total area of the *district* covers about 361324.42 hectares (Brhanie et *al*, 2018). Out of this 83714.4 (23.2%) ha are Crop land, 17226.5 (4.8%) ha wet land, 177406.8 (49.1%) ha forest land, 1533.4 (0.42%) ha water body, Grass land 25814.98(7.14%), Bare land 34450.9 (9.53%) and the rest 21177.22 (5.86%) ha are wood lands (AWAO,2018). and has 17 rural Kebeles administrations and two urban administrations a total of 19 Kebeles (AWAO, 2018), whereas the total area of Dibechi forest ecosystem is covered about 29637.62 hectares. According to the FAO (2004) report, since 1987 there were six LULC types namely: woodland, forestland, grassland, wetland, farmland and bare land.

The district has two agro-climatic zones woyna dega (10%) and kolla (90%). Accordingly, the mean annual minimum and maximum temperature ranges between 18ºc and 39ºc, respectively in this area the temperature experiences very hot during the months of February and March and it reaches to 45- 47ºc. The average annual rainfall ranges between 900-920 mm. and the main rainy season in the *district is* from mid-April to October (AWAO, 2018).

The average annual rainfall ranges between 900-920 mm. The main rainy season is from mid-April to October. The elevation range is also varies from 500m.a.s.l in the Western and central part to 700 m a.s.l in the North-eastern and South-eastern part. The North-eastern and South- eastern parts of the district are relatively highest elevation and Western most parts of the area are characterized by the lowest elevation.

Agriculture is the main means of livelihood, which is mixed agriculture type in the district, but the majority of the people are focusing on seasonal fruit productions such as papaya, mango and vegetables such as tomato and onion are also produced on a small scale. There are a few numbers of dwellers involving in off-farm activities as a means of livelihood as well. Since study area is potentially favorable for agriculture. Today a number of local investors are also engaged in agricultural crop production such as rice, cotton and mango (AWOARD, 2010).



Figure 8: Figure FDGs were discussed about Dibechi forest at Kebele level

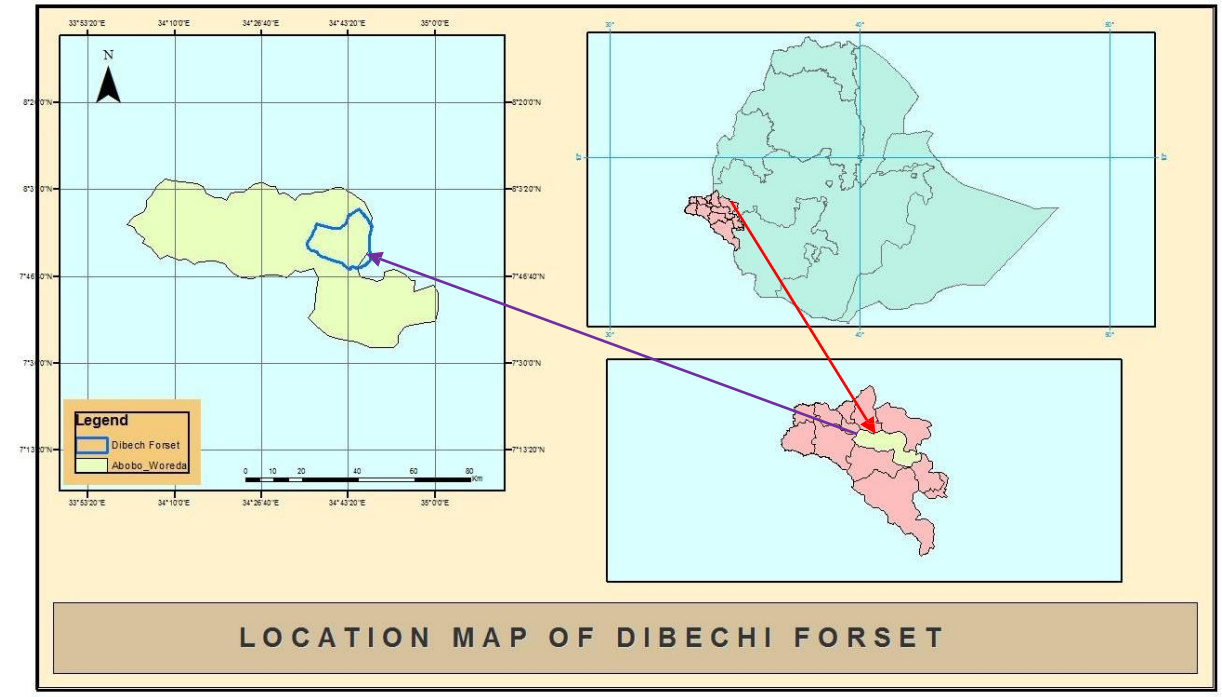


Figure 9: Location map of Dibechi Forest Ecosystem

There are four rural Kebeles bounded the natural ecosystem of Dibechi Forest, namely, Ekunna, Cherchiru, Aberi and Sobekier The above listed Kebeles are the direct beneficiaries and main contributor for the degradation and deforestation of the Dibechi Forest ecosystem.

3.1.1. State and Trend of Land Use land cover Change of Dibechi Forest Ecosystem

Land cover (LC) refers to bio-physical covers of land surface (Pontius, R. 2007). While, land use (LU) is arrangements, activities and inputs carried out in certain LC. Change of LU refers to alteration in management of land by humans, which may lead to LC change (IPCC, 2001). For instance, among other activities agriculture is the major LU that has led to environmental problems (FAO, 2016). Environmental deprivation limits ecosystem services capacity to produce food, fibers and energy. Such problem is common in Africa, sub-Saharan regions, where internal and across territories displaced people exist.

Land-use and land-cover changes (LUCC) increasingly have been regarded as a primary source of global environmental change such as emission of greenhouse gases, global climate change, loss of biodiversity, and loss of soil resources. However, the causes of LUCC are complex and change over time and from region to region. In recent times, land use/ cover (LULC) has generally been considered a local environmental issue, but it is becoming a force of global importance. Worldwide changes to forests and farmlands are being driven by a number of factors (Foley et *al*., 2005).

The pace of change in land use and cover in Ethiopia depends on three main factors that cause pressure on agriculture land: resettlement programmers, population growth and increasing agricultural investments (Azeb, et *al* 2018). Abobo is the district that attracts large-scale agricultural investments that extensively drive land use and cover changes in the region. This fact sheet preparation is to determine the rate, extent and distribution of various land use and cover changes and associated consequences which tacks place in Dibechi Forest Ecosystem, from land sat images 1999 to 2018.

The local specific forces like regional or local policies (Faust, 2007). Obviously, the outstanding characteristics of particular cases, such as economy, culture, climate, and policy, often were considered as the important driving forces in the explanation of LUCC dynamics LUCC in Gambella region at Abobo district is including the Dibechi Forest an outcome socio-economic reason. With the expansion of large scale land acquisition and demographic change results significant and rapid changes in LUCC in the area.

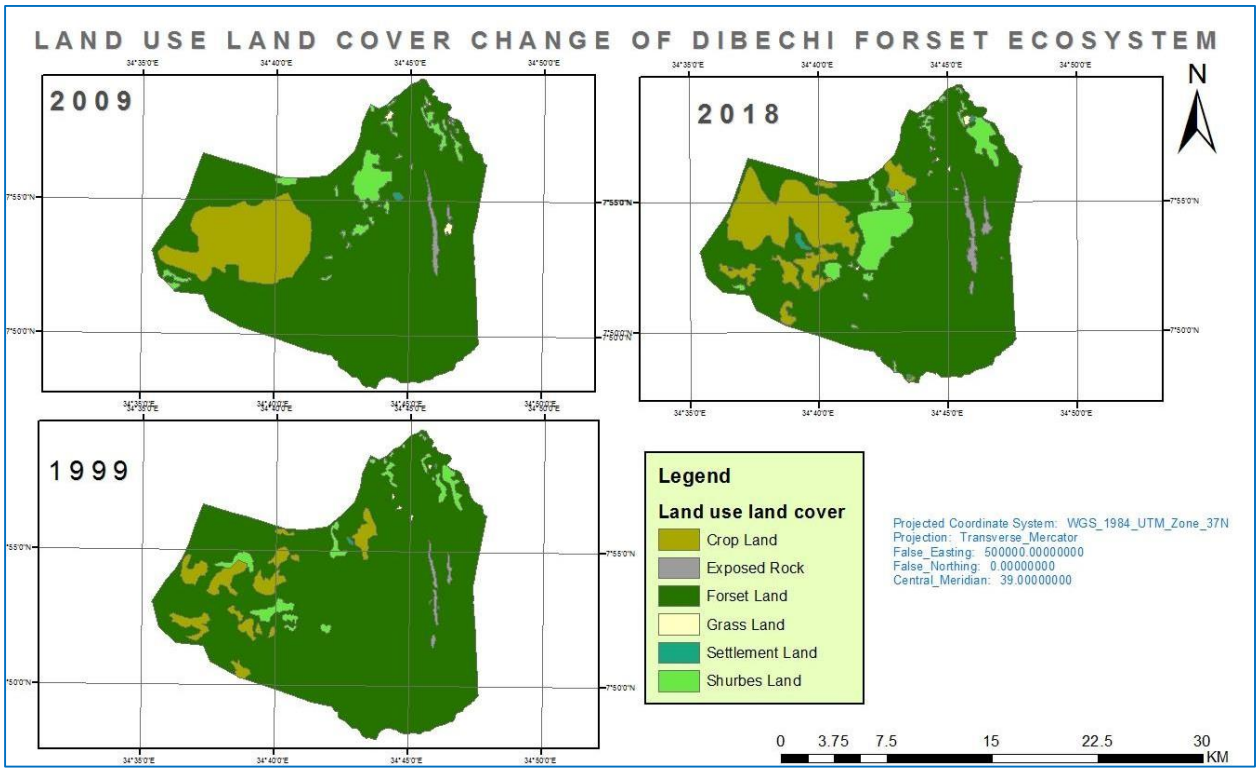


Figure 10: Land use land cover classification in the year: 1999, 2009 and 2018

As indicated in the above maps we conducted to explore extent, trends, and identify causes of land use land cover (LULC) changes over the period, 1999, 2009 and 2018 for about 19 years along with inspecting resettles' involvements in natural vegetation conservation in Abobo district particularly in Dibechi Forest Ecosystem.

Table 6: Land use and land cover classes considered and their descriptions

No	Land use type	Descriptions
1	Crop land	This class describes land which is mainly used for growing crops. Crops in this land are either grown by irrigation (commercial farmland) or are rain-fed (small-scale farmland).
2	Grass land	This class of land cover defines grassland or tropical savannah as the main vegetation cover.
3	Forest land	This class describes the areas with evergreen trees, mainly growing naturally.
4	Shrubs land	Refers to those areas covered with tree, shrub, bushes and some grasses that dominate the foot-slopes and rive ring landscapes. There exists variation in vegetation between dense shrub with an estimated cover of >50% and open shrub lands with less than 50% cover.
5	Bare land	Refers to those land surface features devoid of any type of vegetation cover.
7	Settlement	This class describes the land covered with buildings in the study area. It includes commercial, residential, industrial and transportation infrastructure.

Source adapted and modified from (**Azeb et *al***, 2018)

Based on the patterns of LULC satellite image analysis of 1999, 2009 and 2018 indicated that six LULC categories were identified, namely: crop land, forest land, shrubs land, grass land, settlement and exposed rock in the three consequent periods.

Table 7: Land use land covers distribution for (1999, 2009 and 2018) in Dibechi Forest.

Land use land cover classes	**Year 1999**		**Year 2009**		**Year 2018**		**Rate of change b/n 1999-2009**	**Rate of change b/n 1999-2018**
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)		
Crop land	1659.52	5.6	4144.57	13.98	4477.6	15.11	2485.05	2818.08
Grass land	24.29	0.08	70.92	0.24	58.02	0.2	46.63	33.73
Forest land	26861.2	90.63	24031.8	81.09	22620.82	76.33	-2829.33	-4240.33
Shrubs land	902.55	3.05	1167.64	3.94	2074.32	7	265.09	1171.77
Exposed Rock	171.4	0.58	197.37	0.67	316.07	1.07	25.97	144.67
Settlement	18.72	0.06	25.31	0.09	89.7	0.3	6.59	70.98

Total	29637.6	100	29637.6	100	17834.5	100	5658.66	8479.56

Source: Land classification of land sat images of 1999, 2009 and 2018

The land use land cover classes of 1999 have prepared from satellite image of land sat and involved six main land use land cover categories: Exposed Rock, Forest land, Settlement, Crop land, Shrubs land and Grass land. In the year 1999, about 90.63% was covered by forest land, 0.08% by grass land and 5.6% by crop land; 3.05% by shrubs and 0.06% by settlement and 0.58% was covered by exposed rock. In this period forest land has high coverage and grass land has less coverage.

The land use land cover classes of 2009 have also sex main land use land cover categories: as already mentioned as in the period of 1999, in the year 2009, 0.09% was covered by settlement, 81.09% by forest land, 13.98% by crop land; and 3.94% covered by shrubs lands.

The land use land cover classes of the year 2018 have sex main land use land cover categories: in this year crop land was covered by (15.5%), by forest (76.33%) and by settlement (0.3%), by shrubs land (7%) by exposed rock (1.07%) and grass land (0.2%) as indicated in the above three year's forest land was dominantly covered the area. The main causes of LULC changes were identified as crop land expansion, fuel wood extraction and wildfire; are being the major causes as substantiated by field trip verification.

Table 8:land use lands cover change detection in the year 1999, 2009 and 2018.

No	**Land use land cover classes**	**Change detection between (2009-199)**		**Change detection between (2018-2009)**		**Change detection between (2018-1999)**	
		Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
1	Crop land	+2485.05	+8.38	+333.03	+1.12	+2818.08	+9.51
2	Grass land	+46.3	+0.16	-12.9	-0.04	+33.73	+0.11
3	Forest land	-2829.3	-9.55	-1411	-4.76	-4240.33	-14.3
4	Shrubs land	+265.09	+0.89	+906.68	+3.06	+1171.77	+3.95
5	Exposed Rock	+25.97	+0.09	+118.7	+0.4	+144.67	+0.24
6	Settlement	+6.59	+0.02	+64.39	+0.22	+70.98	+0.314

Land use land covers change detection between 1999 and 2009

In the period between 1999 and 2009 for around 9 year's interval except forest land, others land use types have a positive trend. Due to expansion of agricultural activities by the community and others private investors crop land increased by 8.38% shrubs land 0.89% and settlement 0.02% respectively.

Land use land covers change detection between 2009 and 2018

As indicated in the above table 3, there is land use land cover changing trend in the years of 1999 to 2009; commonly the changing might be positive or negative trends. As a result in this period grass land, forest land, in Dibechi forest ecosystem have negative trends, whereas crop land settlement exposed rock, and shrub lands have positive trends. This result showed that, the forest land and grass land were changed to crop land and the shrubs land may change to settlement and exposed rock etc.

In the period from (1999 - 2018) have high positive trend in crop land, grass land settlement area; exposed land and shrubs land whereas forest land has a negative trend in area. As we observed from the figure below, the local communities were activated in the action of deforestation in Dibechi forest throughout the day for the purpose of agricultural land expansion.



Figure 11: Photos which shows burning of forests (field survey, 2019)

As we have seen in the above table 8, the crop land was increased by 8.38% from year 1999 to 2009 and the forest was converted to crop land and shrubs land and decreased by 9.55% grass

land increased by 0.16% and converted to crop land, shrubs land increased by 0.89%, exposed rock increased by 0.09% and settlement increased by 0.02% respectively.

In the year between (2009-2018) the land detection analysis showed that, about 3.06% Shrubs land was increased and converted to other forms of land, grass land was decreased by 0.04% and changed to crop land and exposed rock, forest land was decreased by 4.76% and settlement increased by 0.22% due to population increment in the area.

Over the entire changing trend from (1999-2018) for the given 19 years, about 14.3% forest land was decreased and converted to shrubs land and settlement and crop land, shrubs land was increased by 3.95% and converted to crop land the crop land also increased by 9.51% for the sake of crop cultivation.

As we observed from the above figure, the local resettlement communities were illegally devastated the existing natural forests which are found in Dibechi forest ecosystem. According to Tamrat K. (2010) argued that an impact of resettlement in Abobo district has significantly affected natural vegetation, which leads to sever deforestation and degradation. Therefore, this implies that the resettlement has contributed in changing LULC of the study area. Furthermore, regarding the current status of the vegetation; key informants confirmed that now, the vegetation is rapidly depleting due the communities by themselves and by the regional government to allowing the private investors to expand the agricultural lands as they need to be deforested the existing natural habitats / forests/.

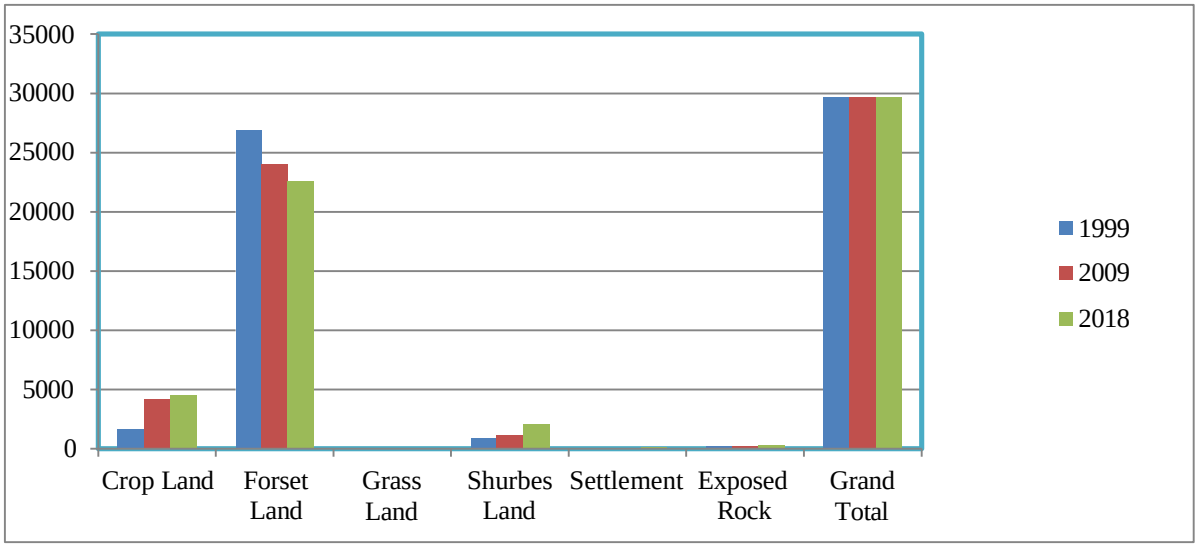


Figure 12: Summary of land use land cover extent by percentage (from 1999-2018).

3.1.2. Drivers and pressures for land Use Land Cover Change

Drivers for land Use Land Cover Change of Dibechi Forest Ecosystem

The Gambella region has both a unique ecology and extraordinarily rich forest diversity. At the same time, the level of resource use in the Gambella region is still comparatively low. This explains why the main mechanism of LULCC in the Gambella region is agricultural land expansion (Azeb et al, 2018). Besides the spread of small-scale farming as a result of the population increase, one of the main agricultural development policies is large-scale farming investment. It is promoted by the Ethiopian government as part of an infrastructure expansion and economic stabilization program me. Since 2005, the country, as well as the Gambella region, saw a flow of domestic and foreign investment into commercial farming. These developments, which began in the 1980s and are still ongoing, have a major impact on the magnitude and nature of LULCC in the Gambella region and throughout the whole of Ethiopia. It is therefore highly relevant to assess and understand LULCC in this region. Existing studies so far have mainly focused on either deforestation or LULCC in specific districts of the Gambella region.

On top of that, according to the views of the majority FGDs suggestions, the driving forces of LULC changes in the study area were crop land expansion, wildfire and fuel wood extractions Hence, LULC of study area was facing a great challenge from agricultural expansion and fuel wood harvest. Expansion of rapid population growth, more production and changing technologies, economic growth, cultural diversity and government policies are the major drivers of LUCC dynamics in the world today. However, large scale commercial farming, resettlement,(drivers) wild fire, crop land expansion and fuel wood harvest,(pressure) and population growth are among the many drivers in the area. The socio-economic, political, cultural, demographic and environmental conditions are largely characterized by high human populations the land use land cover pattern of an area is an outcomes natural socio-economic factors and their utilization by human in time and space.

Pressures for land use land cover change

LUCC is nowadays are necessary and essential for economic development and social progress; however, it leads to social and environmental costs (Wu, 2008). The changes are not only driven by natural processes, but mainly due to human interferences, such as unsustainable utilization of

natural resources such as deforestation, commercial farm expansion, and settlement/encroachment, and wild fires. LULCCs are traditionally interpreted by distinguishing two transformation types: conversion and modification. Land use/land cover conversion refers to the complete replacement of one land cover type with another, while land use/land cover modification refers to the more subtle changes that affect the character of the land cover without changing its attribute classification.

The resettlement program, combined with socio-economic development has placed tremendous pressure on Dibechi forest ecosystem for wild fruit and crop production. In the current context of declining forest natural ecosystems, coupled with increasing pressures on land resources, land use change is often associated with degradation that reduces forest and ecosystem services. Therefore, the pressures for this land use land cover change are intensive farming, wild fire, fuel wood consumption.

3.1.3. Impacts of land use land cover change of Dibeh Forset Ecosystem

Land use land cover is determined by the combined effect of biophysical and socioeconomic factors, it is a fundamental indicator for integrated management and land quality assessment over time (Freire *et al*, 2009). In other ways land use and land cover changes (LULCC) involve either a shifting to a different land use or an intensification of existing land (Ankana, 2016). Currently, across the world, an increasing demand for space for settlement, agricultural investment and industrial activities is being observed. This leads to unprecedented LULCC, and these have caused both socioeconomic and environmental problems. Human use of land has had a profound effect upon the natural environment resulting in an observable pattern in land use and land cover (LU/LC) over time.

Hence land use has a significant impact on forest characteristics, potentially causing large-scale changes in the extent of forest cover in Dibechi forest and elsewhere: - In the area resettlement program, demographic growth and large-scale land investment has caused social and environmental impacts, as forests are cleared and communities are displaced, or lose access to crop land, forest or water resources. Particularly, large-scale land investment without proper environmental impact assessments and unplanned resettlement programs were the cause of enormous LULCC in Abobo district including Dibechi forest.

Most community residents were not convinced that anything good will come out of the transfer of their land to outsiders, though a few of our interviewees said that they had positive expectations initially but not any longer. Everyone is now apprehensive that the clearing of the land by investors, and the large-scale deforestation this has caused, will bring social and economic hardship and that wildlife which used to be plentiful in the area, and which they hunted occasionally for consumption, have now disappeared.

The major impacts of the existing relationship between LULCCs and land degradation sensitivity include:

1. **Crop intensification** determining soil pollution due to an increase in chemical use;
2. **Settlement expansion** favoring soil sealing and the consequent alteration of the hydrogeological cycle; and
3. **Deforestation** causing biodiversity loss and habitat fragmentation
4. **Nutrient depletion** as a form of land degradation has a severe economic impact at large scale due to burning of essential elements which are fund in the soil and plants.
6. **LULCC became source of land degradation** and this degradation is also a major challenge to humans in terms of its adverse impact on biomass productivity and environment quality.

3.1.4. Response measures in improving the status of land use land cover change

Upon the land use land cover change perspective, the local communities, the district and the Gambela region had not taken any response to reverse the degradation and rapid land use land cove change dynamics of Dibechi forest ecosystem for the last 19 years and now also have not any plane in the future.

3.1.5. Outlooks

The indigenous people are depended on forest-covered for their livelihood for generations and despite well-founded fears that the deforestation of the area due to commercial farm could have serious and potentially irreversible effects on the people, habitat, wildlife and water.

In general land use land cover change that results in land degradation and the associated loss of land function is driven by multiple interacting elements from the local to global scales over the coming decades. According to (Land detection analysis, from 1999-2018), the cultivated land expanded by 9.51%, shrubs land increased by 3.95%, exposed rock increased by 0.49% while the

forest land was declined by 14.3% between (1999 and 2018) and the rate of forest degradation was declined by 0.75% per year and the rate of crop land expansion was increased by 0.5% per year for the last 19 years Therefore, as business as usual, we can dedicated that, in the coming 50 years the total crop land will expand to 25% while the forest land will be declined to 37.5% if the rate of increasing crop land and the rate of decreasing forest land per year remain the same. So the all over land use land cover change and the land degradation becomes dangerous.

Hence, based on the result of the discussion of the LULCC, the following recommendations were suggested:

a) Resettlement and forest conserving are incompatible, so it is essential to take into account in planning and completing of future resettlements programs.
b) Trainings should be provided to development agents and extension workers concerning ecosystem service; create awareness to local communities 'regarding the importance of indigenous forest species which are found in the district and Dibechi forest ecosystem as whole.
c) Reforestation activity should be promoted through actively involving the local peoples.
d) The *District* administrators in cooperation with the regional government should struggle illegal Agricultural expansion.
e) The federal and regional government should design environmentally friendly alternative investment options.

3.2. Land Degradation in Dibechi Forest Ecosystem

State and Trend of Land Degradation in Dibechi Forest Ecosystem

According to Encyclopedia Land, in economics, is the resource that encompasses the natural resources used in production. In classical economics, the three factors of production are land, labor, and capital. Land was considered to be the "original and unlimited gift of nature." In modern economics, it is broadly defined to include all that nature provides, including minerals, forest products, and water and land resources. While many of these are renewable resources, no one considers them "inexhaustible. "Land degradation leads to alteration of ecological and economic functions due to a decrease in productivity and quality of the land. Land degradation, a decline in land quality caused by human activities, has been a major global issue during the 20th century and will remain high on the international agenda in the 21st century. The

importance of land degradation among global issues is enhanced because of its impact on world food security and quality of the environment.

Land degradation is the process that makes land unsuitable for human beings as well as for soil ecosystems, occurs in arid, semi-arid and sub humid areas as a result of anthropogenic activities and climatic variations (Barbero-Sierra et al., 2015).

Land degradation can be considered in terms of the loss of actual or potential productivity or utility as a result of natural or anthropic factors; it is the decline in land quality or reduction in its productivity. In the context of productivity, land degradation results from a mismatch between land quality and land use (Beinroth *et al.,* 1994).

Table 9: The Proportion of land owned by community at district level

No	Proportion of land owned by community	Value in ha	Value in %
1	Grazing and exposed soil	171581	62.4
2	Water body	12041.64	4.3
3	Agricultural lands	13146.93	4.78
4	Forest lands	57120.6	20.78
5	Bush and Shrubs	14495.8	5.27
6	Others lands	6429.2	2.33
	Total	**274815.17**	100

Source AWADO, 2018

As the FDGs and key Informants explained that, the land use change value in the area are huge amount forest are cleared and changed in to crop lands to produce maize and sorghum. Before 5 years they got 25 to 30 quintal maize/ ha but now, they are only producing 15-16 quintal maize /ha due to a decline in soil structure leading to crusting, compaction, erosion, desertification, anaerobic, environmental deterioration and unsustainable use of natural resources. Significant chemical processes include acidification, leaching, salinization, decrease in cat ion retention capacity, and fertility depletion.



Figure 13 shows acidification and fertility depletion through burring of plant spps by resettlement

Source field survey, 2018

According to the views of local communities the average land holding and distribution is about 4.5 ha/house hold. These situations showed that, a number of farmers have an access to land, but due to lack of awareness they deforested the existing forests. In addition to deforestation there are many other proportion of land affected by wind erosion was recorded to be 3.2%, 6.44% by rill erosion 3.37% by sheet erosion 6.68% by gully erosion 11.95% by stream bank erosion and 68.33% by sedimentation problem. Vulnerable lands are exposed to stresses such as accelerated soil erosion by wind, soil acidification and the formation of acid sulphate resulting in barren soil, and reduced crop yields. Agricultural activities such as shifting cultivation, without adequate fallow periods, absence of integrated soil and water conservation measures, pesticides use and a host of possible problems arising from faulty planning or management of the land all lead to intense land degradation within the study area.



Figure 14 Indigenous forests like cordia Africana/wanza/ spps were destroyed by investors

Source field survey, 2018

As we have seen from the above figure, without the willingness of the local people, private investors were invasive the forest land and they already changed to crop land using different machines like tractor and dozer therefore, Agricultural policies can have a profound effect on land degradation. Subsidies, incentives and taxes can all have a big effect on what crops are grown where and whether or not the land is well managed. Governments attempting to achieve self-sufficiency in food crops frequently promotes policies which result in marginal land being misused, this, in turn leads to land degradation.



Figure 15: clearly showed that, how dense natural forests are devastated by community

Source field survey, 2018

According to the annual report of (AWAO,2018),there are about 12 private limited companies were established in Gambela region two of them are found in Abobo district where the Dibechi forest ecosystem is located. To mention the name of PLC, **Saudi star agricultural development PLC and Green Valley Agro** PLC both of them are mainly produced different cereal crops like cotton, oil seeds, pulses, fruits vegetables and flowers. As we know, Private investors are already making a significant contribution to agricultural development. Experiences of developed economies clearly show that as an economy grows there is a tendency for some small farmers to quit the sector and seek employment in other sectors, and there are others who accumulate enough capital to go big in the sector. This implies that there is a direct correlation between agricultural growth and the role of private investment in the sector. However, they exaggerated the enabling environmental conditions in general and damage useful tree species in particular in the study area.



Figure 16: The Dibechi forest has cleared by burring of fire for investment
(Source filed survey, 2019)

But the response of FGDs interviewed on the private limited companies as follows

"Before some years, there was a severe shortage of maize because of the drought. We managed to survive the hunger that ensued because we were able to collect roots and other edible plants from the forest. We were able to eat because of the forest. Since the forest has been cleared, I do not know what we are going to eat if there is another food shortage. When there is food shortage it is we women and our children who suffer most because the men go to the towns to look for daily labor. In the past we depended on the forest to get food but now that the forest has been cleared we fear that our children will die of starvation. Therefore we are not happy with the coming of the private investors. In brief the investors will not provide any benefits to us; they have come only for their own interest". While Some Peasants also feel bitter about the destruction caused by the clearance of land undertaken by the investors and displacing of old and much valued trees. But most of them were damaged the forest ecosystem, as indicated in the figure: 5 below.



Figure 17: shows burning of indigenous forest species and deforestation for tradition ship

Source field survey, 2019

Drivers and pressures for land degradation

Drivers in general comprise the factors that bring about socio-economic and environmental changes. They operate at various spatial and temporal levels in society. Land degradation which is also seen as a decline in land quality caused by human activities, has been a major global issue since the 20th century and it has remained high on the international agenda in the 21st century. The importance of land degradation is enhanced because of its impact on food security and quality of the environments. Hence land degradation is the most series environmental problem in

Dibechi forest natural ecosystem associated with the burning of important trees species by the private investors and local communities. The drivers of land degradation are numerous, complex and interrelated (Nkonya *et al*, 2011). However, the main drivers of land degradation are

- Population growth
- Land tenure problem
- Un controlled fire
- In appropriate land use problems
- Resettlement programs
- Rapid expansion and unsustainable management of crop lands is the main driver of land degradation, causing significant loss of biodiversity and impacting food security, water purification, the provision of energy, and other contributions of nature essential to the local people.



Figure 18: Farmers delebrately divastated natural forest by fire

Source field survey, 2019

As we have shown from the figure: 18 above, the local youths illegally burin the mulches, the crop residue and other important trees species this accelerates the land degradation problems. This picture clearly show that, how, rapidly depleting the forest land by poor management systems and how could affect the sustainability of environmental conditions.

As shown in the figure above, this charcoal production was collected in Abobo Woreda Administrative office and it was out of use because it exposed to rain fall, sunlight and other externalities.

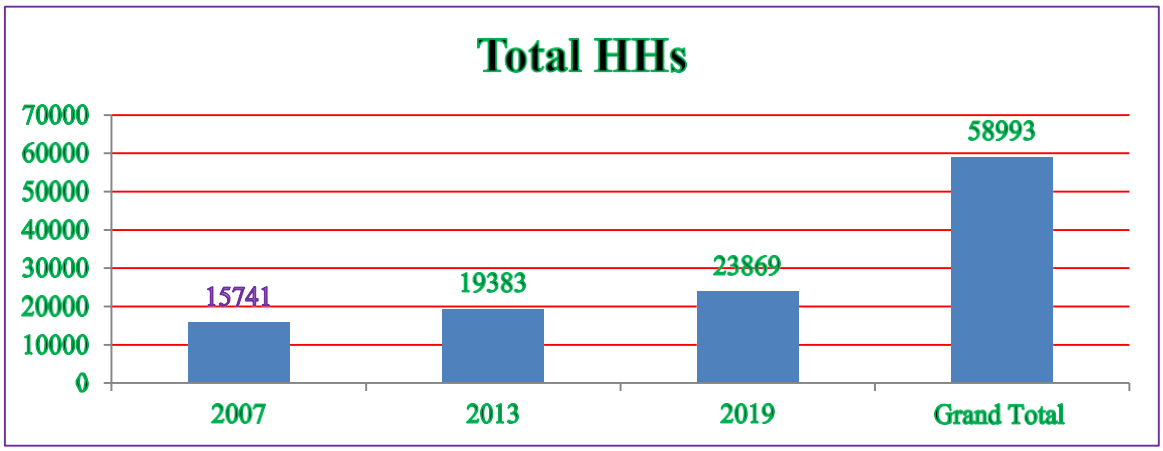


Figure 19: Population growth rate at Abobo district between 3 consecutive years.

As indicated from year, 2007 to year 2013 the population numbers increased by 18.7% and from year 2013 to 2019 the population increased by 18.7% and the total population growth rate from 2007-2019 was increased by 18.7% this indicated that the population numbers alarmingly amplified in Abobo district for the last 12 years.

- ✓ **The pressures** of land degradation in the area are deforestation, intensive farming, over use of agro-chemicals, excessive use of natural resource, land fragmentation and expansion charcoal extraction.

Impact of land degradation on livelihood system of local community

Biological processes include reduction in total and biomass carbon, and decline in land biodiversity. The alteration in ecological and economic functions due to the decrease in the productivity and quality of the land can lead to decline in the biological productivity of land due to climate change and human activities Land degradation poses a great threat to food security and damages the environmental safety of land as well as influences the sustainable development of society and economy (Zhao et al, 2013). “Land degradation, biodiversity loss, and climate change are three different faces of the same central challenge: the increasingly dangerous impact of our choices on the health of our natural environment,” said Sir Robert Watson, chair of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES. The major impacts related to land degradation are:-

1. **The loss of gross agricultural output**: in a single year due to land degradation in the same period of time. The comparative format is generally if no land degradation took place. The concept is "gross" because it does not account for
    - the cost of combating land degradation or
    - Any cost reductions related to lower production.

2. **Loss of soil fertility***:* Because the loss of soil particles is irreversible, the *loss in any one year* will affect production in all future years. In other words, this concept captures a loss of natural capital and is relevant for any discussion on adjusting the System of reflect environmental damage.

3. **Soil erosion and nutrient removal***:* This concept capers the fact that land degradation is a cumulative process, in which each year's erosion and nutrient removal is followed by another, adding layers of cost on top of each other.

4. **Loss or decline of crop production**

Response measures in improving the status of land degradation

Above and beyond the intensified of land degradation problem in the area, No response has been taken to protect the land from degradation by the region, district and by the local people pending this study has been conducted.

Option for future action /outlooks/

More than 75 percent of Earth's land areas are substantially degraded, undermining the well- being of 3.2 billion people, according to the world's first comprehensive, evidence-based assessment. These lands that have either become deserts, are polluted, or have been deforested and converted to agricultural production are also the main causes of species extinctions. If this trend continues, 95 percent of the Earth's land areas could become degraded by 2050. That would potentially force hundreds of millions of people to migrate, as food production collapses in many places, the report warns.

IPBES is the "IPCC for biodiversity" a scientific assessment of the status of non-human life that makes up the Earth's life-support system. The land degradation assessment took three years and more than 100 leading experts from 45 countries. The same problems are also found

in Dibehi forest ecosystem for example, the major sensitive land use type for land degradation, are crop land and exposed rock were covered 16.57% for the last 19 years. If the rate of land degradation continue in the same rate by 0.872% business as usual scenario, for the coming 2050 or 32 years, the rate of land degradation at Dibechi forest ecosystem, will cover around 27.9% unless the regional government of Gambela, the Abobo district and the local people will not take any response regarding to the land degradation and complications of this forest ecosystem.

3.3. Forest and Woodland Degradation in Dibechi forest ecosystem

Operational definition of relevant terms

Forest: FAO (2001) defines a forest as "land with a tree crown cover of more than 10% and an area of more than 0.5 hectare; the trees should be able to reach a minimum height of 5 meter at maturity".

According to MEFCC (2015) Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 20 % or tree height of 2 m and an area more than 0.5ha are included under forest, areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest.

Woodland: is an open stand, at least 10 meter tall with canopy cover of at least 40 percent and its field layer usually dominated by grasses. It is a low-density forest forming open habitats with plenty of sunlight and limited shade.

A **shrub** or **bush** is a small- to medium-sized woody plant. Unlike herbaceous plants, shrubs have persistent woody stems above the ground. They are distinguished from trees by their multiple stems and shorter height, and are usually under 6 m (20 ft.) tall(Anna and William,2006). Plants of many species may grow either into shrubs or trees, depending on their growing conditions.

Forest degradation is the decline of the capacity of a forest to produce healthy ecosystem products and services such as the provision of timber and other resources, support to biodiversity, carbon storage and as a result of environmental and anthropogenic changes. Forest degradation results owing to decrease in tree cover, the biodiversity in the forests or the changes to a lower state of the forest structure.

State and Trends of forest and woodland degradation

Forests are one of the most important natural resources with diverse economic, sociocultural and ecological uses. The livelihoods of hundreds of millions of people worldwide have been engaged on forest products either directly or indirectly (Anonymous, 2008). Mostly, indigenous forest dwellers were the primary users of forest resources to a higher degree for domestic uses and income generation.

According to MEFCC, 2017, there were four vegetation types in Ethiopia. Those are Acacia Commiphora, Combretum Terminalia, Dry Afromonotrne, Moist Afromonotra and Moist Afromontra.

Even if Ethiopia is the centre for diverse flora and fauna, these resources are under immense pressure from deforestation and forest degradation, overexploitation, overgrazing, habitat loss, invasive species and pollution. Recently, it is reported that about 14% (2.1 million hectares) of forest cover in the country was lost since the close of 1990s (Fekadu, 2010). The depletion of forests has many ecological, social and economic consequences, including the extinction of biotic communities leading to reduction in biodiversity, soil erosion, global warming and loss of income to forest dwellers (Friis et al. 2011).Continued degradation of the forests can destroy the entire forest cover and biodiversity, and it mainly occurs because of environmental and anthropogenic changes (Abraham, 2016). A growing influence of forest based livelihoods, illegal harvesting of forest products, expansion of farms, overgrazing and other activities were identified as major causes of forest degradation (Fekadu, 2010, Ministry of Environment and Forest, 2014). Due to similar reason, the remaining natural high forest species and woodlands (e.g. Aningeria adolfi-friederci, Arundirania alpina, Albiza schimperiana, Prunus africana, Podocarpus flactus) of the southern and south-western parts of the country were found to be highly vulnerable (Kumlachew, 2003).

In Gambella region Forest land and savanna/grasslands are declining from 1641 km^2 to 1566 km^2, from 1006 km^2 to 693 km^2 respectively. The region covers 9% of the high natural forest. The indigenous people are depended on forest-covered for their livelihood for generations and now deforestation of the area due to commercial farm could have serious and potentially irreversible effects on the people, habitat, wildlife and water (Moges et al., 2014).

According to Abobo Woreda Agriculture office (AWAO, 2018) report the total land area of Abobo Woreda was about 361,324.2 ha of which about 177,408.8 ha and 21,177.22 ha was forests and woodlands respectively. surrounding Kebeles such as, (**sobekire, Oukuana, Tercheru and Aberae**) that was nearly beneficiary and**/**victim from Dibechi forest ecosystem. Each group in FGD consists of 12 individuals and also had a trained facilitator as

well as language translator (i.e. there were 4 translators, one from region forest directorate, one from Woreda forest sector, 2 from Kebele development agent) who guided the participants through sets of prepared questions related to their opinion on forest cover change, drivers of deforestation, their impact, existing remedies and possible solutions., whereas key informants with Kebele administrator and development agents as well as Landsat image are another source of primary data, on the other hand secondary data was collected from published documents, region and Woreda reports.

As we discussed in FGD Dibechi was one of the densely plant and animal populated ecosystem in the previous years but know the forest coverage was declined alarmingly due to various reasons, such as the settlement, agricultural land expansion, increasing fuel wood consumption, boat making and large scale investment.

As we were observed the whole part of the ecosystem the coverage of forest was dramatically changed from forest and wood land to human settlement, agricultural land, investment purpose,

and for boat making. On the other hand FGD participants explained that the changes in government in 1985 (from Dreg's regime to EPRDF regime), had brought disturbed the coverage of natural resource especially forest resources as well as endemic animals. The participants additionally explained that Dibechi forest were degraded mostly for agricultural purpose through burning the forest stem near to the root zone then they cut the forest easily to use the land for cultivation in one round year and also they need to burn other forest area in the next crop season because the forest land that was changed in to agricultural land in one crop season generate or grow different weeds such as runner|serdo that is difficult to cultivate again in another rainy season these is due to the presence of poor farming instrument (i.e. they cultivate there land through digging only),so the residents need to burn and cut other forest area that is suitable and easy for cultivation. These mechanism of forest clearing was enter changeable in any forest area, this damage not only the plant species, but also it damage endemic animal species as well as fluctuate the rainfall and climatic condition of the environment.

Table 10: Land use land cover change of Dibechi forest ecosystem

Year	Total land	Forest land		Percentage change from the year 1999 to 2018	
		Area (ha)	%	Area(ha)	%
1999	29466.23	26861.15	90.63		
2009	29440.26	24031.82	81.09		
2018	29320.46	22620.82	76.33	-4240.33	14.3

Source: From GIS land use land covers detection

As we see in the table above, the forest coverage of Dibechi forest ecosystem was declined from 90.63% into 76.33%. In the meantime, most of the local community used those large natural trees for their own purpose such as to do mortar, boat making, honey production and house construction at this time forest in general or large trees in particular was converted in to shrubs, consecutively the coverage of shrubs were raised.

Table 11: List of tree species found in Dibechi forest ecosystem.

No	Scientific Name	Amharic Name	Local Name
1		ሾላ(shola)	Olam
2	Nicotina tobacco	ቶባኮ	Asawa
3	Maesa lanceolata Forssk	ዋንዛ	Orogu
4	Prunus Africana	ዋርካ	Myro
5	Eucalyptus globulus	ባህርዛፍ	Atiliuo
6	Afrocarpus falcatus	ዝግባ	
7	Phoenix reclineata	ዘምባባ	Tuu

Source- FGD and Abobo Woreda natural resource and forest office

Table 1: List of Shrubs found in the study area

No	Scientific Name	Amharic Name	Local Name
1	Phytolacaceae	እንዶድ (Endodi)	Duenge
2	Calpurnia aurea (Ait) Benth.	ዲጊጣ (Digita)	
3	Solanum in canum	እምባይ	Olemo
4	Mulberry	/እንጆሪ/enjori	
7	Clerodendrum myricoides	ምስሪች (Misrich) Lentile	Ochake

Source፡ FGD

Table 13: List of fruits

No	Scientific Name	Amharic Name	Local Name
1	*Carica papaya*	ፓፓያ	Oulelu
2	*Musa paradisiacal*Rajesh N.	ሙዝ	Bala
3	*Mangiferaindica*	ማንጎ	Manga

Source: Region Environmental protection and Forest Conservation reports



Figure 20: Dense Forest in Dibechi Forest Ecosystem

Source: Filed photo 2018



Figure 21: Degraded forest ecosystem in Dibechi

Source: Filed photo 2018

Driver and pressures Dibechi forest degradation

The degradation of Dibechi forest ecosystem were many drivers some of them are listed below

The major drivers exist in Dibechi forest

- **The large-scale investment agricultural schemes**: According to the perceptions of FGD there were four investment sites around Dibechi forest, like cotton, sesame, rice and peanut. Due to this the coverage of forest were declined. While both private and state

owned investors with large land leases for forest areas to be converted into commercial farm lands. So far there has been no eviction of small-scale farmers, but the forests are being destroyed with an increasing speed; most foreign and local investors were clearing the forest and savanna/grassland areas and afterwards they left the business without any farming activities and also they clear forest for illegal charcoal charking. Around 0.5% of the large agricultural investors are actively involved in farming practices over the total land that they acquired.



Figure 22: Forest land converted in to investment farm

Source: own field photo



Figure 23: Illegal charcoal choking by investors

- **Population growth**: According to Abobo Woreda finance report, 2010 the population of Abobo Woreda was increased highly, due to this the community exert pressure on forest through deforestation to compensate their own food as well as fuel wood demand.

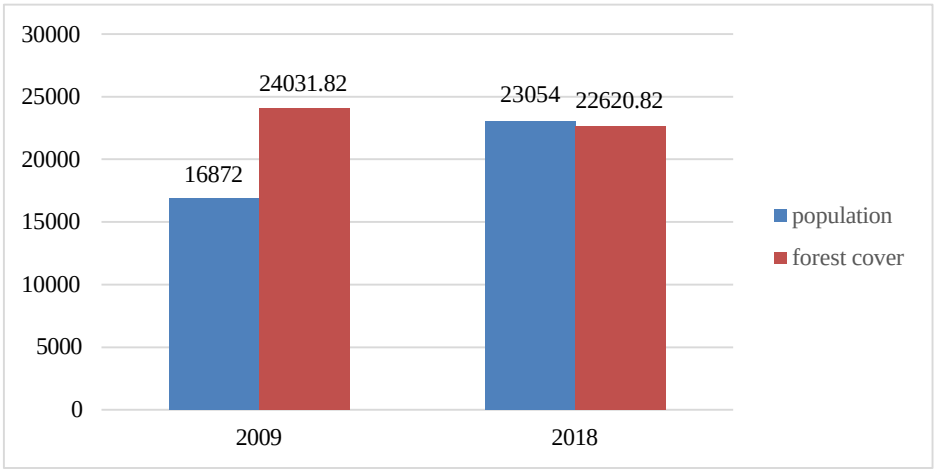


Figure 24: population growth versus forest coverage (ha)

Source: 2007 Census and finance and economic development office of Abobo Woreda

As we see from the figure above the population of Woreda increase at a growth rate of 3.53% in each year, during the year 2009, the population lower but the forest coverage was higher. The number of the population rises by 6182, from the year 2009 to 2018.whereas, the forest coverage was declined by 1411ha with in the year 2009 to 2018.In the year 2018 the population growth and forest coverage was approximately similar. Which shows that population increment was direct and indirect impact on forest degradation and also which was one of the major driver for forest degradation in Dibechi forest ecosystem.

- **Resettlement** were the other driver for Dibechi forest degradation. When we discussed in Woreda forest expert, in previous year the community of Abobo Woreda live sparsely, there was difficulty to guide the rural community, so in order to create association the peoples were resettled. During this time the forest ecosystem degraded for their on consumption.



Figure 25: Resettlement around Dibechi forest ecosystem.

- **Unsecure land tenure**: The FGD explained that, land tenure situation is still not very secure for the local communities and there has been land grabbing by outside investors with dubious agreements with Woreda authorities, and also peoples settled in any forest are by distracting the forest because of the absence of land ownership. This exert pressure on forest resource through deforestation for their own purpose.

  As we disused with Abobo Woreda forest sector expert investor make dubious agreements with Woreda authorities for different farming, but indirectly the investors use the forest area for illegal charcoal trading. The above figure (fig 23) shows during illegal transportation of investor's reach car accident, at that time the Woreda expert seizure the charcoal in their Woreda agricultural office.

The pressures exert on Dibechi Forest Ecosystem:

- **Deforestation:**
- **Forest fire**: According to FGD forest fire was one of the common practice applied for various reasons, such as hunting wild animals, improved grassing, agricultural activities and charcoal making.
- **Increasing demand for agricultural land expansion:** this is one of the pressure exert in local community because when the population of the local community rises there need also rises



Figure 26: **Forest burned for cultivation purpose**

Source: own field photo, 2019

- **Increasing demand for fuel wood**. Often trees are damaged by axe even if only parts of the trees are cut for fuel wood.
- **Boat making**, which is a rather destructive and timber wasting activity. As we discussed in FGD a big tree, usually *Cordia Africana* is felled and a boat is cut out in traditional manner. The price for one sold boat range between 25,000 – 50,000 birr on the local market.

a



Figure 27: **Boat Made From Dibechi Forest**

Source: own field photo

The Impact of forest degradation on the livelihood of local communities

The participants of FGD as well as Woreda forest expert clarified that degradation of forest ecosystem bring various impact to the local community, some of them are listed below

Extinction of indigenous plant and animal species: FGD participants explained that there were numerous plant and animal species in Dibechi forest eco system, currently those plants and animals species were distracted in alarmingly due to deforestation, through large scale investment, Resettlement, population growth as well as unsecure land tenure.

Table 14: Extinct and Endangered forest species

No	Biological Name	Amharic Name	Local Name
1	Phoenix reclineata	ዘምባባ	Tue
2	OlivaAfricana	ወይራ	
3	Eucalyptus globulus	ባህርዛፍ	Atiliuo
4	Maesa lanceolata Forssk	ዋንዛ	Orogu

Source - farmers groups on the ground /FGD/

Table 15: Extinct and Endangered wild animals

No	English name	Amharic name	Locale name
1	Buffalo	ጎሽ	Jobi
2	Elephant	ዝሆን	Luke
3	Hippopotamus	ጉማሬ	Raay
4	Deer	አጋዘን	Buba
5	Hog	ከርከሮ	
5	Leopard	ነብር	Sib eke

Source –FGD

- **The amount of rain fall distribution as well as temperature was fluctuated:** FGD participants explained that the distribution of rainfall was decreased from year to year, due to this the growing season was changed, correspondingly the temperature was raised highly due to this reason government workers such as region as well as Woreda experts' doesn't give service to their client with in the governed time.

Wind erosion occurred**.**

- **The economy of the local community was degenerated:** As we discussed in FGD Dibechi was one of the income source of local community, many of the community produce honey before the forest was degraded, but know honey production decrease alarmingly due to these reason most of them prone to hunger.
- **Destruction of water sources**: On the FGD ,participants were clarified that the amount of different water source like springs and rivers deteriorate, Yield production decreased due to shortage of rainfall and increasing of climate variability and also they supposed that Due to deforestation, drought was occurred frequently as a result the community become vulnerable to food insecurity.
- **Drought and Hunger:** According FGD and Abobo Woreda finance report,2010 drought occur twice within five years due to this many animals was died and also 1200 peoples was starved.

Response of deforestation and forest degradation

Even if the regional does not take any measure in the study area to solve those problems. There are some responses taken for protection of deforestation and forest degradation taken from both the local community as well as government bodies. Some of the responses taken by various sectors in Abobo Woreda as well as local community were given below:

- Woreda agricultural office attempts reforestation through provision of 10900 seedling with in three watershed areas. The main tree species planted were mostly indigenous such as *Cordia africana, Podocarpus falcatus, Acacia lubec,* mango tree, and dominantly *Betlera paradoxa* (the oil tree) and the success rate has been high. The plantation areas were protected from cutting and livestock grazing.

The local communities prohibit illegal settlement in their own surrounding based on their own traditional culture.

Outlook

Unless the regional as well as federal government try to reverse forest coverage change of the area, the people will lose the total forest and shrub area for the next 10 years.

Despite the on-going efforts to restore forest cover, unabated deforestation and forest degradation will have negative effects on the livelihood security of people in rural areas. As the population

proceed with the rate of 3.53 %, it rises from 23863 in to 813806 within the next ten years but the forest coverage of the area will be declined worryingly, because of large scale investment as well as agricultural land expansion. Which will in turn contribute to livelihood **food insecurity** among people living in the forest-farm interface. In general, the mismatch between the rising demand for forest resource and population increment will make forest degradation inevitable.

The adaptive capacity of forests to climate change will be reduced because of deforestation and forest degradation.

If deforestation and forest degradation in Gambella region continues as the existing rate, the amount of rainfall infiltrating in to the soil as well as percolation of water into ground will be reduced. Which leads to low water availability during dry seasons, affecting human and livestock access to water throughout the year.

3.4. Dibechi Forest Biodiversity

State and Trend of Biodiversity on Dibechi Forest ecosystem

Biodiversity is 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystem' (CBD, 1992; Article 2).

Ethiopia is one of the world countries, which is rich in faunal, floral and microbial diversity. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, of which about 15 percent or more are probably endemic. Ethiopia is considered as the fifth largest floral country in tropical Africa (http://chora.virtualave.net/biodiversity.htm). Ethiopia is also rich in faunastic diversity with mammals (277 spp.), birds (861 spp.), reptiles (78 spp.), amphibians (54 spp.), and fishes (101 spp.) (http://www.biodiv.be/ethiopia/).

Gambella Region is endowed with vast pristine landscapes, and a rich array of ecosystems including wetlands, humid montane forest, lowland forest, woodland and shrub-land, wooded grassland, and savannah grassland, all of which harbour diverse and remarkable wildlife resources. These are the resources on which the many local communities of Gambella Region depend for their livelihoods (IGAD BMP NEWSLETTER, 2015).

Dibechi forest is one of the low land forest of Ethiopia found in the Gambella region. It is located in Abobo district, Anuak Administrative Zone. The forest is a natural forest which is characterized by diversified tree species.

Dibechi forest was one of the natural forests which encompass different kinds of plant species, which are very useful for ecological stability. Beside this in Dibechi forest there were different varieties of wild life and bird species. The reason which makes the forest a preferable by wild life species was its appropriate habitat. But nowadays a forest is under a great influence due to different reasons; the main reason is settlement expansion, the other reasons are investment activities and agricultural land expansion.

In Dibechi forest, what we observed during the field was Dibechi forest was a dense forest which field by natural flora species but, recently deforested extensively by fire for the settlement and investment purpose and tends to be a bare land.



Figure 28 Dibechi forest destructed by fire

Source: Field survey, 2019.

The figure 28 explicitly shows us the activity of forest destruction by fire. This is a process of totally clearing the forest land and preparing for other uses. This action aggravated from period to period, due to this reason the biodiversity resources are highly degraded and tend to disappear from time to time.

3.4.1.1. Flora Biodiversity of Dibechi Forest

The floral resources of Dibechi forest ecosystem are plant species listed in the following table by their Local name, common name, Family name, and Scientific name.

Table 16: Identified plant species of Dibechi forest ecosystem.

Local name	**Common name**	**Family name**	**Scientific name**
Abuwo	Dead sea fruit	*Asclepiadaceae*	*Calotropis procera*
Adew	African ebony	*Ebenaceae*	*Diospyros mespiliformis*
Adiiquala leach	Inguachia/merenz	*Loganiaceae*	*Strychnos innocua*
Adiquala	Snuff-box tree	*Salicaceae*	*Oncoba spinosa*
Adu	Injori	*Moraceae*	*Morus mesozygia*
Adudeeguoy	Violet pea	*Fabaceae*	*Baphia abssynica*
Alaro	Egyptian thorn	*Mimosoideae*	*Acacia nilotica*
Alwaru	Quick stick	*Fabaceae*	*Lonchucarpus laxiflorus*
Arim	*Lannea welwitschii*	*Anacardiaceae*	*Lannea welwitschii*
Bala	Banana	*Musaceae*	*Musa acuminata*
Byby	Neem	*Meliacea*	*Azadirachta india*
Char	Yellow wood/podo	*Podocarpaceae*	*Podocarpus falcatus*
Chipolo	Washta/zana	*Bignoniaceae*	*Stereospermum kunthianum*
Downg	Cape jasmine	*Rubiaceae*	*Gardenia ternifolia*
Ja	Sausage tree	*Bignoniaceae*	*Kigelia Africana (k.aethiopum,k.pinnta)*
Jemmoh	Coca/cocaine tree	*Erythroxylaceae*	*Erythroxylum fischeri*
Kijang	Leucaena/lead tree	*Acanthaceae*	*Lepidotrichilia volkensii*
Lang	Kurkura	*Rhamnaceae*	*Ziziphus spina-christi*
Lemum	Lime	*Rutaceae*	*Citrus aurantifolia*
Lemunat	Sweet orange	*Rutaceae*	*Citrus sinensis*
Lero	Hackberry	*Cannabaceae*	*Celtis toka*
Lero	Jujube/chinee apple	*Phamnaceae*	*Ziziphus pubescens*
Liu	Natal orange	*Loganiaceae*	*Strychnos spinosa*
Manga	Mango	*Anacardiaceae*	*Mangifera indica*
Mogno	Creeping barberry	*Rubiaceae*	*Sarcocephalus latiflorus*
Ochino	Acacia	*Fabaceae*	*Acacia abyssinica*
Olam	Cape fig	*Moraceae*	*Ficus sur(f.capensis)*
Opera	Carry cillo	*Poaceae*	*Olyra latifolia*
Orowyyee	African ebony	*Ebenaceae*	*Diospyros mespiliformis*
Pok	Terminus/alshaf	*Combretaceae*	*Terminalia laxiflora*
Pok	Kontir/ kentefa	*Mimosoideae*	*Entada abyssinica*
Reed	Axle wood	*Combretaceae*	*Anogeissus leiocarpus*
Tenga	Bark cloth tree	*Moraceae*	*Antiaris toxicaria*
Toow	Desert date	*Balanitaceae*	*Balanites aegyptiaca*
Uchek	Injori	*Moraceae*	*Morus mesozygia*
Udua	African fan palm	*Palmae*	*Borassus aethiopum*

Ulam	Fig tree	*Moraceae*	*Ficus carica*
Urago	Wanza	*Boraginaceae*	*Cordia africana*
Urao	Violet tree	*Polygalaceae*	*Securidaca longepedunculata*
Urao	Carrot tree	*Apiaceae*	*Steganotaeria araliacea*
Uriemo	Soqotri star-chestnut	*Sterculiaceae*	*Sterculia africana*
Wado	Avocado	*Lauraceae*	*Persea americana*

Source:- (AWANROR,2018) and FGD.

The plant species mentioned on table 16 was available in appreciable manner in the forest; but, nowadays it becomes only a history because of serious deforestation by fire. Especially, *Baphia abssynica* is durable tree species because of this the local community also used it extensively for construction purpose due to this reason it's tend to extinct.

According to FGD in the Dibechi forest there are different kinds of plant species used for traditional medicine purpose. Local community used the parts of these plant species as a cure for different kind of disease. Some of the medicinal plant species are listed on the table below:

Table 17: Medicinal plant species

Local name of plant species	**Its part used for medicinal purpose**	**Method of utilization**	**Kind of disease it prevent**
Urutiya	Leaf part	Through boiling and drinking	Malaria
Jiwu	Fruit part	By massaging and drinking	Back pain
Dijoy	Root part	Through mixing by water	Amebae

Source: - FGD, 2019.

The medicinal plants mentioned on the table 17 are highly declined, because they burn as part of the forest resource.

3.4.1.2. Faunal Biodiversity of Dibechi Forest

Dibechi forest encompasses great varieties of habitat contributing for the occurrence of high faunal diversity. However, the information on this state of environment report is limited to mammals, birds, and reptiles.

Mammal species: - The identified mammal species in the Dibechi forest ecosystem are listed in table 18 by their Local name, common name, Family name, and Scientific name.

Table 18: Identified mammal species in Dibechi forest ecosystem.

Local name	Common name	Family name	Scientific name
Odec	Hyena	*Hyaenidae*	*Hyaenidaecarnivora*
Kuach	Tiger	*Felidae*	*Panthera tigris*
Mere	Duiker	*cephalophinae*	*Cephalophus harveyi*
Bim	Baboon	*cercopithecinae*	*Papio hamadryas*
Agero	Ape	*Hominidea*	*Hylobates lar*
Utur	Pig	*Suidae*	*Sus scrofa*
Rona	Impala	*Bovidae*	*Aepyceros melampus*
Kul	Warthog	*Suidae*	*Phacochoerus africanus*
Hu	Lion	*Felidae*	*Panthera leo*
Yechi	Elephant	Elephantidae	*Elephas maximur*
Jobi	Buffalo	Bovidae	*Bubalas bulbalis*
Ray	Hippopotamus	Hippopotamidae	*Hippopotamus amphibius*
Ri	Giraffe	Giraffidae	*Giraffa camelopardа*
Ugoare	Zebra	Equidae	*Equus quagga*
Dolo			

Source:- (AWANROR,2018) and FGD.

The abundance of almost all mammal species mentioned in the table 18 was in similar manner in the area. However, nowadays almost all species are migrated to the other area and different mammal species like elephant, hippopotamus, giraffe and zebra are totally disappeared from the area. On the other hand, the other mammal species like lion and tiger are highly decreased; because, their habitat is extensively destroyed by fire, for the settlement, investment, agricultural land expansion and resettlement purpose.

Bird species: - The identified bird species in the Dibechi forest ecosystem are listed in table 19 by their Local name, common name, Family name, and Scientific name.

Table 19 Identified bird species in Dibechi forest ecosystem.

Local name	Common name	Family name	Scientific name
Akona	Falcon	Chicquera	Falco eleonorae
Chor	Buzzard	Accipitridae	Buteo buteo
Qura	Crow	Corvidae	Corvus corone
Dakiye	Duck	Anatidae	Anas robripes
Jigra	Goose	Anatidae	Alopochen aegyptiacus
Segon	Ostrich	Struthionidae	Struthio camelus
Regbe	Dove	Columbidae	Columba livia

Dorobaheri			
Achot			
Akuru			
Alero			
Olit			
Agag			

Source:- (AWANROR,2018) and FGD.

In the past there were many different bird species in the forest but, in the present due to the destruction of their habitat the bird species are migrated to the other area.

Repitel species: - The identified Repitel species in the Dibechi forest ecosystem are listed in table 20 by their Local name, common name, Family name, and Scientific name.

Table 20 Reptile species in Dibechi forest ecosystems

Local name	**Common name**	**Family name**	**Scientific name**
Tuwal	Snake	Colubridae	Natrix natrix
Dagway	lizard	Lacertidae	Lacertilia
Nyalo	python	Pythonidae	Python sebae
Ewano	chameleon	Chamaeleonidae	Chamaeleo calyptratus

Source:- (AWANROR,2018) and FGD.

The reptiles are mostly lived in the grass which found in the forest. They also tend to extinct from the forest due to high destruction of their habitat by fire.

Drivers and Pressures of Biodiversity Degradation on Dibechi Forest ecosystem

Anthropogenic factors have major influences on ecosystem functioning and stability, which are often reflected in changes to biodiversity that includes wildlife. This is because abundance and diversity of the ecosystem community are changed.

The drivers of biodiversity degradation in Dibechi forest ecosystems are population growth, settlement expansion, investment activities, agricultural land expansion, and resettlement.

Based on the land use land cover detection the agricultural land and settlement in Dibechi forest ecosystem are increased from 1659.52 to 4477.60 ha and from 18.72 to 89.7 ha, respectively from year 1998-2018.

Biodiversity is declining rapidly due to pressures such as burning of forest, deforestation, forest degradation, hunting and fuel wood consumption.

Forest fire: - "Forest fire" means a fire burning uncontrolled on lands covered wholly or in part by timber, bush, grass, grain, or other flammable vegetation. It is the most common hazard in forests. Forest fires pose a threat not only to the forest wealth but also to the entire regime to fauna and flora seriously disturbing the biodiversity and the ecology and environment of a region. Forest fire is a disaster that causes imbalances in nature and endangers biodiversity by reducing faunal and flora wealth. Forest fire may be caused due to natural or man-made reasons. (https:// definitions.us legal. Com/f/ forest-fire, 2016)

In the study area the action of burning forest is deliberately settled to clear forest land for investment, agriculture and settlement, thereby ensuring that the forest will not return to its former position.



Figure 29: Activity of burning Dibechi forest (field survey, 2019).

Figure 29 shows us the activities of burning forest in Dibechi forest ecosystem. This activity highly affects the biological diversity of the area; because the fire has the ability to remove all the biological diversity, even the microorganisms in the soil. Due to this activity the wild life and bird species are highly disturbed and coerced to leave their homeland and migrated to the other area; because their habitat destruct is destructed by fire. Consequently a total biological diversity of the area, especially the indigenous flora and fauna species are compelled to leave the area.

Deforestation: -**Deforestation**, **clearance**, **clear-cutting** or **clearing** is the removal of a forest or stand of trees from land which is then converted to a non-forest use (https:/ en. Wikipedia.Org/wike/deforestation.). This means deforestation is total destruction of forest resource. In the study area the forest is cleared by fire and Dozen/Tractor for the investment, resettlement and agricultural land expansion purpose.



Figure 30 :Deforestation processes on Dibechi forest by Dozen (field survey, 2019).

Figure 30 shows us the investors clear the forest land to prepare the land for the investment purpose. This activity has a great contribution to the degradation of biological diversity; both for flora and fauna. The flora species are extensively destructed or removed from the area and cannot regenerate again. The fauna species are disturbed due to their habitat destruction and coerced to migrate to the other area.

Forest degradation: - A degraded forest is a secondary forest that has lost, through human activities, the structure, function, species composition or productivity normally associated with a natural forest type expected on that site. Hence, a degraded forest delivers a reduced supply of goods and services from the given site and maintains only limited biological diversity. Biological diversity of degraded forests includes many non-tree components, which may dominate in the under-canopy vegetation. (UNEP/CBD, 2001)

A stand from the above definition in general forest degradation is the reduction in forest amount and its product. In the study area the forest is degraded due to cutting forest for construction material fuel wood consumption and boat construction. Due to this activity the indigenous and durable tree species are highly degraded.

Illegal Hunting: - **Hunting** is the practice of killing or trapping animals, or pursuing or tracking them with the intent of doing so. Hunting wildlife or feral animals is most commonly done by humans for food, recreation, to remove predators that can be dangerous to humans or domestic animals, or for trade. Lawful hunting is distinguished from poaching, which is the illegal killing, trapping or capture of the hunted species. The species that are hunted are referred to as game or prey and are usually mammals and birds.

Illegal hunting is a process of illegal killing, trapping or capturing of hunted species for different purpose. This action severely declines the wild life species. In the study area the investors kill the wild animal by gun and the local community hunts the wild life by using different traditional hunting methods like poaching by capturing and using sling.

Impact of Biodiversity Degradation on Lively Hood System of the Local People of Dibechi Forest ecosystem

Dibechi forest is one of the forests, which is under great impact of land-use changes, mainly due to settlement, investment and agricultural land expansion in the forest area. Losses of biodiversity affect human well-being. These effects include an increased risk of sudden environmental changes such as diseases out break and drought affects the livelihood of the community.

According to the FGD the loss of biodiversity resources that leads the community to scarcity of different forest product. Due to the biodiversity degradation the shortage and uneven distribution of rainfall occurrence increase, due to this reason, crop and animal production are decreased. The activity of burning forest causes environmental pollution, and affects the health of community. In addition to this, the wild life has harmed and migrated to other area and also the environmental sustainability and stability is affected.

In detail the impact of biodiversity degradation on the Dibechi forest ecosystem and local community is explained as follow;

Impacts on local community: - the local community affected by scarcity of different forest product (like; food, honey and honeybee, durable tree species for construction and other uses, etc.) which use for their daily and continues household consumption and also affected by shortage of traditional medicinal plant species. Due to smokes from the forest fire the air is polluted, this makes the local community vulnerable to the respiratory disease.

Impact on the flora species: - if some biological diversity is degraded there is impacts imposed on them and also due to their degradation there is impact observed on the species depends on them. In the study area due to burning of forests the larger and long aged durable tree species are affected. Therefore from smaller plant species and microorganisms, which are depends on larger plant species, up to larger flora species are destroyed; because the fire has the ability to destroy all resources on the surface without selection.

Impacts on wild life: - due to their habitat destruction through fire the wild life species are disturbed and compelled to migrate to other area. Especially bird's species are imposed to migration.

Impacts on soil productivity: - the soil productivity is decreased due to the destruction of soil microorganisms and natural soil mineral in the soil.

Impact on the environment: - the loss of biodiversity can affect entirely the whole environment. In the study are the environment is affected by air pollution from forest burning and also due to the forest land change to the other land use type the ecosystem is changed, for this reason the surface of the environment is changed and stressed.

In general the local community affected socially, economically and ecologically due to the loss and degradation of biodiversity.

Responses to Biodiversity Degradation on Dibechi Forest ecosystem

There is no response taken by local community and government bodies to reduce and control the problem of Dibechi forest ecosystem biodiversity degradation.

Outlook

Based on a global multi-taxon meta-analysis of recorded ecological responses, they estimated that the mean observed extinction risk by 2100 is systematically higher than the mean predicted extinction risk across the theoretical studies considered in the meta-analysis: 12.6% in plants (vs. 4% predicted), 9.4% in invertebrates (vs. 7,2 % predicted) and 17.7% in vertebrates (vs. 12.4 % predicted). Overall, these estimates of biodiversity loss are obviously a major concern. **(**Céline Bellard,[#1] Cleo Bertelsmeier,[#1] Paul Leadley,[1] Wilfried Thuiller,[2] and Franck Courchamp[1] ,2014)

Unless the Federal government and Gambella regional state government concerned bodies and stakeholders deal and work together to protect and save the Dibechi forest ecosystem in common understanding, the future risk is difficult to control. Because, the biodiversity of the area is destroyed severely from time to time as the forest is destruct by fire; this will lead to the total loss of biodiversity species in the area.

3.5. Climate for Dibechie Forest Ecosystem

State and Trend of Climate

Climate: refers to the long term pattern of weather in particular area (usually more than 30 years (https:llwww.national geographic.org.sep.26,2017). Circulations of weather and climate have covers all around the world.

According to Coppen climate classification divides world climate in to five main climate groups, those are Tropical, dry, temperate, conditional and polar and being divided based on seasonal precipitation and Temperature pattern.

Ethiopia is characterized by a wide variety of landscapes and given its geographic location close to the equator and the Indian Ocean, the country is subjected to large spatial variations in temperature and precipitation, which is five climate zone, defined by altitude and temperature. Those are: - the hot, arid zone, the warm to hot, semi-arid zone, the warm to cool, semi-humid zone, the cool to cold humid zone and the cold, moist temperate zone.

The climate of Ethiopia is therefore mainly controlled by the seasonal migration of the Inter tropical Convergence Zone (ITCZ) and associated atmospheric circulations as well as by the complex topography of the country. Due to this, most parts of Ethiopia characterized under bimodal rain fall pattern with two distinct wet and dry seasons.

weather and climate of Ethiopia arises from the influence of tropical weather systems, like the Inter-Tropical Convergence Zone (ITCZ), the monsoon, easterly waves, etc., (Bekuretsion , 1987a) from mention that mainly controlled by ITCZ and associated atmospheric circulations as well as by the complex topography of the country. Due to this, most parts of Ethiopia characterized under bimodal rain fall pattern with two distinct wet and dry seasons. Whereas, some south western parts of Ethiopia receive rain throughout the year.

Broadly classified, Ethiopia has three seasons and three rainfall regimes. The seasons are: *Belg* (short rainy season, February-May), *Kiremt* (main rainy season, June-September) and *Bega* (dry season, October-January).

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer accordingly https://climatechange.ucdavis.edu> science. It is mostly caused by human induced factors.

The data for the study was acquired from the field survey using structured questionnaires, FGD were carried out across 4 Kebeles that was around the Dibechi Forest ecosystem, field observation, official unpublished documents from governmental organization and NMASGB. Although, we find long year meteorological data (above 30 years) of Abobo but we obtain only 13 years metrological data of Gambela from 2006 -2018. Gambela is located around 42k.m from Abobo Woreda. Therefor the available data represented the study area, so we have used to analyze state and trend of rainfall, maximum and minimum temperature as followed.



Figure 31: FGD

Rainfall Pattern of Gambela Region

According to DRMPO 2019, Gambela region can be broadly classified in to three agro-climatic zones namely; moist and dray wina dega, moist Kola and dry Kola or berha (Woldesemayat Alemu, 2018), and altitude of the region ranges from around 500–1,500m, but our studies focus mainly on dry Kola or berha, agro-climatic zone of Abobob Woreda and altitude was around 500masl.

Gambela region is characterized under the warm to hot, semi-arid zone; climate is influenced by the tropical monsoon from Indian Ocean, which is characterized by high rainfall in the wet period and little rainfall during dry period which have seen blow fig. monthly maximum rainfall received from May to October, peeks in July with mean of 2,664.4mm while the other months were recieved less and little amount of rainfall. Generally, Gambela region was received rain throughout the year except the month February which is blow 50mm.

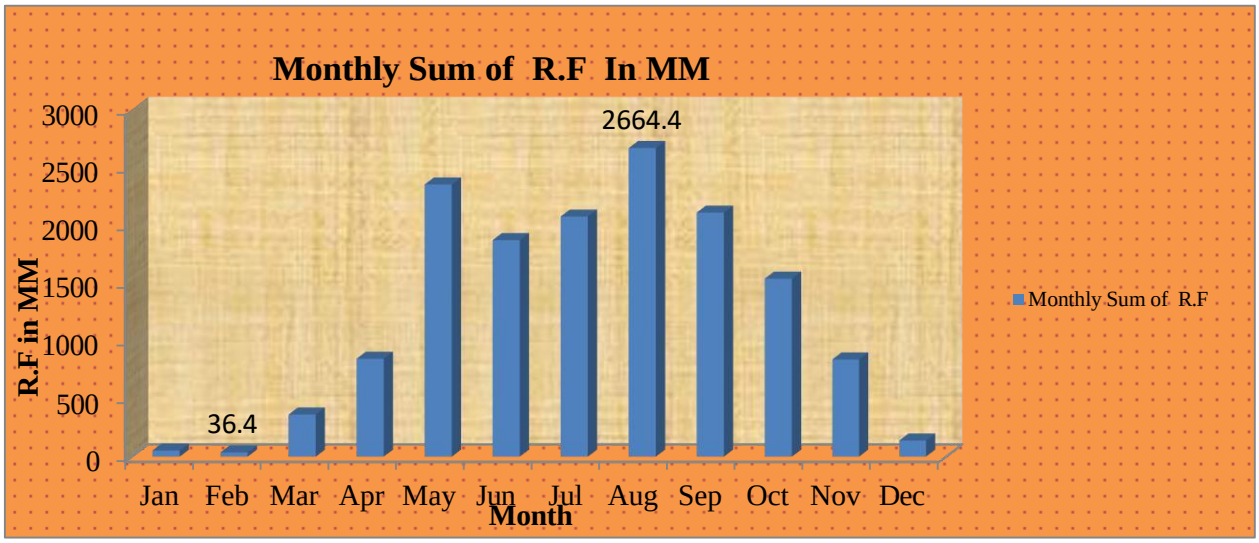


Figure 32: Monthly total rainfall of Gambela from the year2006 to 2018 in mm

The amount of rainfall different from year to year because of climate change and/or variability, as it show in fig.33 and also it indicates total average annual rainfall of Gambela region was 1,143mm, with a highst maximum of 1,424mm in the year 2010 and 2011 while, the lowest minimum of 442.4mm in year 2018.

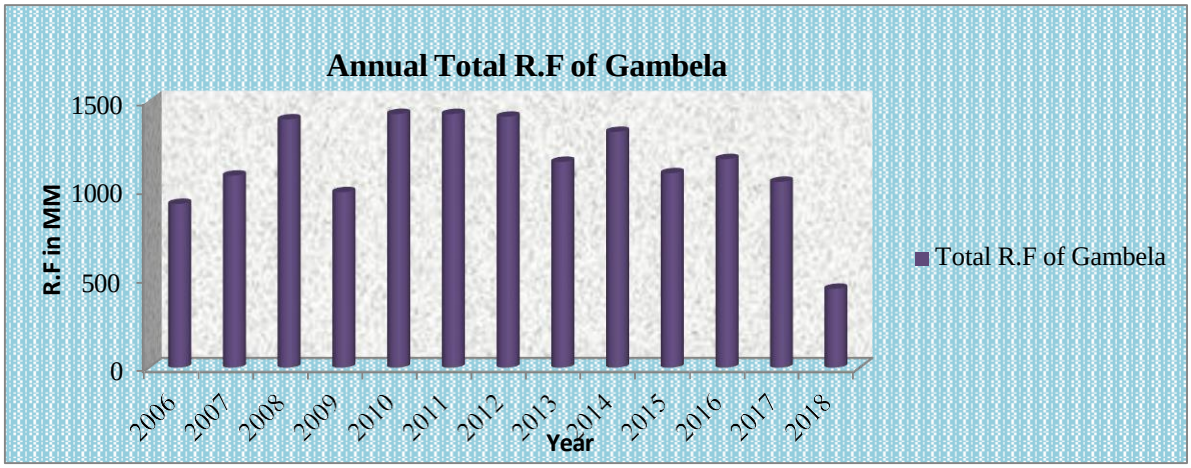


Figure 33: Gambela Annual R.F in mm.

Temperature Pattern of Gambela Region

The atmospheric concentration of CO2 increased from year to year (Alley *et al.,* 2007). Temperature has risen by about 0.3-0.6oC since the late 19th century. The fourth assessment report (AR4) by the IPCC (2007) stated that the best estimates of likely increases in the mean global surface-air temperature by the end of the 21st century are between 1.1°C and 2.9°C for the "low scenario" and 2.4°C and 6.4°C for the "high scenario,". In the same way the metrological data analyses of Gambella region indicated that, temperature increasing from year to year and with maximum of 0.02^{o}**C** per year and also this exploration of temperature accepted by FGD and DRMPO.

Climate conditions change with elevation, the average temperature drops 0.6°C for every 100m increase in elevation (https://earthobservatory.nasa.gov/IOTD/view.php?id=1510).Therefore the nature of terrain dramatically decline from eastern highlands of the region to move western parts, those areas with an altitude is reach around 500masl. Due to this, climate is too hot and humid high temperature was recorded jest before onset of rain in May.

Figure blow illustrates that, the variation of average temperature between minimum and maximum was 21.3^{O}C in the year 2007 and the 37^{O}C in 2016 respectively. Within 13 years, average temperature was 29.15^{O}C and the difference between maximum and minimum or range was 15.7^{O}C.

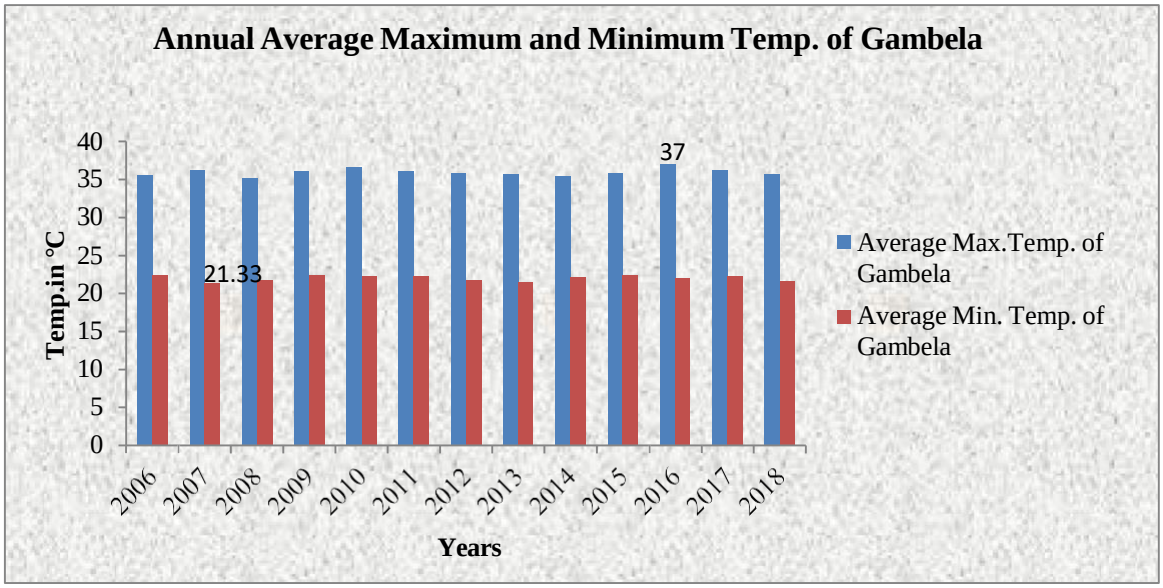


Figure 34: Average Annual Min. and Max. Temprature of Gambela.

Figure blow illustrates that, the monthly average minimum and maximum temperature of the study area ranges from 20.1°c to 40.5°c in the month of March and Jun respectively. Besides, highest temperature recorded from the month of January to April, while the lowest one from Jun to August.

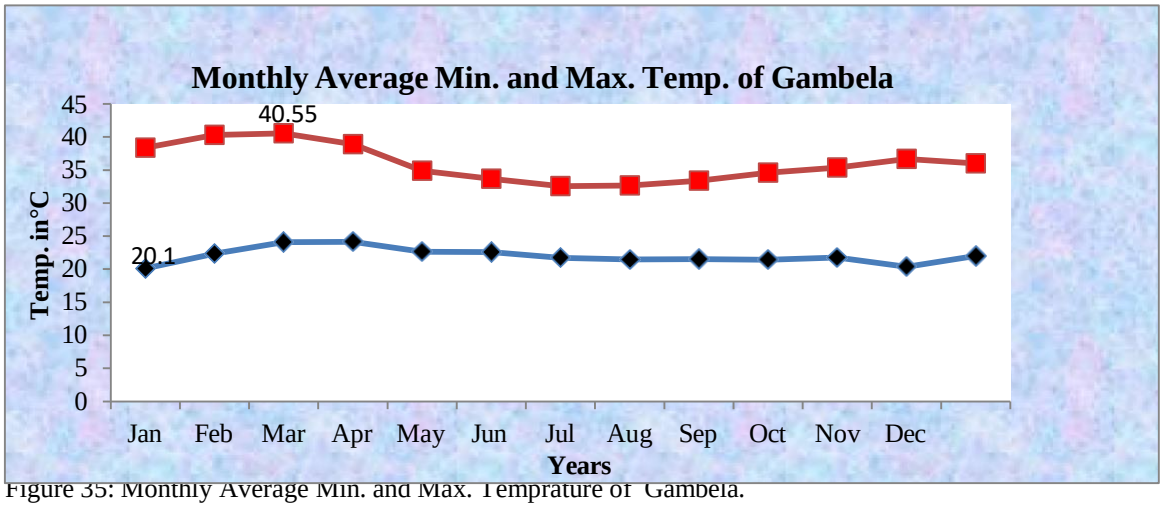


Figure 35: Monthly Average Min. and Max. Temprature of Gambela.

Driver of Climate Variability and/or Change to Dibechi Forest Ecosystem

Resettlement program

In the study area deforestation is the main cause for local micro climate change and/or variability. According to AWANRO and FGD communities, Now a day resettlement program is implemented by the government however it was one of responsible factors for the local climate variability that makes great stress on the forest through cutting the trees for agricultural purpose, wood consumption, household material, timber preparation and sells those cutting trees by making charcoals in order to satisfy their economic interests.



Figure 36: Resettlement area in Abobo Woreda

Source: Field survey, 2019

Agricultural Activities

Agriculture is a great contribution to greenhouse gas emissions in Ethiopia, which covers 61% (https://www.climate links.orh/). Similarly, in the study area it is the main driver for environmental degradation and local micro climate change and/or variability.

Small Scale Agriculture

The economic activities of people in Dibechi Forest Ecosystem was depends on mixed farming, therefore agriculture and limited animal hasbanderies were made accelerated deforestation and overgrazing around the area and we also observed that on the field, most of the people freely or without any governmental or non- governmental body restriction destroy dense forests for the sake of agricultural activities and re-find fertile soil instead of artificial fertilizer, due to this the forest area was changed in to agricultural land and by the case of deliberate wailed fire in the dry season and then cultivate it.

Over grazing was another driver on the environmental degradation of the study area, the peoples which live around Dibechi Forest Ecosystem were engaged on rearing of animal. Therefore,

animal populations were degrading the area and produced methane which is great contribution to greenhouse gas emission next to carbon dioxide, which contributed 10% of GHG emission.



Figure 37: Deliberate Forest Fire with farmer,

Source: Filed survey, 2019

Large Scale Agriculture

As we have seen in the field observation, the study area is potentially favorable for large scale agricultural activities, therefore, depends on the favorable policy of the investment today a number of both local and foreign investors were also engaged in agriculture sector for production of crops such as rice, cotton and mango and it was create mostly seasonal job opportunity to the local peoples of youths (GRLMIO, 2019). However, some irresponsible investors have been monopolized thousand hectares of forest land and destroy the jungle for the sake of charcoal production until borrowed money from development bank. Finally, these investors left the area and engaged on other business without achieving the intended goal and objective. Both large and small scale agricultural activities were negatively affected the climate change mitigation action on the eastern parts of Gambela National Park.



Figure 38: Large scale cultivation of Mango, and currently cleaned investment land

Source: Field survey, 2019

Pressure of Climate Variability and/or Change to Dibechi Forest ecosystem

As socio economic part indication, over population is another reason for expansion of public land and environmental degradation, which was highly intensified by the case of settlement program and it was great pressure to climate change and/or variability the study area.

Settlement program was also one of the main contributed factors for increased frequency and magnitude of environmental degradation in Gambela region as a great driver and pressure. Before 1984, the region was occupied by a few indigenous people in sparsely populated settlement. However, between 1984 and 1996 a great number of people from different parts of the country settled in the region, due to this more than 140,000ha natural forest were cleared in order to meet the need of the population (old et al., 2006). In the case of Abobo, after settlement program population numbers were highly increased as indicates from 19 Kebeles which of 6 Kebele were occupied by settled people (AWANRO, 2019).

As in the field observation, planners could not take into consideration of the other side effects of settlement and resettlement in environmental impact of the area. As a result in Dibechi Forest Ecosystem was deforested that was never excluded exploitation of forest resource, expansion of' agricultural lands in to the frontier forest cover and grazing land. Until know, both settler and host community were severely scrambling the forest land without any exclusion, this idea line with Bisrat worku 2011, before and after resettlement land size per farmer was increased from

0.75 and 1.31ha respectively. There are also continuing conflict between settlers and local people over the forest and grazing land utilization (Dereje, 2007*).* However, the conflict was resolved by local eldest men without any governmental intervention (FGD, 2019).

Impact of climate change and/or variability in Abobo Woreda

The amount of greenhouse gases increase in the atmosphere the case for increasing surface temperature this conditions largely affected developing country such as Ethiopia, which have limited capacity to coup with the effect of a changing climate (Gebeyehu,2016).

Different ecosystem types store different amount of carbon depending on their species composition, soil type, climate and other factors. Therefore the carbon stock of Ethiopian protected areas system are contributes same amount of carbon and its worth about US$938million, while through deforestation about US$18.8 million, are lost annually. Similarly, Gambela National Park was largest and great contribution to carbon store averagely 394±12.21 ton/ha, Abobo Woreda Dibechi forest eco-system is parts of Gambela National Park, 35,300 hectares were reserved which holds forest land and wood land, of which 6,300 hectares(17.84%) are already cultivated (EWCA. 2008). As we have filed observation and information gathered from AWANRO 2019, the situation will be ongoing until now. Therefore deforestation leads to distorting carbon sink; this situation was led to negatively affected micro climate of the Dibechi Forest Ecosystem not only that but also loss donor income to the study area and country.

According to A.W.H.O, 2019, indoor and outdoor air pollution aggravated by forest fire, cooking purpose, preparation and use charcoal, fuel wood and crop residue. Therefore, some people were exposed and affected to by Cough and Asthmatic diseases.



Figure 39: Acceleration of forest fire leads to Air pollution. (Source: Field photo, 2019).

FGD and DRMPO indicated that, climate change and/or variability already loss life, damaging property, affecting livelihood and loss product and productivity. As we have seen on the field visit, the impact was worse and visible in the study area, after the end of 1990 the civil service work time was officially changed for three months from February to April, in the morning starts from 1:00-5:00AM and afternoon from 10:00-12:00PM. This implies that climate change and/or variability reached harsh condition and loss 2hr working period per day and also loss of effectiveness which was directly or indirectly affected the economy of the study area.

Loss of agricultural productivity was Sever problem in the study area, because economic activity is highly depending on climate sensitive rain feed agriculture and limitedly irrigation activities are observed. According to AWANRO and FGD 2019, indications the major effect of climate variability on crop was change in crop planting time which is rainfall coming before or after the beginning of the normal cropping season, sometimes heavy amount of rain and high temperature negatively affected at early or late vegetative stages and unexpected rain devastated the crop product at harvested time, shift in crop type like earlier time maize was predominantly cultivated but now it was mostly affected by disease so shift in to sour gam, raise, cotton etc. and also productivity of crop decline from time to time, before 10 years maize production per hectare was above 25 quintal while know 15.5kuntal in average, due to incidence of pasts and disease, like African army warm.

Another impact was loss of bio-diversity because it has environmental and climatic pressure, that pressure the existence of endangered plants like local named called “Adidaguyi” and “Achari” which are not access available information about Amharic and scientific name from FGD. Whereas from animal like Giraffe (ቀጭኔ፡linnaeus), Hippopotamus (ጉማሬ፡Hippopotamus amphibius), Buffalo (ጎሽ፡Buffalo bubalis), Elephant (ዝሆን፡loxodonta) and Zebra (የሜዳ አህያ፡Equus qugga). Appearance to face extinction as a result of over increasing global warming and illegal hunting was contributed for the extinction (Lemma, 2016). This explanation is line with EDRI, 2015, temperature increase may case for change of ecosystem, were same of cutout their habitats, same may be extenuated the other one will introduce.

Flood and Drought of Dibechi Forest Ecosystem

Flood is the most frequent and devastating types of natural disaster in Gambela region, causing unexpected death, diseases and distraction of property and crops. According to AWANRO 2019, the main accelerated factors for increased frequency and magnitude of flood in study area was land use change, due to resettlement, settlement and increasing human and animal population.

In the year 2000 and 2006 flood was occured and affected 8 Kebeles namly Abiru, Village 17, Teribongo, Pukidi, Abermate, Tercheru, ukuna kejong and chobokor. They are exposed to loss of human life and livestock, damaged to home and business, 2 hectare of fruit crop, soil erosion, grass land and farm land. Its impact was not only limited at Woreda level but also affected the region, for instance, damage crops and incident from land which can lead to food shortages that may lead to malnutrition, in the year 2006 flood damaged 1650 hectare of maize crop. There were 20% of reduce in production of the region (Samson.W.A et al., 2009).

Climate variability may affect health in a number of different ways, one of which is flooding. Malaria and Diarrhea were the two main diseases that FGD and health officials mentioned as the health problem arising from flooding in the Woreda. Malaria epidemics were a common phenomenon in Abobo Woreda and accelerated after flooding not only that but also occurred every year, due to increases in favorable mosquito breeding sites and low-land area.

According to AWANRO indicated that, Drought was also common problem in the study area, occurred in the year 1983, 1884 and 1985, and then negatively affected 1150 people out of them, 428 male and 722 were female, loss productivity of crop and livestock activities that undermine the food security which intern was resulted in poverty.

Response to Climate Change and/or variability in Gambela region Abobo Woreda Dibechi Forest Ecosystem

Local or Community Level

The impact of climate change and/or variability was visible in the study area, so different adaptation options needed for the case of Abobo. As we have perceive from FGD, most peopel percive the ocurance of climate chenge and/or variability in the area. But the response was week for conservation of natural resource. However, some people were changed the way of agriculture to drought resistance crop like cultivate root crop on the bank of river.

NGO (SLMP) Response

The implementation of soil and water conservation practice for instance, distributed seed for all interested farmers which consider raising seedling for reforestation, but now it is faith out.

Government Response at Woreda level

To start early warning system

Attempt to controls animal disease and plant pests with given victim and chemical respectively.

Attempt to teach family planning with health office.

Introduce new technology, like better maize seed distribute to the farmer.

Government response at National level

The Government of Ethiopia has made various policies, legislative and institutional measures. In 2013, the Ministry of Environment, Forest Development, and Climate Change was established. The policies that have been put in place prior to 2007 to direct sustainable forest development and management with wider implications for improved environmental management, and reducing the effects of climate change include the following:

- ✓ **The Ethiopian Constitution (1995)** provides the rights to clean and healthy environment as fundamental rights of citizens (articles 43 and 44).
- ✓ **Environmental Policy of Ethiopia (1997)** is the overarching policy for managing the environment and natural resources.
- ✓ **National Action Program to Combat Desertification (NAP, 1998)** the GoE ratified the UN Convention to Combat Desertification (UNCCD) in 1997 and subsequently undertook the formulation of a NAP.
- ✓ **National Biodiversity Strategy and Action Plan (NBSAP, 2005)** the GoE developed the NBSAP to ensure the conservation and sustainable use of biodiversity, and to provide

for the equitable sharing of the costs and benefits, arising from them and contribute to the well-being and security of the nation.

International Response

The Copenhagen Agreement (UNFCCC,2009), one of the outcomes of the United Nations Framework Convention on Climate Change conference in December 2009, expressed strong support for a mechanism whereby developed countries provide financial incentives to developing countries for reducing emissions from deforestation and forest degradation (REDD) and enhancing sequestration by forests. REDD+ is a component of the Bali Action Plan that aims to enhance national and international action to mitigate climate change, including through policy approaches and positive incentives, conservation, the sustainable management of forests and the enhancement of forest carbon stocks in developing countries (Lisa *et al.,* 2010).it implement in Gambela region.

Outlook for Climate Change and/or Variability of Dibechi Forest Ecosystem

According to Abobo Wreda profile and NMASGB data indicated that, the rate of atmospheric temperature and deforestation are similarly increasing from year to year.

Therefor needs the following problem redaction method should be needed.

- At the local level primarily create awareness about potential climate change and existing climate variability of the currant and the future climate itself. Then the coping mechanism to climate variability and adaptation option for climate change should be studded and implemented.
- Adaptation options should focus on reforestation, aforestation, area closure and ensuring better management of soil and water, implement cut and carry system of cattle, cultivate shorte growing crop and drought resistance crop cultivation should be possible.
- Plan commission should be considered environmental problem on the resettlement program and should need to improve arrange of policy as well as improve the integration and co-ordination between policies across many sectors.
- Government controlling and monitoring system of investment program implementation should be strength from federal up to Woreda level.

If the rate of deforestation will continue for the next three decade,

- Maximum temperature will rise above 0.46°C due to this; in the Gambela region especially Abobo Woreda will be difficult to survive harsh climatic condition for human and animal.
- Loss capacity to capture and store carbon for local micro climate and also loss carbon trading income.

Reference

- Abate (2010), about the factors of forest degradation.
- Aberham.2016.Vegetation Composition and Deforestation Impact in Gambella National Park, Ethiopia accessed 1 September 2009.
- Albert, S.et al., 2017 heading for the hills: climate driving community relocations in the Solomon Islands and Alaska proved insightfora1.5cfuture. Regional environment changes 1-12, do: 10.1007/s10113_017-1256-8.
- Anna Lawrence; William Hawthorne (2006). Plant Identification: Creating User-friendly Field Guides for Biodiversity Management. Rutledge. pp. 138-. ISBN 978-1-84407-079-4.
- Anonymous (2008) Sustainable Forest Management Practices in Ethiopia
- Bilsborrow, R.E. (1991).Population Pressure and agricultural development in developing countries: A conceptual frame work and recent evidence. World development, vol. 15(2):183-203.
- Boserup, E. (1981). Population and Technological change. Study of long term Trends, Chicago: University of Chicago press.
- Census 2007 Tables: Gambela Region Archived 2010-11-14 at the Wayback Machine, Tables 2.1, 2.4, 2.5, and 3.4.
- Climate Variability and Household Adaptation Strategies in Southern Ethiopia EDRI2015R,
- Ethiopian Mapping Authority (EMA) (1988) The National Atlas of Ethiopia. EMA, Addis Ababa EWCA. 2008. The Value of the Ethiopian Protected Area System: Message to Policy Makers.Addis Ababa, Ethiopia.
- FAEDOAW, (2015), about different socio economic data.
- FAO, 2001. Global Forest Resources Assessment, Main Report, FAO Forestry Paper 140. FAO, Rome.
- FAO, 2010. Global forest resources assessment 2010: Terms and Definitions. Working paper 144/E. Rome.
- FDRE: MOFED (2010), Growth and Transformation Plan (GTP) 2010/11-2014/15, Addis Ababa, Ethiopia.
- Fekadu Gurmessa(2010) Floristic Composition and Structural Analysis of Komto Afromontane Rainforest, East Wollega Zone of Oromia Region, West Ethiopia, MSc thesis Addis Ababa University June 2010, Addis Ababa.
- GRSEBESAA, (2017), about participation of females.
- http://chora.virtualave.net/biodiversity.htm http://www.biodiv.be/ethiopia/ Encyclopædia Britannica, Inc., 2018
- http://www.definitions.net/definition/social environment
- https://www.climate links.orh/.
- https://www.researchgate.net/publication/258049236_Biodiversity_Status_in_Ethiopia_and_Cha llenges accessed Dec 11 2018 © ResearchGate 2018.
- IGAD /Biodiversity management programme/ Issue No.2, December 9, 2015
- Kumlachew Yeshitila and Tamrat Bekele (2003) The Woody Species Composition and Structure of Masha Anderacha Forest, Southwestern Ethiopia. Ethiopia. J. Biol. Sci., 2(1): 31– 48, Addis Ababa.

- Land classification of land sat images of 1999, 2009 and 2018.
- Millennium Ecosystem Assessment Ecosystems and Human Well-being: Biodiversity Synthesis (2005)
- Ministry of Environment and Forest (2014) on Overview of REDD+ Process in Ethiopia. A Proceedings Paper, January 2014, Addis Ababa.
- Nadkarni, M (2005) Global Forest Resources Assessment 2005, FAO Forestry Paper No. 147
- Ola et al., G.H.leeks, G.J.I. pack man, J, C., Smith,B,P.G., Lewis.s,. Hiwitt, E., J.2006 river flow and assisted transport of sediments and Solute through highly urbanized catchments, Bradford, west yorksimire, science of the total environment 360:98-108.
- Rapport and Friend, (1979), state about DPSIR approach.
- Samson Wakuma Abaya1,2*, Nicodemus Mandere3,4 and Go¨ ran Ewald3-Floods and health in Gambella region,Ethiopia: a qualitative assessment of the strengths and weaknesses of coping mechanisms- Accepted: 4 October 2009; Published: 28 October 2009
- Wassie Berhanu 1,* and Fekadu Beyene , 2015)
- Woldesemayat Alemu (2018) land use land cover changes environmental analyses and implication for sustainable agricultural development in Gambela Woreda, Gambela region south western Ethiopia.
- World Bank (2001), Understanding Forests' Contribution to Poverty Alleviation.
- *1994 Population and Housing Census of Ethiopia: Results for Gambela Region*, Vol. 1 Archived 2008-11-19 at the Wayback Machine, Tables 2.1, 2.7, 2.16, 2.19, and 2.21

Prepared by	**Educational States**
M.r Tilahun Alemu	MA in Environment Land Resource Management (Information management Directorate)
M.r Assaye Tesega	MA in Environment Land Resource Management
M.rs Banchaymolu Terefe	Msc in water Resource Management
M.s Yewubdar Alemu	Msc in Climate Change and Development
M.r Kassahun Defaru	Bsc in Natural Resource Management
M.r Eyayew Moges	Bsc in Statistics
Facilitated by M.r Anteneh Teshome	MA in Climate Change and Adaptation (DJ,State of the Environment Reporting)