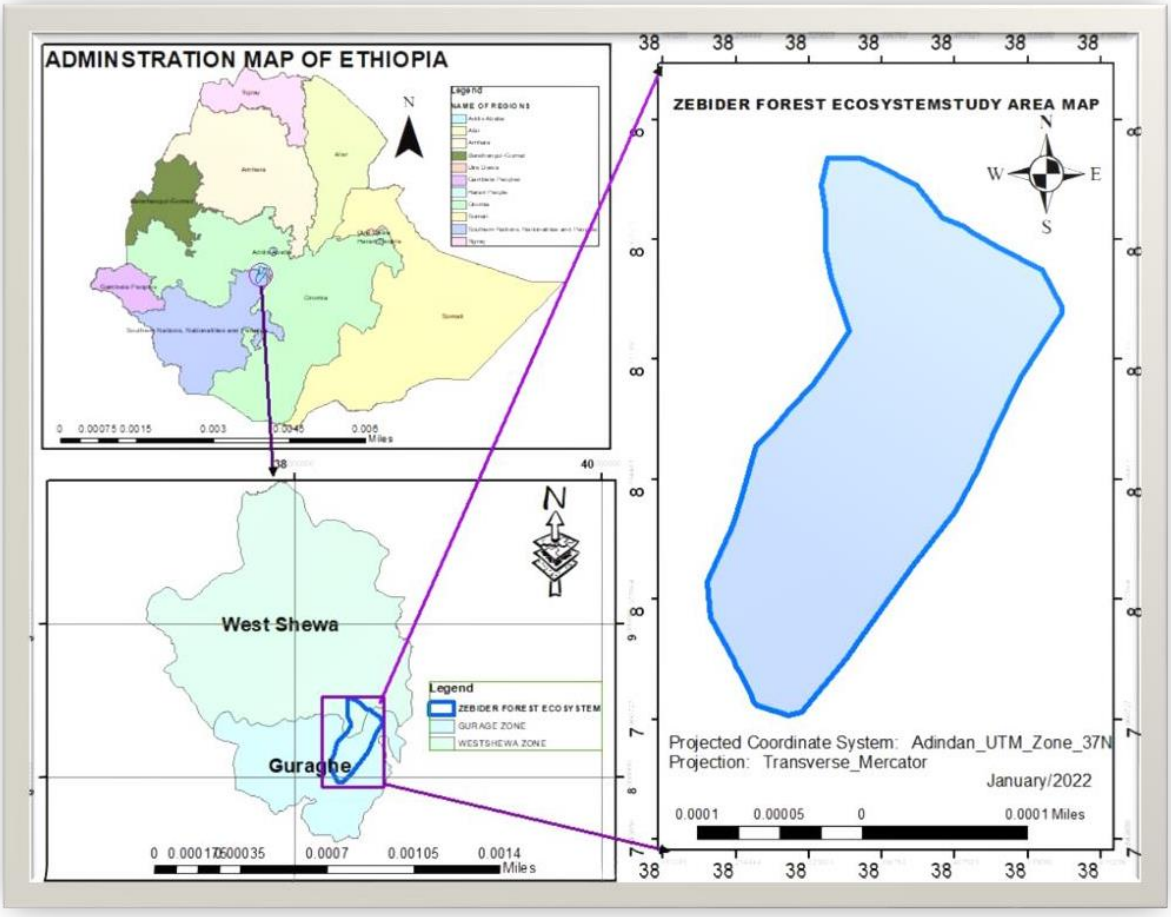
Environment Protection Authority

Environmental Information Management Directorate

Fact Sheet of Zebider Forest Ecosystem

In SNNP Region



Prepared By EIMD

Addis Abeba 2022

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Acronym and Abbreviations

BMP**:** Biodiversity Management Program

CBD: Convention on Biological Diversity

DPSIR: Driver Pressure State Impact Response

Driver: Pressure-State-Impact-Response Framework

FAO: Food and Agricultural Organization

FDEMADRMFSEWRD- Federal Democratic of Ethiopia Ministry of Agriculture Disaster Risk Management and Food Security Sector Early Warning and Response Director

FDRE :Federal Democratic Republic of Ethiopia

FGD: Focus Group Discussion

FGD**:** Focus Group Discussion

FGD: Focused Group Discussion

GDP: Growth Domestic Product

GO _ Governmental Organization

GOV: Governmental Organization

GTP: Growth and Transformation Plan

GZEFCCPO: Gurage Zone Environment Forest and Climate Change Office

GZPD: Gurage Zone plan Directive.

GZSAD: Gurage Zone Statistical Abstract Document

GZSAD_ Gurage Zone Statistical Abstract Document

GZWTDRMO - Gurage Zone Wolkite Town Disaster Risk Management office

GZWTDRMO –Gurage Zone Weliqite Town Disaster Risk Management Office

ha: hectare

IBC - Institute of Biodiversity Conservation

IPCC, T, A –R Intergovernmental Panel on Climate Change Third Assessment Report

ITCZ_ Inter-Tropical Convergence Zone

KI: Key Informant

LSICLLCC – Land sat image of land use land cover change

LULSE : Land Use Land Sat Image

M.a.s.l- Meter above sea level

Max. – Maximum

MEFCC: Ministry of Environment, Forest and Climate Change

Min. – Minimum

NBP: National Biodiversity Policy

NGO _ Non-Governmental Organization

NGOV: None-Governmental Organization

NMASDDB- National Metrology Agency

OCHA: Office for the Coordination of Humanitarian Affairs

R.F – Rainfall

SDGs: Sustainable Development Goals

SNNP: South Nation Nationality and People

SNNP: South Nation Nationality and People

SWCA : Soil and Water Conservation Activates

SWCA : Soil and Water Conservation activity

Temp. –Temperature

UNFCCC: United Nations Framework Convention on Climate Change

1. General Back ground

1.1. Environment for Green Economy Development

Human societies of different interests and values, intending to use 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.

Growing awareness of the failure of traditional development thinking to satisfy the needs of the expanding global population, in turn, led to the emergence of the idea of sustainable development**.** Sustainable development is development that 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.

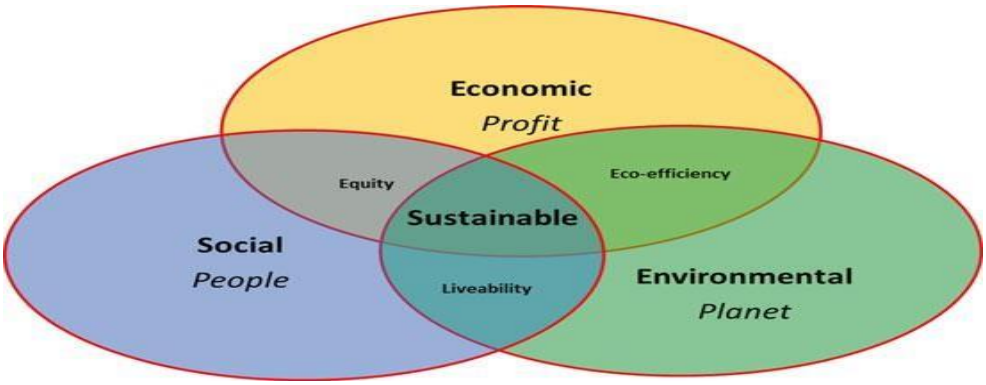


Figure 1**:** the Three Dimensions of Sustainability (**Source:** Green Growth, Green Economy and Sustainable Development: Terminological and Relational Discourse 2017)

The kind of economy developed in this case is a 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).

In practical terms, in a green economy investing in ecological resources and services, such as a stable climate, biodiversity and clean air and water, can be an opportunity for profit, employment and growth rather than a cost and burden on the economy.

The Government of the Federal Democratic Republic of Ethiopia is striving to fulfill its responsibilities to its citizens. The government strives to provide Social services and securities ensure the adequate functioning of infrastructure, provide a climate Conducive to employment and pay their debts. 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 II (2015/2016-2019/2020) and the newly 10- year strategic action plan that aims at improving the livelihoods of its people is being implemented.

Furthermore, the environmental sector plan is also mainstreamed into the GTP II and the newly 10-year strategic action plan of the country. One of the activities outlined within the environment sector plan of the GTP II is the preparation of a Fact sheet of the country through undertaking assessment. To this end, The Environment protection authority has conducted an assessment of the Zebider forest ecosystem in the SNNPR region 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 puts 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 feedback in terms of environmental change, or could be an intentional or un-intentional by-product of other human activities (i.e., pollution);

STATE: Environmental state also includes trends, often referred to as environmental change, which could be both natural 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.

Forest: According to Ethiopia's forest proclamation No. 1065/2018, the forest is defined as "trees, plants and other bio-diversity accumulation at and in the surrounding of forest lands, roadsides, riverside, farm and grazing lands as well as residential areas or parks that grow naturally or developed in some other ways". This is the legal forest definition of Ethiopia.

Our study mainly focuses on the Zebider forest ecosystem. It is found in the Gurage zone, which is one of the administrative zones of Southern Nations, Nationalities, and People Region, central Ethiopia. It is about 158 km southwest of Addis Ababa and also 259 km from Hawassa. Spastically the study areas include 8 woredas of the Gurage zone which are, Esa, Gebrano Gutaber welene, Sodo, Dbube sodo, Gumer, Mehur akilil, Mseqan, Merabe Mseqan woreda. Absolutely located between 38000'00" to 380 50' 00" East longitude and 70 53' 51" to 80 28' 36" North latitude.

2.1.1 State and Trends of Social and Economic Environment

2.1.1.1 Population

Population in urban areas grows more rapidly than rural populations worldwide, particularly in developing countries including Ethiopia. Population in this sense describes both human and animal populations. The animal population is described in the other portion of this study. According to the 2007 national census of Ethiopia, human population annual growth rate within the study area is expected to be **2.8%** calculated with Bob Parker, 2002 formula**.**

According to GZSAD 2021, the Zebider forest population number has 894,577 in 2020; of whom 409,904 are men and 444,673 are women and density was 330 persons/ square km. it's 47.35% of zonal coverage.

Blow figure indicates that the annual increments of population number in the study area were 37,007, this indicates high population growth. In addition to the fertility rate, it is also due to migration from all woredas of the Gurage region and SNNPRS. The study area is known for its religion and ethnic diversity.

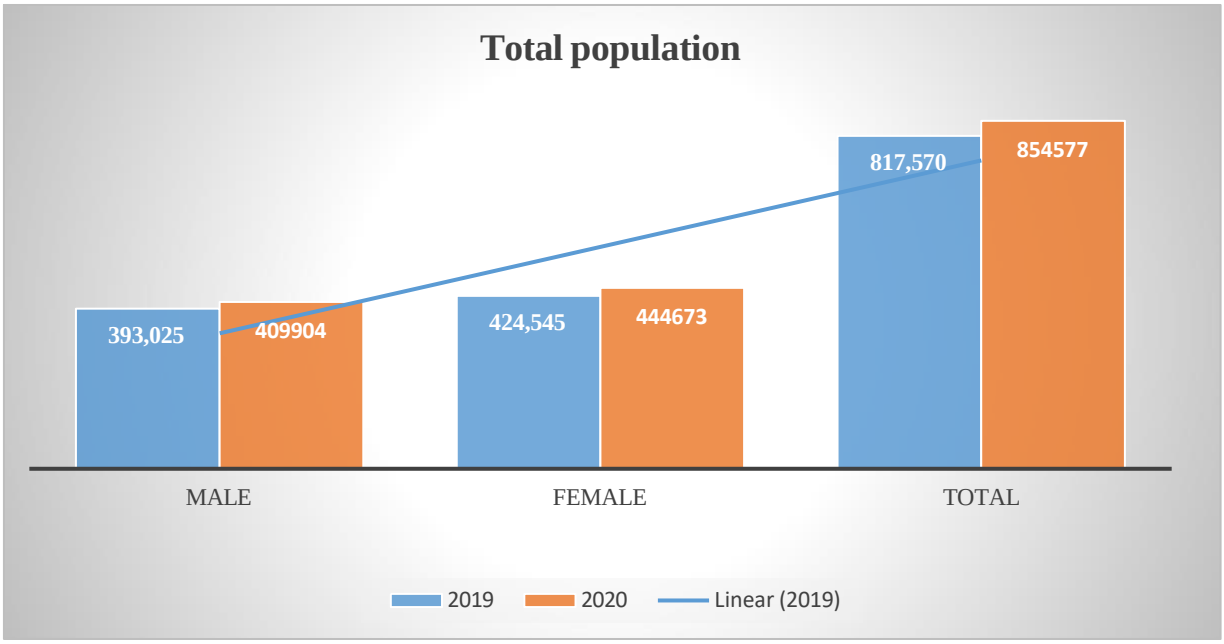


Figure 2 Population number of Zebider forest ecosystem in 2019 and 2020 (Source: GZSAD, 2021).

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 underprivileged section of the society. One of the primary goals of the Ethiopia Ministry of Education is promoting primary education in every corner of the country, based on the motto "Education for all". Accordingly, regions are working in line with this objective.

Educational participation and Distribution

From the year 2002 to 2012, the number of students increased, which children is starting from 7 years old in elementary school raised by 21%, whereas preparatory class coverage was 25% increased due to high governmental attention in the building of the school. However, enrolment of zero class, number one class student coverage and number of school, primary (1-8) and secondary cycle (9-10) educational coverage highly decline especially from the year 2018 and also blow table indicates that student class enrolment **declined** when student improved a number of class series of due to unfavorable educational environment to child (4-6 year old), uninterested to attend the class because students have seen joblessness after graduation due to finding better job opportunity within and out of the country, unfavorable educational environment, weakness of educational structures and based on political instability, same schools don't work properly (security problem) (PED, 2021). There is some fluctuation of student enrolment for each year,

but there is an unexpected decrease of student enrolment between 2020 & 2021 in the case of covid-19, many schools are not open.

Table 1 **Governmental school enrolment**

S/N	Class	Enrolled students in Zebider Forest						
		Number of student			Number of teacher			
		M	F	T	M	F	T	No of school
1	KG	11754	11041	22145	51	60	111	34
2	1-4	35284	30767	66051	2120	1317	3437	297
3	5-8	31923	29160	61083				
4	9-10	5104	4767	9873	571	238	779	43
5	11-12	2634	3300	7200				
Total	1-12	74945	67994	144207	2691	1555	4216	340

Source ; GZSAD, 2021.

Table 2 **ratio of students to teachers, class and textbook**

Year	**Class Student ratio**		**Student book ratio**		**Teacher student ratio**	
	1-8	9-12	1-8	9-12	1-8	9-12
2010	1:63	1:69	1:2.4	1:2.4		
2020	1:50	1:46	1:1.5	1:2	1:12	1:18

Source; Plan and Economy Directive, 2021.

Table 3**None - Governmental School**

Year	**No of school**	**No of Student**			**No of Teachers**		
		M	**F**	**T**	**M**	**F**	**T**
2020	2	131	104	235	34	3	37

Source; GZSAD, 2021.

The above table indicated the ratio of the students to teachers, sections and textbooks between 2010 and 2020. The national standard for student-teacher ratio is 50:1 for primary and 40:1 for secondary schools. The lower the student-teacher ratio the higher the opportunity of contact between the teacher and students, however, the very low student-teacher ratio indicates the inefficiency of the education system or underutilization of the resources. As indicated in the above table, a very low student-teacher ratio compared to the standard in 2020. This shows underutilization of resources/teachers.

And student-section ratio has similar standards with that of the student-teacher ratio. Then, in the above table, which shows above the standard in the year 2010. Therefore, a higher student- section ratio indicates overcrowding of class and hence less interaction between students and teachers as well as among students themselves. But after 10 years it reaches standard and near to standard in the primary and secondary school respectively.

With regard student- textbook ratio, it has a 1:1 ratio which improves the quality of education. However, the government try to solve the problem but it's not achieving the standard which affects the quality of education.

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 an overarching effect on sustainable socio-economic development. Health is a fundamental prerequisite for the successful achievement of any work which has significant importance for the family, organization and for the country in general.

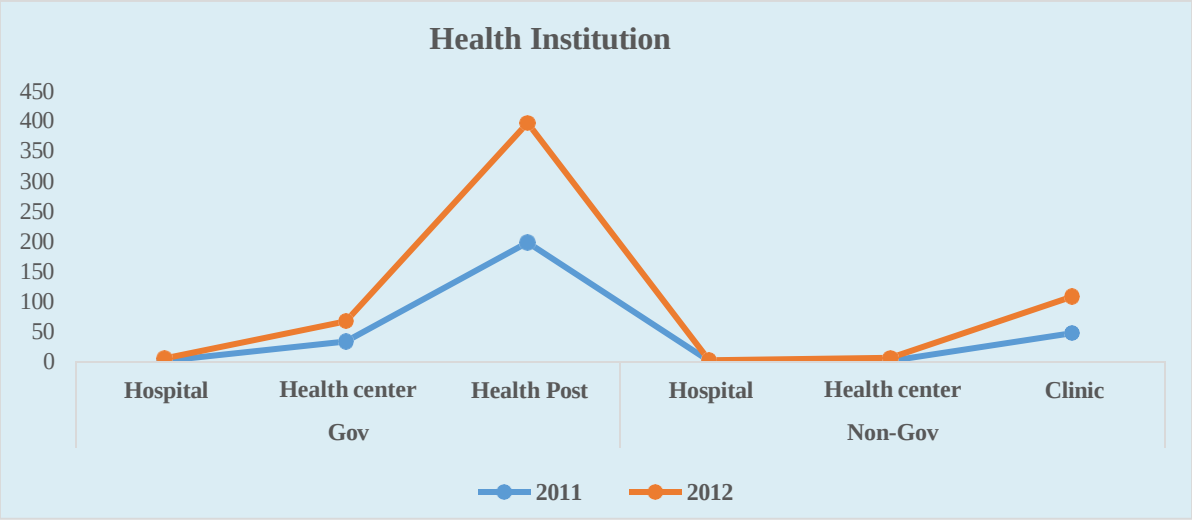


Table 4 Health Institutions in Zebider Forest

Source: GZASD, 2021

In the study area different health facilities such as Hospital, Health center and Health post were constructed and improved annually by 8.1% from 2019 to 2020, its coverage was reached 100%. However, their functionalities vary in providing the required services such as Medicine, electricity service and expert. In governmental and non-governmental office skilled person coverage were annually increased by 20.4% between 2019 and 2020 whereas zonal coverage was reached 98.21% in 2020.

Table 5**Types of Health experts**

Year	Types of Health experts																							
	Governmental									None Governmental														
	Doctors			Health officer (HO)			Nurse degree			Pharmacist			Lab-technician			Environmentalists			Midwifery nares			others		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
2019	10	5	15	112	42	154	22	14	36	7	1	8	3	1	4	15	3	18	13	16	29	24	11	35
2020	12	9	21	114	54	168	32	20	52	26	24	50	6	1	7	9	4	13	7	14	21	21	7	28

Source: GZASD, 2021

According to the assessment made by the health office of the study area on patients, the most prominent diseases are global warming disease and environmental pollution related diseases like malaria, typhus, giardia and TB.

According to WHO 2016 estimate from 100,000 population 192 peoples have all types of TB due to this the zonal governments of Gurage zone was done to minimize the death of TB declined from 2 to 0.4% from 2010 to 2020 year (Plan and Economy Directives). At the national level the study area is malaria prone area due to the government implement same preventing measures to control the problem (Gurage zone plan Directive, 2021).

2.1.1.4 Infrastructures

The length of dry and all-weather gravel roads in Zebider forest is **8889.3km**. Asphalt and gravel/rural roads are connecting keble to keble, woreda to woreda and woreda to Welkite and

Butajira city. The types and coverage of roads in the study area are main asphalt (3.1%), all-weather (21.5%) and dry weather rood (75.3%). From the study area except for Gebrano Gutaber welene and Mehur akilil woreda the remaining 75% have asphalt, all-weather and dry weather road network. But 25% is that provides service all season and dry weather road network are accessible.

Table 6 **Types of Road and its Service**

Year	**Main asphalt**	**Types of Road and its Service**						**Cumulative**
		All weather			**To dry weather**			
		Main Gravel	Medium Gravel	Total	Dray season road	Woke road	Total	
2011	173	289	474.7	763.2	489.5	865.29	1355	2291.04
2012	165	524	614.3	1138	1249	2739	3988	5291.3

Source: GZASD, 2021.

The water supply source of the study area is through surface water, hand-dug wells and rope pumps, deep and shallow wells, Bono and spring development. While the total water schemes are not well known, according to the GZSAD, 2021 indicated that 63.71% of the communities have a clean water problem. However some water sources have in the study area which is hand- dug 13, spring development 5, Bono 1 and another source 18 in number but functionality is very low due to less accessibility of water which is a 24.77% decline within 30 years (Landsat image 2022), weak control and rebuilding activity with the concerned body. The water supply of Zebider forest is covered 36.29% and 8.88% decline from 2012 compare with 2011.

The study area has 24hrs electric service for the urban and semi-urban and rural kebeles, whereas there some kebeles do have not 24 hours electric service. Instead, 36, 901 number of people use 14,514 solar lanterns(GZSAD,2021) but the remaining people use firewood and charcoal for cooking and lighting purpose from the forest. The firewood used in the house is release carbon mono oxide and exposed the household members to related diseases.

With regard to communication, the study area has mostly accessed post office, digital telephone, & mobile telephone services and mobile networks in all the rural woredas and kebeles.

Regarding economic activities, Ethiopia's economy is highly dependent on Agriculture. At present, the economy of the country is growing at the fastest rate. The economy uses natural and environmental resources as essential inputs in the production process. Economics and the environment are intimately linked, as natural resources are the basis of production, manufacturing, and waste disposal.

The study area is characterized as an agricultural economy whereby the main social, and economic aspects are expressed in terms of crop production and animal husbandry. The agricultural production system is mainly mixed farming, including crop and livestock productions. Major harvests are wheat, Beans, Teffe, maize, Barley, inset, chat and vegetables have produced. Inset is the dominant crop production in the study area.

Similarly, animal husbandry is another major source of livelihood in the area i.e. Such as cattle, sheep, goat, and poultry, donkey, hours, and mule. However, the blowing table shows that animal population increased from 2019 to 2020 but productivity declined because grassing land declined by 70.6% in the last 30 years (Landsat image of LULCC) this idea in line with FGD participant explanation.

Table 7**Animal populations in Zebider Forest**

Year	Cattle population	Sheep	Gout	Hen	Hours	Mule	Donkey
2011	699,680	457,838	261,615	1,094,748	45,846	9,610	95,846
2012	881,199	671,221	400,640	1,868,545	67,543	12,262	124,381

Source: GZSAD, 2021.

2.1.2. Drivers and Pressure of Social and Economic Environment Change

The causes of environmental change are complex and there are numerous factors that lead to the change of ecosystems of Zebider forest resources.

- **Demographic pressure:**

In developing countries high population pressure and urbanization increase the demand for land, encourages deforestation, increases pollution and promote the trade of species in danger of extinction. The driver of environmental change is mainly the results of population growth. Due to;

(i) As the study area surrounded the Butajira town and also near to wolkite town, there is high labor demand, the surrounding communities especially the youths migrate to the urban area for casual labor.

(ii) Lack of awareness on contraceptive methods contributes to high birth rates. Even though, currently, much attention is given to the provision of primary health care in households, the provision of family planning services is still low. As a result, there is much more delivery and an increase in the existing population.

- **Intentional wildfire;**

Wildfire is the most common and frequent problem in the study area, the people intentionally burning the forest for different purposes like the expansion of agricultural activities mainly needed better grass for grazing activities and easily accessed fuel wood. Wildfires have burned a large number of forest areas in the past several years. Due to forest fire ambient air covered with smoke for 3-4 days, same times rain comes to let the fair live for 6 month (dray seasons), this situation is responsible for instability in the social settlement because same times wind speed raised it was accelerated and loss wealth, air pollution resulted and biodiversity loss.

- **Land-use change**

Landscape changes included a reduction in forest land and an increase of perennial crops (chat and inset) at the expense of annual crops, grasslands, and bare soil. The main consequences of the landscape changes are habitat loss for wildlife and a decrease in water availability (Yodit kebede, 2019). As key informants from the disaster risk management office indicated that however the expansion of transportation is important to socio-economic value but on the hillsides of Zebider forest, the road construction of Wolkite - Butajira due to the problem of

construction design resulted in a decline of natural forests and associated forest fragmentation on the tip of the hillside, a decline in food crop production and accelerate soil erosion from steep land cultivation, for instance, nine farmers reported in FGD dictation landslide and flood loss their crops as a result they decreased crop production not only that totally losses their farmland. The other case was forest product easily transported to seal and accelerated the rate of deforestation. The FGD participants explained that after construction of the asphalt highways highly increased the extraction rate of forest products. A decrease in forest coverage has been reported by the land sat image of LULCC which investigated the effect of land cover/land-use change on the environment of the study area.

- **Farmland expansion and Deforestation**

Smallholding agriculture and deforestation are other prominent activities in the Zebider forest. These activities have been practiced around the forest due to economic dependency on the natural resource, it had been covered with natural forest. However, expansion of farmland coupled with the rise in the demand for its products at the nearby urban centers such as welqite and Butajira are responsible for continuous decline of the forest cover in the area. These activities, in turn, have affected the quantity and quality of forest coverage and income generation from the forest. Regarding this, FGD indicates that the society uses forest for income generation it's responsible for the loss of forest coverage but now it decline.

- **Expansion of Urbanization**

Expansion of the urban city seriously impacted the forest size. Its pressure on land policy and the undergoing urban development endeavors are shaping new settlements at Butajira city. Therefore, 871.37ha forest areas have been transformed into settlement areas or urban districts (satellite image of LULCC, 2022). Besides, forests have been used to generate a substantial amount of income for the people through supplying them for construction and domestic energy sources in the nearby rural and urban areas.

2.1.3. Impacts of Social and Economic Environmental Change

The main pressure and driver of social and economic environmental change of the study area is a high rate of population growth, there is a very high demand over the available natural resources to satisfy the increasing demand by cultivating the forest land, using forest products and

expanding settlement area in the forest, which intensified the condition of environmental degradation.

As a result of this, the area experiences severe water shortages when to the decline of underground water during December–May. Therefore people in the study area travel long distances (3.5to 4km) it takes 1:30 to 2:00 hours every other day to drink water. Such long- distance trekking undoubtedly hinders household heads or other family members from devoting enough time to other livelihoods and, therefore, incurring further economic losses and made sanitation problems and also responsible for water-borne diseases like typhoid, typhus and giardia, this indicated by FGD participants. According to GZSAD, 2021 indicated that malaria occurred and affected 2452 people in the year 2019 and 2020. In turn, this being unhealthy can affect farming and other domestic and economic activities, reducing food security and economic well-being.

According to GZSD,2021 due to climate variability of the study area agricultural product and productivity partially declined by 15.97% in the year 2019-2020 within the crop types of Meal, Vegetable, Root crop, Stimulate Plant and pulse. As a result, the people exposed to food insecurity in Mesqan woreda and supported with a productive sefti-net program.

2.1.4. Responses to Social and Economic Environment Change

- There are many potential policy responses to the environmental implications of local population pressure. The population policy of Ethiopia aims at
  - ✓ Closing the gap between high population growth and low economic productivity through planned reduction of population growth;
  - ✓ Improving the carrying capacity of the environment by taking appropriate environmental protection measures; and
  - ✓ Improving the social and economic status of vulnerable groups (Women, Children and Elderly).
- In line with the policy document, Ethiopia set out a national population program by 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.

- Incorporating environmental education into the national curricula;
- Providing incentives for human activity that embraces ecological considerations;
- Enhancing stakeholder awareness through programs in the media, workshops, short courses,
- To reduce the problem and provide quality education at the primary school level, schools were constructed at the village level, teachers were trained and placed, and girls' participation was increased to some extent. In recent years as a part of the growth and transformation plan, health service coverage and school enrolment at primary school 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 especially malaria. In the implementation of the health policy, the involvements of private sectors are also great in the delivery of health services.

Based on the health policy the Gurage zone government was minimized TB caused human death by 0.6% and also malaria case death attempts to reach 0% from 2010 to 2020.

Below table shows that the expansion of disease like TB and malaria declined by 41.76% from 2019 to 2020. It indicates the health facility like human resource, material improvements, better social awareness creation with governmental and non-governmental bodies cooperatively give attention to health care which shown in below figure decline the spread of diseases from year to year.

Table 8 Spread of TB and Malaria Diseases of Zebider Forest Area

Year	**Types of Diseases**					
	TB			**Malaria**		
	M	**F**	**T**	**M**	**F**	**T**
2011	322	479	801	248	177	425

2012	175	134	309	260	145	405

source :GZSAD

In the study area Soil and Water conservation activities were widely implemented from 2002 but in our available data started from 2016-2020 mentioned as 592,422 ha, different types of structure 14,554.5 km, Kit ire 156,508 Meter cube and Biological work (seed collection 383.8 quintals, plantation of tree 395.6 million in mill) in the study area.



Figure 3 SWC activities in Zebider Forest Ecosystem (Source**:** the picture taken from agriculture rural development annual report (1999).

2.1.5. Outlook for Socio-Economic Environment

If everything continues as it is practiced as a present population growth within the study area of 4.3% will continue. The baseline data in the year 2020, there are 894,577 people are living in the study area, it will be reached 1654073 in the year 2050. Similarly depending on the baseline data of Land classification of land sat images of 2000 to 2020, the coverage of bare, settlement and farmland were increased by 37, 171% and 109.5% respectively, but forest, grazing, shrubs, farmland and water body were decreased by 115%, 105.9%, 146.7%, 109.5% and 31% respectively will be reached in 2050.

It indicates the subsistence mode of the economic situation that based on farming land expansion will pressurize the limited natural resources. Then, the natural environmental could not be able to provide the environment service.

If the government will be given attention and dune on Student class attendance by improving joblessness after graduation and awareness creation on << After education how do we create better job opportunities through risk minimization within and out of the country? >>, create a

favorable educational environment, rebuild weakness of educational structures and to make political stability and to avoid security problem and properly control spared of disease, the access and quality of human capital will be improved and save the environment.

If different interventions are taken by governmental and non-governmental bodies to influence the imbalance of overpopulation to that of the natural resource base, such as demographic programs incorporating family planning, health and education services are properly implemented, the demographic trend would be stabilized. Moreover, diversification of activities will generate income and minimize impact on a given natural resource that is instead of depending on forest for different purposes could be engaged in other activities such as poultry production and irrigation.

2.1.6. Recommendations

- Health center should be cerise attention on family planning and implement it.
- All concerned body gives serious attention to the female empowerment.
- Improve the integration and coordination between policies across many sectors.
- Water mineral and energy office purify water source and improve water coverage supporting with interested individuals.

3. Physical Environment of Zebider Forest Ecosystem

The study area is in a Region in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia. Gurage Zone is one of the zone in the Southern Nations, Nationalities, and Peoples' Region. It is bordered on the southeast by Hadiya and Yem special woreda, on the west, north and east by the Oromia Region, and on the southeast by Silt'e. Welkite is the administrative centre of the Region. The distance between wolkite to Addis Ababa is 192 Km by road.

Gurage Zone has about 8 woredas, 1 of them; Gedebano Gutazer Welene is an important for the Zebider forest center situated approximately 45.3 km east of Welkite town. Gedebano Gutazer Welene is bordered on the south by Muhor Na Aklil, on the west by Kebena, on the north by the Oromia Region, and on the east

by Meskane. The administrative center of Gedebano Gutazer Welene is Mehal Amba.

The highest point in this woreda, as well as in the Zone and Region, is Mount Zebider. The mountain has a latitude and longitude of 8°17′N 38°23′ECoordinates: 8°17′N 38°23′E and an elevation of 3719 meters above sea level. The Zebider forest is in central part of Mount Zebider of the region.

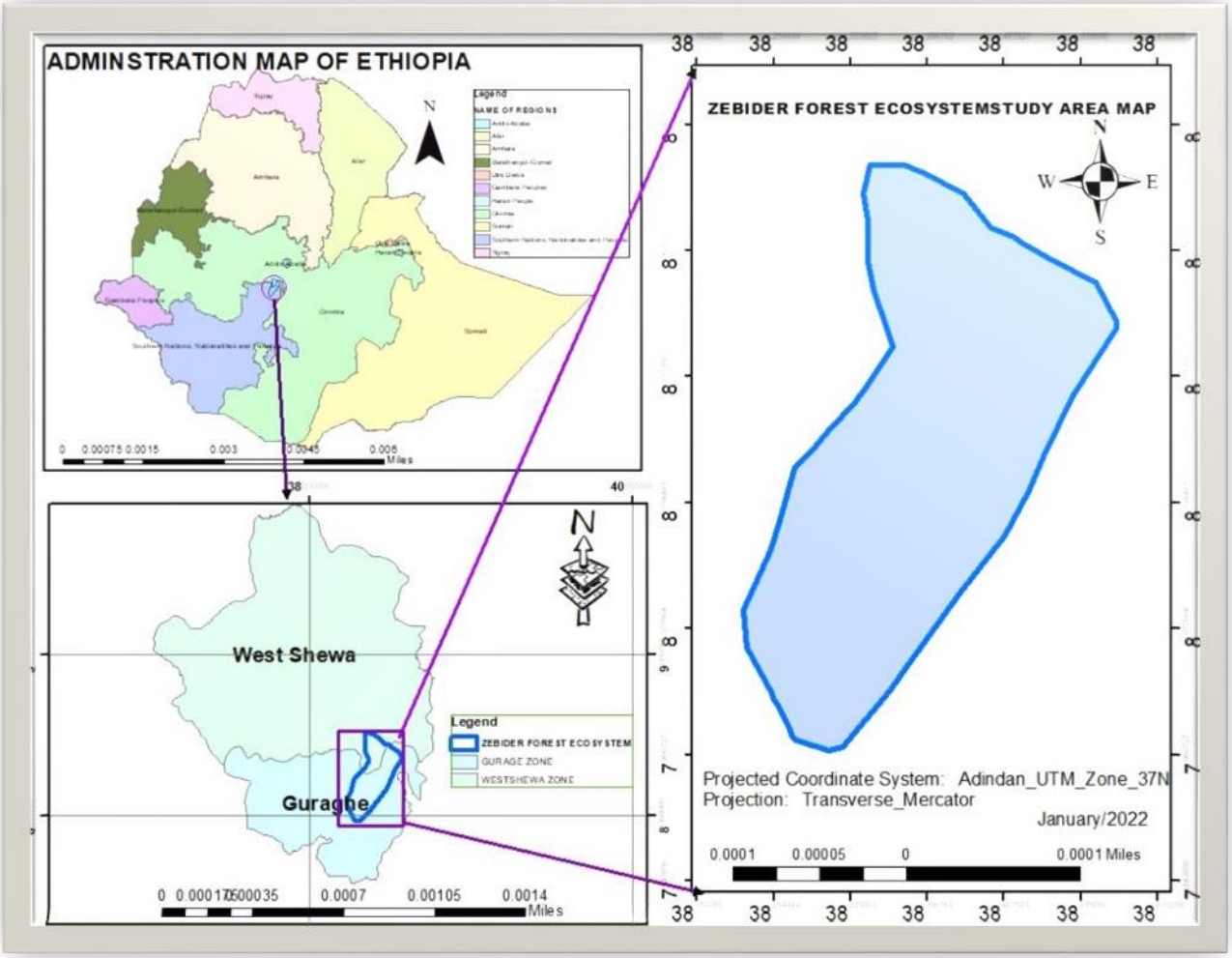


Figure 4 Map of Zebider forest ecosystem

3.1. Land

3.1.1. State and Trend of Land Use Land Cover Change for Zebider Forest Ecosystem

Land use/land cover change (LULCC) is a term used for the modification of the earth terrestrial surface by humans, mostly the results of an interaction between natural and anthropogenic processes (RAWAT, KUMAR 2015). Anthropogenic processes are the major driving force in shaping LULCC and are significantly changing the Earth surface, resulting in to an observable changing pattern in the LULC (land use/land cover) over time (BARLOW et al. 2016)

Various studies have indicated that LULCC are significantly affecting the functionality of Earth system directly or indirectly (BARLOW et al. 2016; BISIRI et al. 2017). LULCC has different negative socio-economic and environmental consequences such as: reduction of landscape diversity and an increase vulnerability of certain natural hazards (floods, droughts, fires) alters ecosystem services to human needs and alters the streamflow pattern (JIN, FAN 2018).

Like many other developing countries across the globe, significant land-cover changes have occurred in Ethiopia since the last century. These changes were primarily due to anthropogenic activities, in connection with the population increase and due to land use changes, including deforestation, over grazing, and improper cultivation of agricultural land which led to accelerated soil erosion and associate soil nutrient deterioration (Eleni et al., 2013). Studies conducted in different parts of the country reported a significant decrease of vegetation cover due to the expansion of cultivated land (Abate, 2011).

LULC change is basic data on the extent and trend in the study area that would help for planning and the adoption of sustainable land management practices. Therefore, the study preparation is to determine the rate, extent and distribution of various land use and cover changes and associated consequences which tacks place in Zebider Forest Ecosystem, from land sat images 2000 to 2020.

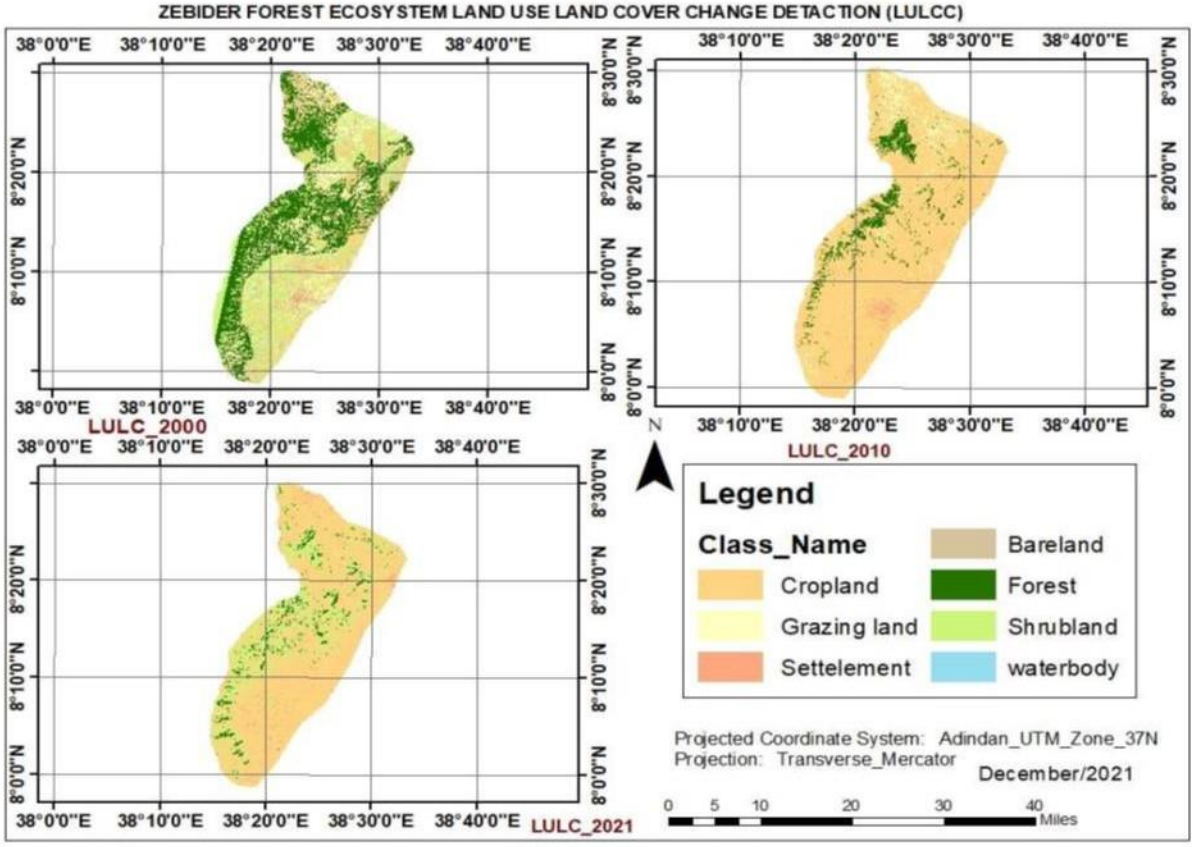


Figure 5 **Period Satellite Data (2000, 2010 And 2020) of the Zebider Forest**

As indicated in the above maps the study was carried out using three time period satellite data (2000, 2010 and 2020) of the Zebider forest. Using the supervised digital classification method (maximum likely hood classifier), along the Zebider Mountain and the surrounding Weredas LULC have been identified.

On running change analyze is among the seven LULC classes, it was observed that the various classes had different trends of change through the three decades as shown in Table 9.

Table 9**:-Land Use and Land Cover Classes Considered and Their Descriptions**

No	Land use type	Descriptions
1	Farmland	This class describes land which is mainly used for growing crops. Crops in this land are rain-fed (small-scale farmland).
2	Water Bodies	The area covered with water either along the river bed and ponds.
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.
6	Grazing Land	This class of land cover defines grassland.
7	Settlement	This class describes the land covered with buildings in the study area. It includes commercial, residential, industrial and transportation infrastructure.

The study area was defined to have seven major land uses and land cover categories i.e. Farmland, Forest land, Shrubs land, Grazing Land, Water Bodies, Bare land and Settlement. The land use land cover classification over twenty years (2000-2020) was shown in Figure 5.

Table 10 **Land Use Land Covers Distribution for (2000, 2010 and 2020) in Zebider forest.**

Land use land cover classes	**Year 2000**		**Year 2010**		**Year 2020**		**Rate of change b/n 2000-2010**	**Rate of change b/n 2000-2020**
	Ar (ha)	%	Ar (ha)	%	Ar (ha)	%	Ar (ha)	Ar (ha)
Forest Land	29457.11	31.75	8281.44	8.92	6825.41	7.36	-21175.67	-22631.7
Farmland	19724.39	21.25	70,606.96	76.1	73,086.05	78.76	50882.57	31158.18
Grazing Land	15854.79	17.1	5922.88	6.38	4649.72	5.01	-9931.91	-11205.07
Shrub Land	22122.92	23.84	1683.89	1.81	533.31	0.57	-20439.03	-21589.61
Water body	28.16	0.03	21.00	0.02	22.31	0.02	-7.26	-5.85
Settlement	762.77	0.82	898.23	0.97	1634.14	1.76	135.46	871.37
Bare Land	4840.00	5.22	5375.75	5.79	6,039.19	6.51	535.75	1199.19
Total	**92.790,14**	**100%**	**92.790,14**	**100%**	**92.790,14**	**100%**		

Source: Land classification of land sat images of 2000, 2010 and 2020

The land use land cover classes of 2000 have prepared from satellite image of land sat and involved seven main land use land cover categories: Forest land, Farmland, Grazing Land, Shrub land, Bare Land, Water body and Settlement. In the year 2000, about 31.75% was covered by forest land, 21.25% by Farmland, 17.1% by Grazing Land, 23.84 by Shrubs land, 5.22 by Bare Land and 0.03% was covered Water body. In this period Forest land has high coverage and Water body has less coverage.

The land use land cover classes of 2010 have also seven main land use land cover categories: as already mentioned as in the period of 2000, in the year 2010, 8.91% was covered by forest land, 76.1% by Farmland, 6.38% by Grazing Land, 1,81%

Shrub lands, 0.02% by Water body, 5.79 by Bare Land and 0.97% covered by Settlement area

The land use land cover classes of the year 2020 have seven main land use land cover categories: in this year Forest land was covered by (7.36%), by Farmland (78.76%) and by Grazing Land (5.01%), by shrub land (0.57%), by Water body (0.02%), by Bare Land (6.51) and Settlement (1.76%) .

Overall, Forest, Grazing Land and Shrub lands were decreased by 76.83 %, 70.8 %, and 97.59 respectively over twenty years (2000 - 2020). However, Farmland was increased by 370.52 % "Between" 2000-2020 in the study site. The study shows that the forest cover is the most dominant land cover in the study area that comprises about 29457.11 (ha) forest cover. Over twenty year period, forest cover was significantly decreased in the study site.

The Land Use Land Cover Change (LULCC) Detection indicates that, nearly 85.74 % of forest and Shrub land had already been lost. The rate of forest and Shrub land removal has been at an alarming rate. On the average 4.28 % of forest and Shrub land had already been lost each year. Settlement was increased by 0.15 % "Between" 2000-2010. However, the rate of change in Settlement was higher in the later period. This could be due to the construction of Welkite - Butajera Asfalt road (የዘቢዳር መንገድ) in 2014. Consequently, forest and Shrub land were converted in to Settlement and Farmland

3.1.2. Drivers and Pressures of the Zebider forest ecosystem

Drivers

Drivers are those factors acting upon the environment and which are responsible for the state of the environment. These factors explain the existing situation in which the country/region is operating and how this impacts on the environment.

In Ethiopia, population relocation causes ecological deterioration and severe resource depletion due to uncontrolled encroachment for settlement and farmland expansions (Berhanu et al. 2016; Wayessa and Nygren 2016).

In many parts of Ethiopia, the extent of forest cover has reduced through time due to continuous deforestation (FAO 2010). Likewise, it is one of the major threats to the forests and shrub lands of Zebider forest due to ongoing population growth. The clearing of land for cultivation, growing demand for household energy and construction materials has aggravated the problem of deforestation in the area.

The rapid population growth rate, a scarcity of land, and construction are among the many problems in the area. Constructions can trigger soil degradation and soil erosion, which changes watershed properties that may cause flooding in nearby areas.

Anthropogenic factor come from population pressure on the environment, As a result of human population growth, nutrient depletion particularly associated with a lack of limestone in the soil and the decline in agricultural production. The main drivers for the deterioration of the ecosystem are population growth and infrastructure (road construction).

Pressures

Pressures are often classified into basic forces of economic and social such as population growth, consumption (use of resources) or poverty which impacts on environment. The pressures on the environment are often considered from a policy perspective as the starting point for tackling environmental issues.

In Ethiopia, forest fire is one of the major causes for the ruthless destruction of vegetation resources during the past and present (Kidane et al. 2012). Likewise, human induced fire incidence has threatened the forest and shrub land covers in the study area. The study result indicated that the local people set fire on the forests and shrub lands of the area to expand agricultural lands. As we have discussed with FGD in adjacent weredas about driver and pressure of this problem, they had stated that, land clearing for cultivation is the main cause of forest fire in the area.

As we have seen the above, population pressure on the environment, As a result of human population growth, average land distribution per household for different uses, deforestation, intensive farming activities and maximum rate of agro chemical use (fertilizer consumption) are among the many pressures in the area.

3.1.3. Impacts of Land/Use Land Cover Change

At zonal level, government officials complain that the contraction of Welkite - Butajera Asfalt road (የዘቢዳር መንገድ) which changes watershed properties that may cause flooding and land slide. The flood which occurred in 2013 has caused loss of 22 cattle and 5 horses. as well as damages an estimated 35.5 ha of farm lands.

Population number of the road side also increased. Hence, the study area is experiencing rapid population growth and high population density which induces increased demand for farmlands, and exacerbates the rate of resource depletion in the area. According to the respondents, the productivity of cropland has deteriorated over time due to continuous cultivation, requiring the use of fertilizers.

Further land redistribution to address landlessness is difficult due to very small size of farm land holdings and enforcement of land certification. It is almost impossible for new generations to practice their life. So, they forced to leave and migrate to other regions.

The increased frequency and magnitude of seasonal frost in the study area in recent years is also analyzed based on climate change induced annual temperature variability. An increase of frequent seasonal frost has been experienced since 2000. It causes famine in some part of the rural Kebele.

There are also direct impacts of deforestation on the livelihood of local people. It is already being used by local people as subsistence farming and as the sources of food in different ways. The participants of FGD from local people stated as: forest is our food from where we find roots and leafs for eating especially during dry season. It is our medicine that we use it for all sickness; it is our building material which we use it for building our houses. so our land and its forests are all in all for us....

3.1.4. Responses

According to key informants and FGDs the soil conservation program or which is called “Tefases" has taken to protect the land from degradation by the region, cluster and by the local people. Farmers use an artificial fertilizer as one of the strategies to improve agricultural productivity. However, the government is promoting organic based farming and advising individuals to switch to compost, manure and other organic sources of soil fertilization.

Apart from efforts made to rehabilitate and reforest degraded areas, challenges due to are reported to have negatively affected the anticipated success. For instance, FGD participant explained that they planted Asta and Bambo seedlings in the degraded areas; however, most of them failed due to the serious seasonal frost stress prevalent in the area. Regardless of farmer’s interest, officials pressured farmers to plant new tree specious. They also introduced and provided like Abesha Tsed, Dicerens and kosso

3.1.5. Outlooks

Zebider forest ecosystem has been experiencing different LULC changes. The main finding of this study revealed that a fluctuated change of LULC types between 2000 and 2020 due to some proximate and underlying drivers in the study area. During 20 years period settlement and farm land were increased respectively, with a corresponding decline in the area of forestland and shrub land. If the rate of LULC changes continues in the same rate in 2030, farm land and settlement are expected to increase by 13.52 & 5.58 respectively. On the other forest and shrub land are predicted to shrink by 3.84 & 4.87 respectively. If the rates of LULC changes continue in the same rate the natural resource utilization never is sustainable.

3.1.6. Recommendations

Forest resources development, protection and use strategies need to be devised to counteract the deteriorating forest /shrub and avoid further extinction of important tree/shrub species.

Soil conservation is done before in all rural weredas the soil and water conservation works; the Zonal administration should be continued rehabilitation project works especially in steep slope areas of the administration.

Vegetation planted along a stream or riverbank helps hold the soil in place and prevents it from running off the fields and into the flood.

Besides, it should also promote community based integrated water shade management through rehabilitation projects by collaborating with neighbor regional state.

In the face of the growing household level land shortage and growing number of landless youths, it will be imperative to create and strengthen non-farm/off-farm income generating activities, due to limited capacity of agriculture to accommodate additional population.

New development constructions will involve more careful assessment of environmental impacts and the existing EIA should be revised.

3.1.7. State and Trend of Land Degradation in Zebider Forest Ecosystem

Throughout the world today, depletion of natural resources is among the major problems facing human beings. It is one of the most critical environmental issues facing many countries today (Ayalneh, B., 2002.). In Africa, it is estimated that about 320 million ha, or about one quarter of its dry lands, are affected by different types of soil erosion (Alemayehu, D.,2009).Land degradation, especially in the highlands, has been identified as the most serious environmental problem in Ethiopia.

The Ethiopian highland studies revealed that the Ethiopian highlands, which cover 44% of the country's total land area are seriously threatened by soil and biological degradation. Land degradation, especially in the highlands, has been identified as the most serious environmental problem in Ethiopia (Aune, J. B., Bussa, M. T., Asfaw, F. G. and Ayele, A. A., 2001). Some 27 million ha representing approximately 50% of the highlands are already significantly degraded. Of this area 14 million ha are badly eroded and if the present trend of soil degradation continues, per capita income in the highlands will fall by 30% in 20 years' time. Around 54% of the remaining highlands are highly susceptible to erosion (Genene, T., 2006).

According to (Genene, T., 2006), The Bilate River basin, which starts in eastern slopes of Gurage highlands and stretches through eastern Hadiya and Kembatta highlands are some of the seriously eroded/degraded land surfaces in Ethiopia.

Land degradation is a serious problem in the study area cutting across the whole region, with its associated consequences such as soil erosion and desertification, prominent in the lowland part of the region.

The altitude of the study area reaches 3719 meters above sea level. It is characterized by ranged mountain. The main parts of the mountain parts are dominated by steep slope, deep valleys and highly exposed to erosions. It is exposed to sheet, rill and gully erosion. This part potentially source of unexpected floods during rainy seasons. The steep slopes aggravated surfaces run-off down the hills which is potentially disastrous to the lower built up.

Table 11 **The Proportion of land use type owned by the communally from the total land**

No	**The proportion of land owned by the community**	**Value in ha**	**Value in %**
1	Grazing land	38,281	6.79
2	Water body	8,515	1.51
3	Agricultural land	479,325	84.98
4	Potentially cultivable land	37,891	6.72
	Total	**564,012**	**100**



Figure 6 Land Degeradation on Zebider forest ecosystem

3.1.8. Driver and pressure for land Degradation

There is a general agreement on the direct causes of land degradation. These include production on steep slopes and fragile soils with inadequate investments in soil conservation or vegetative cover, erratic rainfall patterns, decline uses of fallow, limited recycle of dung and crop residues to the soil, limited application of external source of plant nutrients, deforestation and overgrazing. Many factors underlie these proximate or direct causes including population pressure, poverty, high costs of inputs and limited access to agricultural inputs and credit, low profitability of agricultural production and many conservation practices, high risks facing farmers, fragmented land holdings and insecure land tenure, short time horizons of farmers and farmers' lack of information about appropriate alternative technologies (Alemayehu, D.,2009).

There are four major causes of land degradation such as deforestation, overgrazing, agricultural activities, and over exploitation. The well-known proximate causes of land degradation include deforestation, overgrazing, limited soil and water conservation measures, limited application of nutrients/organic matter, burning of dung and crop residues and declining use of fallow (Hawando, T. 1989).

Population increase, land shortage, insecure land tenure, poverty and economic pressure are indirect causes of land degradation (Hawando, T. 1989). Population growth has long been considered a prime cause of environmental degradation (Atakilite, B., 2003). It forces farmers to cultivate marginal land. With current trend of population growth there is a poor prospect for ecological sustainability and economic viability of the current agricultural practice unless an effort is made to integrated development in family planning, environmental rehabilitation, and agriculture supported with enabling policy (Hawando, T. 1989).

Road development as one of the basic infrastructure, road development has great role in the integration of economic, social, political and cultural conditions of any country of low economic development like Ethiopia. The development of all-weather roads in the Gurage land contributed to the land use and land cover change (Woldetsadik, 1994). As one of the factors of production, roads stimulate farmers to plant cash crops, which have high demand in the market. Due to its nearness to Addis Ababa and restriction of cutting of the trees from existing natural forests by Government, the community's at large and individual households, in particular, shifted their attention to using fast growing trees, such as eucalypts. Welkite - Butajera Asphalt road construction (የዘቢዳር መንገድ) was also disturbed all natural catchment of the study area which causes of unexpected flood in the region. Thus, the need of infrastructure has its own impact on the natural resource in the area.

As we have discussed with FGD in adjacent kebeles about driver and pressure of this problem, they had stated that, the population is showing an increment every year. In addition to communal grazing land and wooded areas for the extraction of firewood give rise to land degradation.

So, extraction of firewood for household energy, demand on forest lands for other uses that leads to deforestation, population growth rate and road development are the major derivers of land degradation in the study area.

Pressures

As reported by key informant and focus groups, the population increment and deforestation the natural forest pressure became savior that leads to the land degradation. With the growing trend of population pressure and degradation of natural forests, farmers' decision to use agro chemical is unquestionable in the study area, which is one of the most densely populated areas of the zone.

Therefore, the pressures for this land degradation are Intensive Farming activities, Rate of agro chemical use (fertilizer consumption) and Deforestation.

3.1.9. Impacts of land degradation

Land degradation, defined as a temporary or permanent decline in the productive capacity of land, or its potential for environmental management, has significantly contributed to the low yield of crops and livestock of the study area. It can be triggered by various processes that lower the potential productivity of land leading to long-term (sometimes irreversible) deterioration. Estimates vary considerably but direct losses of productivity from land degradation in Ethiopia are minimally 3 percent of agriculture GDP (Berry 2003).

Land degradation threaten food security for many of the poorest and most food insecure living in the study area. The impacts of land degradation include a reduction in crop productivity which is closely linked to poverty and food insecurity. As plan, economic and development report that crop production decreased for instance in Meal, Vegetable, Root crop, Stimulus plant and Pulse in the past around 251,972 kuntal, 7,191,259 kuntal, 5,318,027 kuntal, 5,428,604 kuntal and 2,722kuntal produced respectively but currently they produce 237,166kuntal, 6,358,923kuntal 3,524,388 kuntal, 3,543,313 kuntal and 1,596kuntal respectively. The damage to soil, loss of habitat, water shortages, and has economic consequences.

3.1.10. Response

Land degradation can be prevented through different mechanisms depending up on the nature and form of degradation. Most types of soil degradation can be prevented or reversed by adding nutrients to nutrient depleted soil, rebuilding topsoil through soil amendments, reestablishing vegetation, or buffering soil acidity. According to key informants and FGDs, they treated according to the type of land degradation by using different ways of improving degraded land.

eg :- Fertilization, Animal manure, Soil conservation, Re-vegetation of denuded lands, and Terracing

3.1.11. Outlooks

Most cost estimates of land degradation do not distinguish between soil erosion, soil degradation and land degradation in their analyses. In many economic analyses, there is a tendency to attribute soil fertility decline only to soil erosion. In fact, soil erosion could be a major component of on-site costs, particularly on steeper slopes (Kerr and Pender, 2005). However, in many developing countries, especially in Africa, soil nutrient mining is also often identified as a very serious problem (Stoorvogel, et al. 1993; Bojö and Cassells, 1995).

The methods to assess present land degradation depend on the type of land degradation: physical, chemical or biological. The approaches to land degradation range from simple qualitative observations in the field to elaborate computer simulation modeling of complex processes. So, a simple qualitative observations approach to the assessment of land degradation was adopted.

Most parts of the study areas are exposed to severe rill and gully erosions that have been created trenches of shallow and deep gullies that would influence loss of land and soil and in some cases sedimentation of excessive unwanted materials. If the rates of land degradation continue in the same rate, the natural resource utilization never is sustainable. Finally, it can put disastrous impact on the socio-cultural environment and ecological setting of the region.

3.1.12. Recommendation

Land degradation can be prevented through different mechanisms depending on the nature and form of degradation. If good soil conservation is done, Plants have better growth and establishment, and therefore, a good canopy is achieved, preventing raindrop impact, reducing surface water logging which leads to erosion and loss of topsoil, nutrients, and organic matter.

So, as it is done before the soil and water conservation works, the Zonal administration should be continued rehabilitation project works especially in steep slope areas of the study area. Besides, it should also promote community based integrated water shade management through rehabilitation projects.

Soil and Water conservation practices are tools the farmer can use to prevent soil degradation and build organic matter. These practices include: *Terracing and Check dam and Vegetation planted on denuded lands and along a stream bank.*

Terracing and Check dam

Traditional soil and water conservation measures existed in the study area. There are terraces. They need improvement. We can improve them by increasing their height so that they become Bench Terraces. If they are discontinuous, close the gaps between them.

If there is no traditional terracing, measure the slope gradient on the cultivated land we want to treat. For slopes with gradients of less than 15%, we can suggest Conservation Tillage or Mulch for moisture conservation and apply Trash Line. Above the cultivated land, construct a Cutoff Drain to use for Water Harvesting or safely drain it to next river or gully. For slopes between 15 and 50%, measure the average rework able soil depth first. Add Cutoff Drain above the cultivated land.

In gullies, construct a Check dam. On degraded cultivated land with shallow soil, apply Area Closure. Land with a slope gradient above 50% must be changed with the farmer's agreement into forestland or grassland. Cut and Carry must be used here for grass management. Above gullies, make a Cutoff Drain and in gullies, use Gully Rehabilitation with a Check dam. On medium slopes, combine Area Closure with Trench for Tree Planting. On steep slopes, make a Hillside Terrace

Vegetation planted on denuded lands and along a stream bank

Vegetation planted on denuded lands and along a stream or riverbank helps hold the soil in place and prevents it from running off the fields and into the flood. When soil runs into waterways, it not only carries off nutritious topsoil but it also depletes the living organisms in that waterway.

3.2. State and Trends of Forest

Ethiopia has close to 17.35 million ha (15.7% of the country area) of forest resources, including bamboo, dense woodland, natural forests, and planted forests. Plantation forest also comprises public industrial plantations and private woodlots. Most of the natural forests exist in the south-

Western and south-eastern parts of the country (MEFCC, 2015). Oromia, Gambella, SNNPER, Amhara and Benishangul Gumuz are regional states that have most of the natural forest resources, while Oromia, SNNP, Amhara and Tigray have most of the industrial plantations and woodlots. Oromia, Amhara and SNNP have the largest commercial plantations. Oromia, SNNP and Amhara together contain approximately 93.5% of the total plantation resources in the country.

Forests are important sources of livelihood for millions of people and contribute to the national economic development of many countries. Despite their crucial importance in livelihood and climate regulation, forest resources all over the globe are subjected to enormous pressure resulting in deforestation and degradation due to the increase in human and cattle population and widespread rural poverty (FAO, 2011). 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 (Chakravarty, etal.2012).

In Ethiopia, the diverse forest resources available provide goods and services of significant values to the society, environment and economy (Moges etal, 2010). Afromontane vegetation, which covered more than 50% of the highlands in Ethiopia, is one of the key biodiversity hotspot areas in the country, with enormous plant species. Afromontane vegetation, especially the dry Afromontane forests, provides a diverse range of ecosystem services including serving as habitat for wild animals, watershed protection, soil erosion prevention and control, provision of fodder for livestock, non-timber forest products, groundwater regulation, flood control and climate change mitigation. Wujig Mahgo Waren forest is one of the remnant dry Afromontane forests in northern Ethiopia which plays a crucial role in the livelihoods of the local communities (Asfaw, 2013).

Even if forests provide multiple ecosystem services spanning from local livelihoods and socioeconomic development related goods and services such as food, wood, and water to the global ecological and economic services, such as ecosystem functioning, biological diversity, carbon dynamics, and climate, deforestation and forest degradation are causing a significant reduction in the provisioning of valuable ecosystem goods and services from forests in

developing countries (Lawson, *et al*, 2014). On the other hand, efforts to save forests have attracted enormous international attention.

The United Nations Millennium Development Goals and the UNFCCC have emphasized forest conservation as part of achieving sustainable development (UN, 2016). These efforts have been reinforced through new global development agendas such as the Sustainable Development Goals.

Hence detecting the state, trend, driver and impact of this change on livelihood and ecosystem service and communicating to relevant actors and decision and policy makers is an important role of the Ethiopian Environment Protection Authority (EPA). As part of this role, this report is compiled to present the state, trend, drivers and impacts of deforestation and forest degradation of Zebider forest ecosystem in SNNP.

3.2.0. Deforestation and Forest Degradation in Zebider Forest Ecosystem

Forest: According to Ethiopia's forest proclamation No. 1065/2018, the forest is defined as "trees, plants and other bio-diversity accumulation at and in the surrounding of forest lands, roadsides, riverside, farm and grazing lands as well as residential areas or parks that grow naturally or developed in some other ways".

According to MEFCC (2015) the technical forest definition of Ethiopia used for MRV purpose is 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 of more than 0.5ha are included under forest, areas normally forming part of the forest area which are temporarily unstock as a result of human intervention or natural causes but which are expected to revert to forest.

According to FAO (2006a), the forest is defined as the presence of trees with the land cover of more than 0.5 ha. The tree must be able to reach a minimum of 5m in situ and canopy cover at least 10%.

Woodland: is an open stand, at least 10 meters tall with canopy cover of at least 40 percent and its field layer is 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 to provide important goods and services to people and nature and also undermine the ability of the 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.

Deforestation is the complete removal of forest and conversion of its land use for other land uses such as agriculture and road construction.

There are four types of forest ecosystem services all of which contribute to a range of human outcomes. **Provisioning services** are the familiar, tangible and direct products extracted from the forests to be used or sold. They are wood, fiber and fuel. They also include crops such as ginseng or truffles, which may be planted or developed in the forest, and koura (freshwater crayfish) grown in fire ponds. **Regulating services** include the ability of the forest to store carbon, reduce erosion, improve water quality, and reduce the effects of floods. Steep land planted in trees will also have less erosion than if it were in pasture. **Cultural services**, Non-material social and cultural benefits are also provided by planted forests. These include recreational opportunities, aesthetic enjoyment and spiritual enrichment, as well as a biodiversity and conservation appreciation. **Supporting services**, the biological and physical processes in a forest drive the other three services. Examples of these include soil formation, nutrient cycling, water regulation, and oxygen production.

3.2.1. State and Trends of Forest on Zebider Forest Ecosystem

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 depending 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 are four vegetation types in Ethiopia. These are Acacia Commiphora, Combretum Terminalia, Dry Afromonotrne and Moist Afromontra.

Though, 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. The depletion of forests has many ecological, social and economic consequences, including the extinction of biotic communities leading to a 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 anthropogenic changes (Abraham, 2016). A growing influence of forest based livelihoods, illegal harvesting of forest products, expansion of farms(smallholder and commercial farms) ,overgrazing and other activities were identified as major causes of forest degradation (Fekadu, 2010 and Ministry of Environment and Forest, 2014). Due to similar reason, the remaining natural high forest species and woodlands (e.g. *Aningeria adolfi-friederci, Yushania 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).

According to the information from FGD Zebider forest was one of bio-diverse (plant and animal) and populated ecosystem in the previous years. But currently the forest coverage was declined alarmingly, due to various reasons, such as agricultural land expansion, cutting of tree stands for selling as a raw material for timber production and fuel woods, over utilization of forest products for house construction and fuel wood consumption. Population growth also contributes to this change to a high extent by increasing demand for agricultural land. Due to these reasons the abundance of plant and animal population in the forest ecosystem is declined continuously and flood amount is increased from year to year.

Table 12 Land use land covers distribution for (2000, 2010 and 2020) in Zebider Forest Ecosystem.

Land use	**Year 2000**	**Year 2010**	**Year 2020**	**Rate of**	**Rate of**

land cover classes							change b/n 2000-2010	change b/n 2000-2020
	Ar (ha)	%	Ar (ha)	%	Ar (ha)	%	Ar (ha)	Ar (ha)
Forest Land	29457.11	31.75	8281.44	8.92	6825.41	7.36	-21175.67	-22,631.7
Farmland	19724.39	21.25	70,606.96	76.1	73,086.05	78.76	50882.57	53,361.66
Grazing Land	15854.79	17.1	5922.88	6.38	4649.72	5.01	-9931.91	-11205.07
Shrub Land	22122.92	23.84	1683.89	1.81	533.31	0.57	-20439.03	-21589.61
Water body	28.16	0.03	21.00	0.02	22.31	0.02	-7.26	-5.85
Settlement	762.77	0.82	898.23	0.97	1634.14	1.76	135.46	871.37
Bare Land	4840.00	5.22	5375.75	5.79	6,039.19	6.51	535.75	1199.19
Total	**92.790,14**	**100%**	**92.790,14**	**100%**	**92.790,14**	**100%**		

Source: Land classification of land sat images of 2000, 2010 and 2020

As indicated in the above table, the total area of Zebider Forest Land was 29,457.11 ha from this the forest coverage of the forest ecosystem in the year 2000, 2010 and 2020 was 31.75%, 8.92% and 7.36% respectively. Whereas the shrub land in the year 2000, 2010 and 2020 was 23.84%, 1.81% and 0.57% respectively. The forest land and shrub land cover change from the year 2000 to 2020 was declined by 22,631.7ha and 21,589.61ha respectively. Whereas coverage of other land uses, such as farmland, settlement, and bare land were increased. This indicates that the forest and shrubs in the study area were directly and indirectly converted into other land-use systems.

3.2.2. Driver and pressures Zebider forest degradation

As we get the data from primary and secondary sources Zebider forest ecosystem has various drivers and pressures. Some of the major drivers for deforestation and forest degradation are listed below

The major drivers in Zebider forest ecosystem are;

- **Population Growth:** As we get the data from primary and secondary source the number of human population in the Gurage Zone was increased.

Based on the Statistical Abstract of Gurage Zone the population number of eight woredas those bounded the forest ecosystem is increased from 817,570 to 854,577 between 2019 and 2020. This shows us the population number is increased by 37,007 in one year only.

- **Agricultural land expansion:** the other major driver of Zebider forest loses is agricultural land expansion.

Based on the land use land cover detection the agricultural land in Zebidar forest ecosystem were increased from 19,724.39 to 73,086.05 ha from the year 2000-2020. This means the agricultural land increased by 53,361.66 ha in twenty years. This shows us there is a high increment in the agricultural land. Beside this the forest land is decreased from 29,457.11 to 6,825.41 ha. It decreased by 22,631.7 ha; this indicates that there is a high deforestation rate and change of forest land to the agricultural land.

The major pressure exerted on the Zebider forest

- **Intentional Forest Fire:** In study area the forest fire is intentionally settled to clear forest area for different purposes. For example, the forest is burned for the expansion of agricultural land and to get better grasses for cattle fodder. This is the most common and frequent activity as a result the forest area is highly diminished.
- **Deforestation:** The FGD participants explained that the forest ecosystem is cut and deforested by fire for a different purpose. The main reason is for agricultural land expansion purpose.
- **Forest degradation**: - according to FGD the forest is also degraded for a different purpose. These are cutting of durable trees for selling as a raw material for timber production, fuel woods, and charcoal production. As we get the information from the FGD different tree species are gathered and shipped by cars frequently for timber production. Besides this the forest is also degraded for house construction and fuel woods consumption.

3.2.3. Impact of deforestation and forest degradation on the livelihood of local communities.

The participants of FGD as well as Key Informants woredas and Zone forest experts clarified that degradation of forest ecosystem bring various impact to the local community, some of them are:-

- **Loss of indigenous plant and animal species**: FGD participants explained that there were numerous plant and wild animal species in Zebider forest ecosystem. Currently the number of those plant and wild animal species are declined due to high deforestation of forest resource by fire. Due to their habitat destruction by fire the wildlife are compelled to migrate to the other area.
- **The variability in amount and distribution of rain fall:** FGD participants perceive that the distribution of rainfall was decreased from year to year. Due to this problem the growing season was changed and correspondingly the temperature was raised. As a result, the crop and animal production is decreased due to this reason the income of the local community is highly decreased. According to the information from the Gurage Zone Statistical Abstract document, 2021 due to the rainfall variability of the study area the productivity of different crop types (meal, vegetable, root crop, stimulate plant, and pulse) was declined by 15.97% in the 2019 and 2020. As a result the local community exposed to food insecurity. From this a part of Misqan Woreda community supported with productive safety-net program.

- **Occurrence of flood:** As we discussed in the FGD the occurrence of the flood increased from period to period due to the degradation of Zebider forest ecosystem. This causes the damage of crop land, houses and domestic animal death on the local community. Based on the information from Gurage Zone Wolkite Town Disaster and Risk Management Office from the year 2013 to 2015 a fertilizer which its cost is estimated to be 30,000,000 was damaged and one person life was lost due to flood in Butajira woreda from Butajira mutual work group. Beside this from 2019 to 2021 about 8 hectare of crop was damaged by flood this affect 9 households in Mihur Aklil woreda.

3.2.4. Response of deforestation and forest degradation

Even if there was no response given by the Federal and Regional Government to solve those problems, some (not enough) responses are taken for the protection of deforestation and forest degradation from the local community. The responses taken by local community were practice of soil and water conservation activities.

3.2.5. Outlook

If regional and federal governments as well as the concerned stockholders try to reverse forest coverage change of the area by practicing different remedial action, the community will lose the total forest and shrub land area for the next 30 years.

Even though 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. The population growth rate between 2019 and 2020 was 4.52%.

If the population continuous at the existing rate, the population in the next 30 year will be 1,108,624.92 but the forest coverage is degraded by 2.4% in each year and also the total coverage of the forest will be declined by 72% within the next 30 years. In general, the mismatch between the rising demand for forest resource and population increment will make forest degradation inevitable.

If deforestation and forest degradation 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. This leads to low water availability during dry seasons, affecting human and livestock access to water throughout the year.

3.2.6. Recommendation

Working to end deforestation and forest degradation while helping to restore forests lost is our best chance to solve the climate emergency, protect wildlife, and defend the rights of Indigenous Peoples and traditional local communities. That's why we are campaigning for more forests tomorrow than there are today. So in order to reduce and to end deforestation and forest degradation all stockholders should better to undertake the following actions:-

Participatory forest management should be practiced in and near watersheds, as part of the national Sustainable Land Management Program (SLMP). This is contributing to greater resilience on the part of smallholder farmers, in the face of climate change.

Appropriate soil and soil water conservation practice should be applied for better management of forest as well as to create sustainable and suitable environment.

Reinforcing and expanding forest protected areas; and adopting agroforestry, afforestation and reforestation and sustainably managing existing planted forests to meet demand for wood, thereby reducing pressure on natural forests.

Establishes forest nursery seedling site in the command area and produce sufficient amount of seedlings for plantation purpose

Putting in place disincentives such as fines for forest clearing, laws and regulations to protect forest, and zoning for production and protection. The concerned body should give awareness for the community about the impact of deforestation and forest degradation on the local community as well as the environment.

Generally, the government as well as the local community should practice Environmental policy on the ground level.

3.3. State and trend of Biodiversity

3.3.1. State and trend of Biodiversity for Zebider 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' (Safeopedia Inc, 2022).

The earth is bestowed with so much biological diversity in myriad forms, which is important for our very existence on the planet. The variety of genes, species, and ecosystems are various components of biological diversity, which is important to mankind for various reasons. This includes a source of food, timber, medicines, fiber, etc., support functions, such as flood control, climate regulation, and nutrient cycling, resilience to disturbance and environmental change, source of pollinators and pest control in agriculture, and, carbon storage and sequestration, economic, recreational, human health benefits and social contributions (Husen, Mishra, Semwal, & Kumar, 2012)

Ethiopia is one of the world's countries, which is rich in faunal, floral, and microbial diversity. Ethiopia is that the fifth largest floral country in tropical Africa. The flora of Ethiopia is very diverse with an estimated number of between 6,500 and 7,000 species of

higher plants, of which about 15 percent are endemic. Ethiopia is also rich in faunal diversity with mammals (277 spp.), birds (861 spp.), reptiles (78 spp.), amphibians (54 spp.), and fishes (101 spp.) (Gebretsadik, 2016)

SNNP of Ethiopia Regional state is one of the eleven regional states of Ethiopia, which is rich in faunal and floral biodiversity. It's highly characterized by diversified tree species and different fauna species.

Zebider forest is one of the natural forests of Ethiopia found in the SNNP of Ethiopia regional state, Gurage Administrative Zone. The forest is a natural forest that is characterized by diversified tree species. It is also one of the high land forests of Ethiopia.

Zebider forest ecosystem was a natural forest that encompasses different kinds of plant species, which are very useful for ecological stability. Besides this, in the Zebider forest ecosystem, there were different varieties of wildlife and bird species. The reason that makes the forest preferable to wildlife species was its appropriate habitat. However, the forest is losing its previous potential as a result of widespread deforestation for agricultural land expansion.

3.3.1.1. Flora Biodiversity of Koysha Forest

Flora refers to all plant life that occurs within a habitat or region. Usually, it refers to naturally present plants instead of plant species which are introduced by human being. Occasionally, the term also embraces the species of bacteria and fungi that occur (Safeopedia Inc, 2022).

Plant life is the basis of all life occurring within an ecosystem. Should the composition of the flora change, the ecosystem will no longer be able to support the animal and insect life that should occur in the region and the ecosystem, in turn, becomes disrupted (Safeopedia Inc, 2022).

There are different floral resources in the Zebider forest ecosystem; these different plant species are listed in the following table by their Local name, Common name, and Scientific name.

Table 13 Identified plant species of the Zebider forest ecosystem.

Local name	**Common name**	**Scientific name**
Yehabesha Tid	African pencil cedar	*Juniperus procera*
Weyra	African wild olive	*Olea europaea*
Koso	Hagenea	*Hagenia abyssinica*
Kerkeha	Mountain bamboo	*Arundinaria alpina*

Bisana/Daya	Bisana	*Croton macrostachyus*
Tikur Enchet	Red stinkwood, Ironweed	*Prunus africanus*
Yedega Abalo	Abalo	*Terminalia brownii*
Wulkeffa/Buret	Wulkeffa	*Dombeya torrida*
Shola	Cape fig	*Ficus sur*
Wanza	Wanza	*Cordia africana*
Girar	Acacia	*Acacia abyssinica*
Bahirzaf	Eucalyptus	*Eucalyptus*
Granville	Silky oak	*Grevillea robusta*
Yebahir Tsid		
Asta/Gadra		
Gomra		
Kolchem/Korchem		
Dakerans		

Source:- (**GZEFCCPO**,2021) and FGD.

According to FGD, all the plant species mentioned in table 13 were decreased because of serious deforestation for agricultural land expansion purposes. For example, ***Hagenia abyssinica/* Koso**, ***Juniperus procera*/Yehabesha Tid, *Prunus africanus*/Tikur Enchet, *Olea europaea*/Weyra and Asta** were highly threatened, because, ***Juniperus procera*/Yehabesha Tid, *Prunus africanus*/Tikur Enchet** and ***Olea europaea*/Weyra** are durable tree species used for timber production and fuel woods, furthermore these tree species are extensively used as income generation tools by selling as a raw material for timber production through shipping by cars frequently. Due to these reasons, the forest ecosystem was highly deforested from time to time.

3.3.1.2. Faunal Biodiversity of Zebider Forest

Fauna is a general term for the list of animal species being in a particular region. Fauna can refer to a primordial collection of beasts, as might be inferred from the relic record, or to a contemporary assemblage of species living in a region. More locally, a faunation refers to the communities of individualities of the different animal species happening in a specific place. On the other way, Fauna is all animal being that exists in a particular geographical area throughout a particular time in history. The type of fauna to be exists in any particular region is determined by aspects such as plant life, physical environment, topographic barriers, and Evolutionary history (Encyclopedia.com., 2018).

Zebider Forest ecosystem encompasses desirable habitats contributing to the occurrence of high faunal diversity. However, the information for this state of the environment report is limited to mammals and birds.

Mammal species: - The identified mammal species in the Zebider forest ecosystem are listed in table14 by their Local name, common name, and scientific name.

Table 14Identified mammal species in the Zebider forest ecosystem.

Local name	Common name	Scientific name
Jib	Hyena	*Hyaenidae carnivora*
Midaqowa	Duiker, Grey	*Sylvicapra grimmia*
Zinjaro	Baboon, Anubis	*Papio anubis*
Tota/Monkey, Grivet	Ape	*Cercopithecus aethiops*
Asama	Pig	*Potamocochoerus porcus*
Kerkero	Warthog	*Phacochoerus aethiopicus*
Kebero	Jackal, Golden	*Canis aureus*
Tinchel	Hare, Abyssinian	*Lepus habessinicus*
Jart	Porcupine	*Hystrix cristata*
Dikula	Bushbuck, common	*Tragelaphus scriptus*
Shelemitmat	Mongoose, Southern dwarf	*Helogale parvula*

Source:- (**GZEFCCPO**,2021) and FGD.

The abundance of almost all mammal species mentioned in table 14 was respectable in the area. However, nowadays many species were migrated to other areas and different mammal species like ***Panthera pardus*/Leopard, *Felis serval*/Serval,** and ***Syncerus caffer*/Buffalo** are extincted from the ecosystem. On the other hand, the other mammal species like ***Phacochoerus aethiopicus*/ Warthog, *Sylvicapra grimmia*/Duiker,** and ***Tragelaphus scriptus*/ Bushbuck** were highly decreased; because, their habitat extensively destroyed by fire, for agricultural land expansion.

Bird species: - As part of wildlife resources, besides assessing the abundance and diversity of larger mammalian species, attempting to identify and record bird species of the relevant areas within the territory of the forest ecosystem is equally important. Hence, through efforts made to identify available bird species in the potential ecosystem, several bird species have been identified and listed in table 15 by their local name and scientific name.

Table 15 Identified bird species in the Zebider forest ecosystem.

Local name	Common name	Scientific name
Dakiye	African Black Duck	*Anas sparsa*
Jigra	Egyptian Goose	*Alopochen aegyptiaca*
Regbe	Dove	*Columba livia*
Qura	Crow	*Corvus corone*
Chilfit/Chilat	Falcon	*Falco eleonorae*
Tinbansa	Buzzard	*Buteo buteo*
Erkum	White Stork	*Ciconia ciconia*
Qoqe		
Yesetan Doro		
Ebet cherash		
Meser/Anchit		

Source:- (**GZEFCCPO**,2021) and FGD.

According to FGD, there were many different bird species in the Zebiider Forest ecosystem in the past, but now a day many bird species have migrated to the other area. Because, their nests and eggs are frequently affect by forest fire.

3.3.2. Drivers and Pressures of Biodiversity Degradation on Zebider 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 the abundance and diversity of the ecosystem community have changed.

The main drivers of biodiversity degradation in Zebider forest ecosystems are agricultural land expansion and population growth.

Based on the Statistical Abstract of Gurage Zone the population number of eight woredas that bound the forest ecosystem increased from 817,570 to 854,577 between 2019 and 2020. This shows us the population number is increased by 37,007 in one year.

Based on the land use land cover detection the agricultural land in the Zebider forest ecosystem increased from 19,724.39 to 73,086.05 ha from the year 2000 to 2020. Besides this, the forest land decreased from 29,457.11 to 6,825.41 ha.

Biodiversity is degraded rapidly due to pressures such as Intentional Forest Fire, deforestation, and forest degradation.

Intentional Forest Fire: - In the study area, the forest fire is deliberately settled to clear forest areas for different purposes. For example, the forest is burned for the expansion of agricultural land and to get better grasses for cattle fodder. This is the most common and frequent activity in the study area, as a result, a forest fire is a major reason for biodiversity degradation.

Deforestation: - In the study area, the forest has been cleared by fire for agricultural land expansion. This trend of the burning forest is deliberately settled to clear forest land for agricultural land expansion, thereby ensuring that the forest will not return to its former position.

Forest degradation: -In the study area the forest is degraded due to cutting tree stands for selling, fuel wood consumption, and construction material. According to the information from FGD different tree species used for timber production were frequently harvested and shipped by cars for sale. Due to this activity, the indigenous and durable tree species were highly degraded.

3.3.3. Impact of Biodiversity Degradation on Lively Hood System of the Local People of Zebider Forest ecosystem

Zebider forest is one of the forests that are under the great impact of land-use changes, mainly due to agricultural land expansion purposes. Losses of biodiversity affect human well-being in different ways. Based on the information from FGD the impact of biodiversity degradation on the Zebider forest ecosystem and local community is explained as follows;

Impact on the local community: - The local community is affected by the scarcity of different forest products, (like; honey, durable tree species for construction and other uses, etc.). Due to the biodiversity degradation the shortage and uneven distribution of rainfall occurrence increase, due to this reason, crop and animal production were decreased. For example, according to 2021 Gurage Zone Statistical Abstract document due to the rainfall variability of the study area the productivity of different crop types (like meal, vegetable, root crop, stimulate plant, and pulse) was declined by 15.97% in the 2019 and 2020. As a result the local community exposed to food insecurity. Beside this, due to the high degree of forest degradation, water quality and quantity are decreased, which makes the local community vulnerable to a shortage of clean water.

Impact on the flora species: -the floral species are also highly degraded because it is imposed to forest fire destruction and overutilization of different tree species. Due to these reasons, different tree species are highly degraded and tend to extinct in the study area. A forest fire can destroy all floral resources starting from grasses in the forest up to higher tree species without selection.

Besides this different tree species are over-utilized for selling as a raw material for timber production through shipped by cars.

Impact on wild-life: - Due to the activity of forest fire and deforestation the wildlife and bird species are highly disturbed and coerced to leave their homeland and migrated to the other area; because their habitat was destructed by fire. The fire can destroy all biodiversity resources even reptiles in the grasses, eggs of birds, and microorganisms in the soil as a result the biodiversity resource of the Zebider Forest Ecosystem was highly degraded.

3.3.4. **Responses to Biodiversity Degradation on Zebider Forest Ecosystem**

Now a day to reduce and control the problem of Zebider forest ecosystem and biodiversity degradation, the local community, and the government bodies did not take any actions. But, there are guides or course of actions which stated in the National Biodiversity Policy and Strategies if it's applied. For example, according to (Medina I. et'al, 2018) the National Biodiversity Policy (NBP) was established in 1998 based on a holistic ecosystem approach to conserving, developing, and utilizing the country's biodiversity resources. Integration of biodiversity conservation and development in federal and regional sectoral development initiatives, and mobilization of international cooperation and assistance, have been identified as the principal strategies for implementation of the policy. The policy guides effective conservation, rational development, and sustainable utilization of the country's biodiversity, and contains comprehensive policy provisions for the conservation and sustainable utilization of biodiversity, but the implementation of these policies was the main problem, manifested in the study area, particularly to control the biodiversity devastation, and forest ecosystem degradation.

3.3.5. Outlook

Unless the Federal government and SNNP of Ethiopia's regional state government, concerned bodies and other stakeholders deal and work together to protect and save the Zebider forest ecosystem in common understanding, the Zebider forest ecosystem is at great risk and it's difficult to control the future risk.

The population growth rate of the eight Woredas that bounds Zebider Forest ecosystem was 4.52% between the year 2019 and 2020. If the population continuous at the existing rate, the population in the next 30 year will be 1,108,624.92, while the forest coverage is degraded by

2.4% in each year and also the total coverage of the forest will be declined by 72% within the next 30 years. In general, the mismatch between the rising demand for forest resource and population increment will make biodiversity degradation inevitable.

If the practices like deforesting for agricultural land expansion and over-utilization of forest products are continues as it is practiced at the present, the biological diversity resource of the Zebider Forest ecosystem will destruct within the coming three decades.

3.3.6. Recommendation

- Promote public training, education, and community-based monitoring, where appropriate, as integral elements in conservation and management.
- Ensure legislation and guidelines to introduce a system of direct and indirect incentives to promote the conservation and sustainable use of biodiversity.
- Promote joint forest management and participatory forest management programs.
- Implementing the National biodiversity policies like; the policy guides effective conservation, rational development, and sustainable utilization of the country's biodiversity, and contains comprehensive policy provisions for the conservation and sustainable utilization of biodiversity.
- Conducts ecological principles of conservation methods, such as
    - Biodiversity is supported by the protection of any species and varieties
    - Habitat maintenance is fundamental to species conservation
    - We can start planting trees at an individual community level to restore our degraded environments.

3.4 State and Trends of Atmosphere

The Weather and climate of Ethiopia depended on altitude and geographic location (precipitation varies with latitude, decreasing from south to north). The landscapes of Ethiopia are wildly varied from the Afar Depression (~125 m below sea level) in the east to the spectacular world heritage Mountains of Ras Dashen (4,533 m above sea level) in the north (IBC, 2005). The Elevation is the most important determinant of the average annual temperature of the country

with a reduction of 0.5–0.7 °C per 100 m increase in altitude (Liljequist, 1986), given its geographic location close to the equator and the Indian Ocean.

The Weather and climate of Ethiopia arise from the influence of tropical weather systems, like the Inter-Tropical Convergence Zone (ITCZ), the South Indian Ocean anticyclone (Mascarin High), the low-level jet (LLJ), the South Atlantic anticyclone (St. Helena), etc. (Bekele F. 1997). It is mainly controlled by ITCZ and associated atmospheric circulations as well as by the complex topography of the country.

Climate is the "average weather" or more specifically the statistical aspects of the atmosphere-hydrosphere-land surface system that varies over time ranging from months to millions of years. Climate also describes long-term statistical averages and measures of variability associated with daily weather (Peter T. et al., 2015).

Climate change is inevitably resulting in changes in climate variability and the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events (IPCC, 2012).

A different source indicates that Ethiopia has less contribution to climate change but is highly exposed to its impact. Climate change increased the number of 'hot' days in Ethiopia by 20% from 1960 to 2003, and a 37.5% increase in the number of 'hot' nights over the same period (Alex Evans, 2012).

Climate Variability is defined as variations in the mean state and other statistics of the climate on all temporal and spatial scales, beyond individual weather events. The term "Climate Variability" is often used to denote deviations of climatic statistics over a given period (e.g. a month, season, or year) when compared to long-term statistics for the same calendar period. Climate variability is measured by these deviations, which are usually termed anomalies. Variability may be due to natural internal processes within the climate system (internal variability) or to variations in natural or anthropogenic external factors (external variability) (WMO, 2019).

Drought

An extreme climatic event (drought) is shortening (Gutierrez et al., 2014).

Flood: An overflow of water onto normally dry land. The inundation of a normally dry area is caused by rising water in an existing waterway, such as a river, stream, or drainage ditch. Ponding of water at or near the point where the rain fell. Flooding is a longer-term event than flash flooding: it may last days or weeks (NWSWFS, 2021).

Flash flood: A flood caused by heavy or excessive rainfall in a short period, generally less than 6 hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through river beds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain has fallen, for instance after a levee or dam has failed, or after a sudden release of water by a debris or ice jam (NWSWFS, 2021). Specific topics, with climate change and its implications become the most investigated theme in the last decade.

The study focuses mainly on climate change and/ variability of the Zebider Forest in Gurage Zone SNNPR; it's located at 07°53'51''to 08°28'36'' N latitude and 37°50'09''to 38°42'490 9''E longitude, with an altitude range between 1000 to 3,721 m.a.s.l at mount Zebider. Its agro- ecology is included "Dega"55.6% "weynadega'' 5.6% and Kola 38.75% and it's located around 88k.m far from Wolkite city (GZSAD 2012).

The field data collection process took place in December 2021 with trained data collectors supervised by the Director. More data were gathered through focus group discussions (FGD) which were carried out across eight Kebeles around the Zebider Forest Ecosystem including Esa, Gedebano Gutaber welene, Sodo, Debub Sodo, Msqan,Merab Mesqan, Gumer, M/aklil. Structured questionnaires and field observation were employed together with the necessary data. The study also used Meteorological data collected from the National Meteorological Agency of Ethiopia for the period 1988–2018 other relevant data and official unpublished documents from the governmental organizations were employed.

3.4.1. **State and Trends Climate Variability and/or Change of Zebider Forest Ecosystem**

Rainfall

The climate of the region is characterized by monomial rainfall distribution which occurs in the summer season. As indicated in fig.1 high rain fall recorded in the summer "Kiremt" season includes June to August, peeks in July a mean of 199.6 mm. Due to the influence of the Guinean

monsoon, equatorial warm and humid winds, are also substantially influenced by the orographic diversity (M. Fazzini et al.2015).

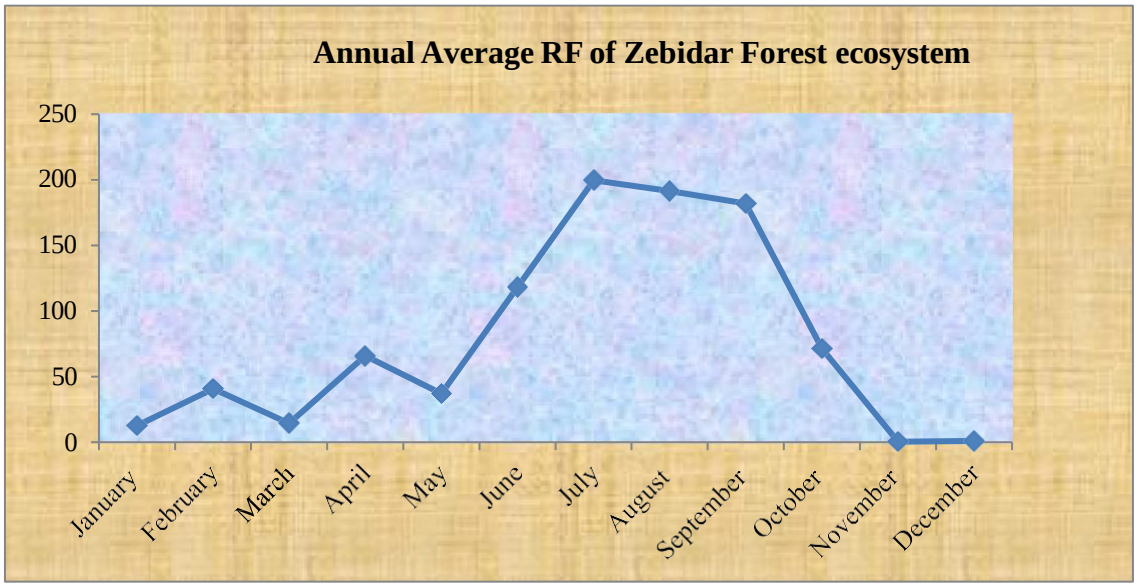


Figure 7 *Monthly Average rainfall of Zebidere forest (1988 to 2018 in mm).*

The amount of rainfall differs from year to year because of climate change and/or variability, as blow figure indicated that the total **average** annual rainfall of Zebider forest was **915.45mm** with the **highest** of **1102.98mm** in the year 1993 while, the **lowest** of **686.3mm** in the year 2002. The study area has a high annual RF variability due to the seasonal progression of the inter-tropical convergence zone (ITCZ), an atmospheric circulation feature often modified by the El Niño–Southern Oscillation (ENSO) (Tafesse M. 2019).

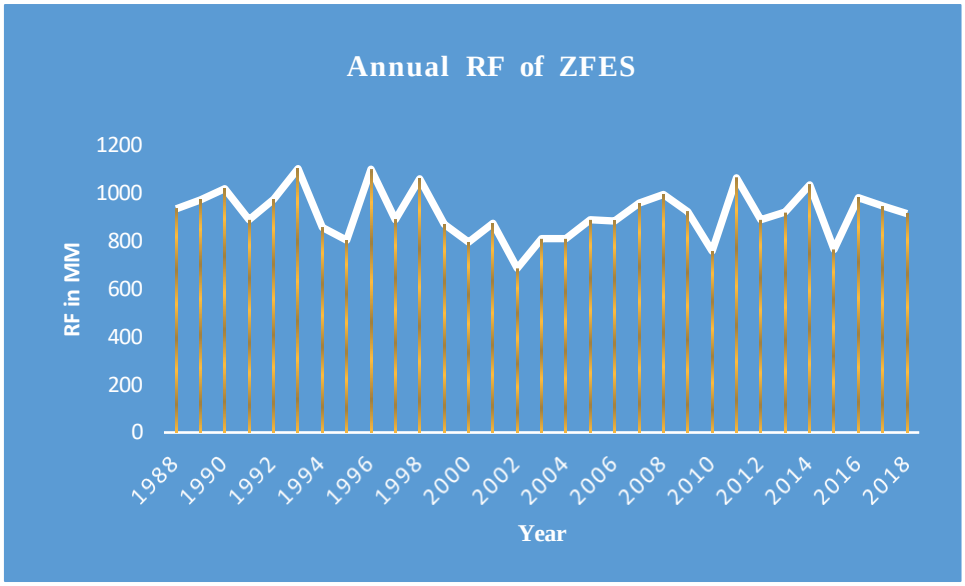


Figure 8 Annual Average Rainfall of Zebider RF in mm (1988-2018).

Rainfall Anomaly (Drought) Index

According to WMO 2012, put the range of standard precipitation value **of agricultural**, metrological and hydrological drought from extremely wet to dry between 2 up to negative 2 respectively, as shown as below table.

Table 16 **Standard Precipitation Value** (SPV)

SN	Range of standard precipitation value	Category of precipitation
1	2.0+	Extremely wet
2	1.5 to 1.99	Very wet
3	1.0 to 1.49	Moderately wet
4	-99 to 99	Near normal
5	-1.0 to 1.49	Moderately dry
6	-1.5n to -1.99	Severely dry
7	-2 and less	Extremely dry

Source: WMO, 2012, Standardized Precipitation Index User Guide.

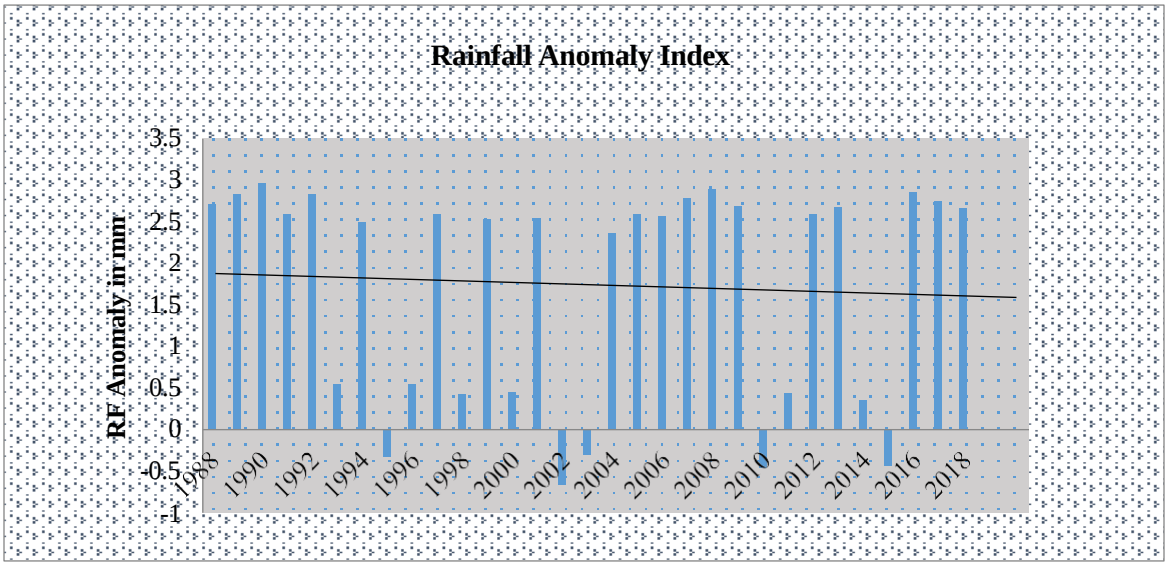


Figure 9 RF Anomal Index of Zebider Forest Ecosystem (1988-2018)

Depending on **standard precipitation value**s (SPV) rainfall anomaly index of Zebider forest indicated that the majority of the year (56.6%) was categorized under **extremely wet** precipitation and the remaining 43.3% was **near normal** perspiration. it shows variability increased from the year 1992 to 2004 and 2009 – 2016. The trend line was decreased as a result the frequency of drought increased and averagely occurred in 6 years, the result is accepted by FGD.

State and Trend of Temperature for ZFES

The atmospheric concentration of CO2 increased from year to year (F. Joos et al., 2013). 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,". Associate it with the incremental of temperature.

The metrological data analyses of Zebider forest in blow figure black line indicated that the average annual temperature **trend was** averagely increased from the year 1988 to 2021. The variation of the average temperature between the lowest was 23.98^{O}C in the year 1989 and the highest was 25.67^{O}C in 2017 whereas; the average temperature and range were 24.64^{O}C and 1.69^{O}C respectively. The rate of change or slope is 0.027^{O}C.

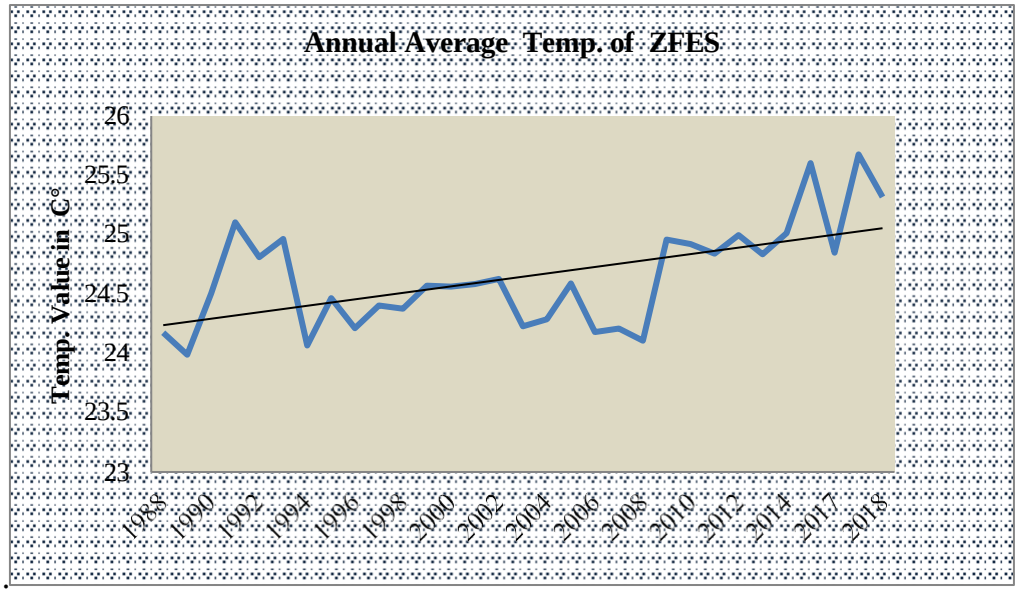


Figure 10 *Average Annual Temperature of ZFES from the year 1988-2018.*

The Below figure illustrates that **the Monthly average** temperature of the study area was **24.57°c** whereas; **the highest and lowest value recorded in April (25.9°c) and July (22.79) °c** respectively, the range was 3.11**°c**. Additionally, the figure shows that the long dry season extending from October to June has resulted in the difference between the thermal anticyclone of western Asia and Egypt and the equatorial low pressures determine the presence of trade winds blowing from northeast to southwest. These winds relatively cool but rather dry, control the dry period (M. Fazzini et al.2015).

Generally, the meteorology data was indicated that the trend of the average temperature of Zebider Forest was raised from year to year within **30** years.

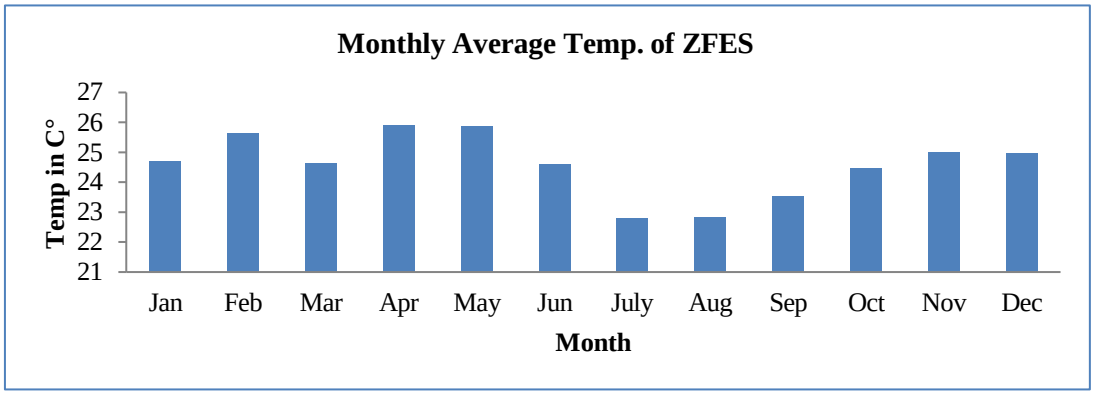


Figure 11*Average Monthly Temperature of Zebider Forest Ecosystem from 1988-2018.*

Temperature Anomaly

A positive anomaly means that the temperature was warmer than normal whereas a negative anomaly indicates that the temperature was cooler than normal.

Depends on the blow figure 60% of the year was recorded a negative temperature anomaly from 1991-2008 except 2002 and 1993 with lowest cool temperature of -0.08°C in 1989 and the remaining 40% was a positive anomaly from 1991-1993 and 2009 to 2018 with peak of 0.12°C was recorded in 2017.

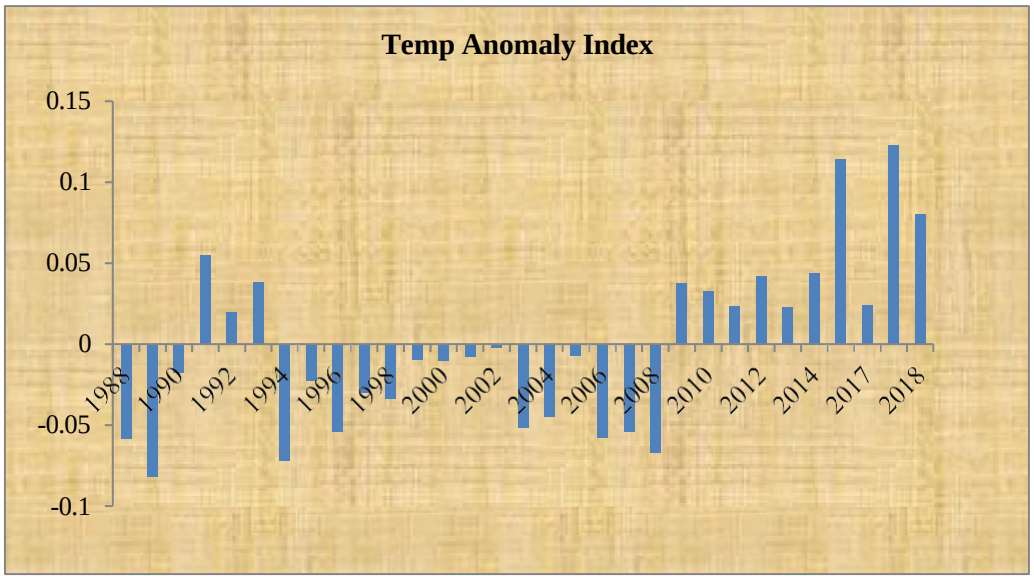


Figure 12 Averages Annual Temp. Anomaly of ZFES (calculating with WMO, 2017)

3.4.2. Driver and Pressure for Climate Change/Variability of Zebider Forest Ecosystem

GHG Increasing in the Atmosphere

It is responsible for regional micro and macro climate change and global warming. In the year 2015 Global level of CO_2 crossed the symbolic and significant 400 parts per million benchmark (WMA, 2019).

Intentional wildfire; Wildfire is the most common and frequent problem, people intentionally burn the forest for different purposes for instance the expansion of agricultural activities mainly needed better grass for grazing activities. Due to forest fire, ambient air is covered by smoke for 3-4 days, if the weather dry it Persisted for 6 months**.**

Wildfires Affect Climate: Its releases large amounts of carbon dioxide, black carbon, brown carbon, and ozone precursors into the atmosphere. Its emissions affect radiation, clouds, and climate on regional and even global scales (Mackenzie Solomon, 2014).

Fine particulate matter (PM2.5) is the major pollutant emitted by wildfires. Tropospheric ozone (O3) is another pollutant related to wildfires (Weeberb J. 2021). FGD implies that the society was used the forest for economic purposes, fuelwood collection, house construction, etc. but now declines it.

LULCC

Rapid population growth: - This leads to 55,431.53 ha of land use converted into other types of landform 2000-2021 (LULCC, 2022) it was contributed significantly to SO_2 (Oluwasinaayomi et al. 2018) and CH4 emissions (Frank Brentup, 2008).

Agriculture

Agriculture is limited (0.03%) impact on global climate variability and/or change but Ethiopia greatly contributed which is 61% of Green House Gases (GHG) emissions (USAID, 2015).

The economic activities of the people around Zebider Forest ecosystem are mainly dependent on Agriculture; therefore the farmer is mostly known for crop cultivation and animal grazing. It is responsible for microclimate change and /or Variability around the area.

Agriculture's contribution to climate change is great in the study area;

1. Land use change (CH_4 from deforestation)
2. Crop production (N_2O emission from organic and mineral N imputes. Burning of crop

residues, N_2O and CH_4 from manure handling (storage, etc.) and

3. Cattle farming ($CH_4$from enteric fermentation), being the major source (Frank Brentup Year GambH and Co.KG May 2008).

Deforestation (CO_2 from Land-use change);

In the study area 58,629 ha of forest land (LULCC 2022) or Dry-afromin woodland vegetation (Lemenhi and woldemariam, 2010) changed in to agricultural land due to this **14,715,879 tone/ha** of **CO_2** (calculate with Efccc MRV directorate rule) emit to the atmosphere, which is **affected net mitigation potential (4.7 MtCO_2 e/year) of Ethiopia** through afforestation or enhancement of forest carbon stocks (UNFCCC 2017). This study is related to the estimation of Bellarby et al. (2008) about 12% (range of 6% - 17%) of the global GHG emissions are due to land conversion to agriculture.

Crop production (N_2O emissions from organic and mineral N inputs, burning of crop residues, N_2O and CH_4 from manure handling (storage, etc.)

Managed soils or all agricultural soils are directly and indirectly emits nitrous oxide that is usually estimated from data on nitrogen supplied to soils, including nitrogen fertilizer usage or sales, crops residue management, organic amendments, cultivation of organic soils (i.e. drainage of peatlands in agricultural land) and land-use conversions that enhance mineralization of nitrogen in soil organic matter (Rome, 2014).

The application of mineral fertilizer is a significant material for agricultural products and productivity improvement. In the climate change context, the fertilizer industry is a consumer of energy and an emitter of CO_2 and other greenhouse gases (GHG). Crop cultivation in Ethiopia emitted a nitrous oxide total of 12 Mt CO_2e, which cover 9% of the total emission. (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ethiopia%20First/INDC-Ethiopia-100615.pdf

And the production of N fertilizer (in IPCC assigned to “Industry”) releases another 410 Mt CO2-equivalents (CO2eq) per year, which is equivalent to 0.8% of the global GHG emissions.

Major socio-economic activities around the forest are smallholding agricultural activities. Due to the improvement of agricultural productivity farmers used chemical fertilizers such as DAP, UREA. As a result, our study area use fertilizer as followed and contributed to GHG emission.

Table 17 Use and Emission factors of mineral fertilizers in the ZFES

(Gurage zone)

Years	**Dap in Kg**	**Emission factors of DAP**		**Urea in Kg**	**Emission factors of urea**
		N_2O in ton	**CO_2** in ton		**CO_2 in ton**
2015	10,789,900	1,942.182	4,963.354	10,789,900	2,157.98
2020	10,417,400	1,875.132	4,792.004	10,417,400	2,083.48
Average annual Emission	10,603,650	1,908.657	4,877.679	10,603,650	2,120.73
Total 6 year Emission	63,621,900	11,451.942	29266.074	63,621,900	12,724.38

Source; GZPED 2020) data calculated by MRV given value

Methane (CH_4) emissions from enteric fermentation (cattle farming);

Animal population: FGD participants indicated that the economic activities of the people were depending on mixed farming so the number of animal reared in the study area. Livestock is a significant source of global methane (CH_4) emission, among Ethiopian livestock species, the major contributor to CH_4 emission is cattle which account for 83%. The amount of methane emission is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed IPCC (2006).

In the context of the study area, the livestock population was increased by **1,247,590** from the year 2019 – 2020, which contributes to the annual rising of CO_2 emissions.

Table 18 Enteric Fermentation and Manure Management (in CO_2 equ)

Livestock	Population	Enteric Fermentation	Manure Management		Total Emission	
		CO_2 equ	**CO_2 equ**	**CO_2 equ**	**CO_2 equ**	**Mt CO_2 equ**
Cattle	881199	145854225	22029975	264739439.5	432623639.5	0.043262364
Sheep	671221	83902625	3356105	26211126.35	113469856.4	0.011346986
Goat	400640	50080000	2203520	19627834.37	71911354.37	0.007191135
Donkey	124381	31095250	3731430	13299115.03	48125795.03	0.00481258
Horse	67543	30394350	3697979.25	13221558.46	47313887.71	0.004731389
Total	**2,144,984**	**341,326,450**	**35,019,009.25**	**337,099,073.7**	**713,444,533**	**0.071344453**

Source: To covert CH_4 and N_2O to CO_2 equation I used the Global Warming Potential (GWP) from the Fourth Assessment Report, IPCC 2006.

Livestock manure is primarily composed of organic material and water. Under anaerobic conditions, the organic material is decomposed by anaerobic bacteria. The end products of anaerobic decomposition are methane, carbon dioxide, and stabilized organic material.

The methane production potential of manure depends on the manure's specific composition, which in turn depends on the composition and digestibility of the animal diet (Francesco N. et al. 2014). In Ethiopia livestock emitted **methane** and **nitrous oxide** total of **65 Mt CO_2e**, which cover 42% of the total.

3.4.3. Impact of climate change on the Zebider Forest Ecosystem

The amount of greenhouse gases increases in the atmosphere case of increasing surface temperature. These conditions largely affected developing countries such as Ethiopia, which have limited capacity to cope with the effect of a changing climate (Gebeyehu, 2016).

Drought

Drought exists when seasonal rainfall drops below normal by almost 30 to 50 % (Getachew Alem, 2018). It's largely influenced by the variation in the seasonal precipitation cycle (Viste et al. 2013). FGD participants explained that the frequency of drought was occurred within five or six years (RF Anomaly index analyses). In 2021 a drought was occurred and affected on average 3 cattle, 1 mule and 5 sheep losses per household. The major effect of climate variability and/or change was changed crop cultivation period which is rain comes after the beginning of the normal cropping season, and occasionally heavy amount of rain, snow and high temperature

occurred, for the fact that negatively affected at early or late vegetative stages of crop and also unexpected rain devastated the crop product at harvesting time. FGD participants explained that the Seasonal change has occurred which implies, before 20 years permanent crop harvesting season was taken 3 months but now it takes 8-10month it means two cropping seasons changed to one. The kiremt rain is irregular and unpredictable, resulting in different cultivated agricultural types /kinds/ of products 50% decline like (Meal, Vegetable, Root crop, Stimulate Plant, pulse) within one year (2019 until 2020).

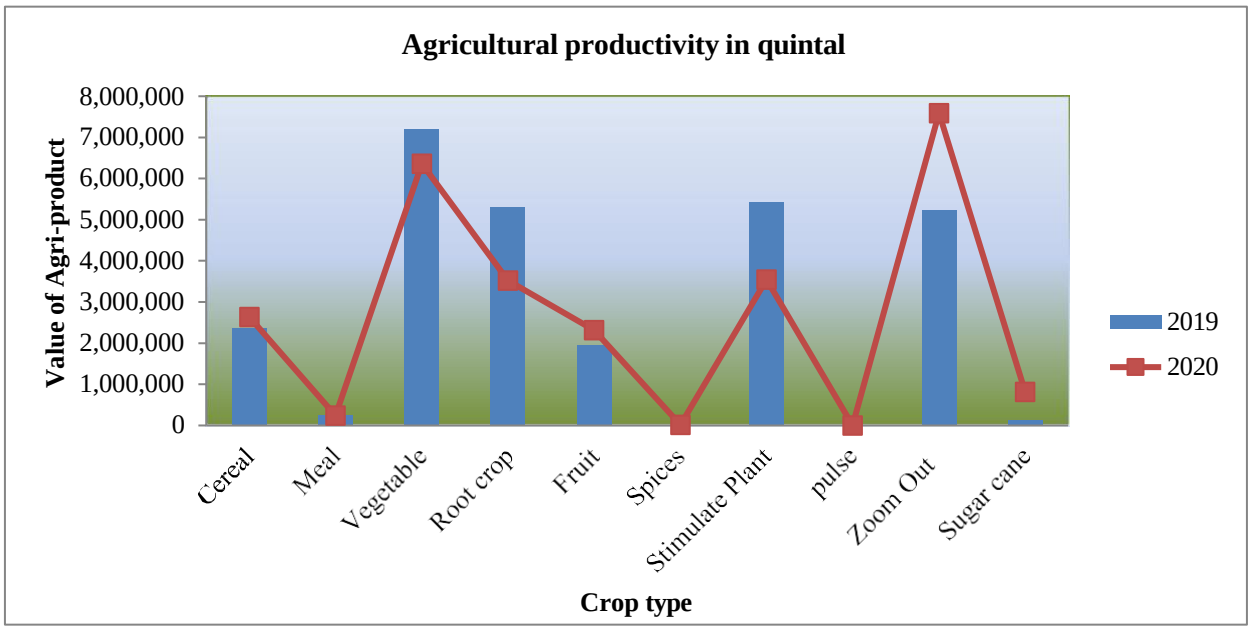


Figure 13 Rate of change in Agricultural product and Productivity from 2019-2020

Source; GZSAD, (2019 and 2020).

Due to climate variability and/or change factors the 50% of types of crop products was declined by 15.97%, so the food scarcity problem was occurred in the 2021 Zebider forest area, **Whereas** at the national level **in 2015** drought-affected **10 million people (10%) its** highest number in the last 50 years (Getachew Alemu, 2018), and global level with 700 million people now living in extreme poverty and hunger (Oasis Earth, 2021).

Flood

From years 1988 to 2018 forest land, Grazing land, shrubs and water bodies highly declined by 76.8, 70.6, 97.5 and 20.77% (LSILULCC, 2021). Due to this increased loss of infiltration capacity of the soil, it was responsible for the occurrences of floods in the study area.

In the study area flood occurred and damage animals, humans, and agricultural material and crop products. Since the area is located a higher elevation, there are run-offs from the surrounding highlands that damaged crops and houses, animals and humans.

Table 19 Flood and snow events and their impacts

Types of disaster	Year	Affected kebeles woreda and city administration	Loss of material	Loss in many	Affected household	Loss of life
Flood	2013 to 2015,	1. Butajira mutual work group	Fertilizer	30,000,000		1
	2009 2019 to 2021	2. Muhur Akilil	8 ha crop		9	
Land slide	2020	3 .Esa 4.Muhur Akilili 5.Gedebano	2 house with full material			
Snow	2021	5. Sodo 6. Miskan 7. Gumer	Crop			

Source: GZWTDRMO, 2021.

Health Impact

As the climate is changing, the existing diseases will aggravate and new diseases will emerge. Diseases such as cardiovascular mortality, respiratory illnesses, water-related contagious diseases, and malnutrition are directly or indirectly associated with climate change (Tafesse, 2019). FGD participants indicated that the health-related impact in the study area is human diseases like malaria, typhoid, typhus, giardia, and malnutrition (42.6%) and TB (3/100,000). This explanation line with GZPED, 2021, the epidemic of malaria-affected 4.7/1000 due to prevention measures implemented by the national government collaborated with regional and zonal governments to identify the area free from malaria death.

The use of fertilizer is a case of the declining outdoor air quality which is lead to the emission of toxic gases of NO_2, and CO_2. The result especially NO_2 levels, may decrease lung function and increase the risk of respiratory symptoms, such as acute bronchitis, cough and phlegm, particularly in children (Oluwasinaayomi et al., 2018).

Forest fires cause many environmental impacts including air pollution. Wildfires emit substantial amounts of air pollutants that can travel over large distances, affecting air quality and human health far from the originating fires. Fine particulate matter ($PM_{2.5}$) is the major pollutant emitted by wildfires. Regarding the health impacts of wildfire smoke exposure is associated with respiratory diseases and growing evidence suggests associations for specific **cardiovascular endpoints (Weeberb et.al 2021)**. FGD participants explained that due to forest fires air pollution is known in every dry season in the study area.

FGD explained that the area experiences severe water shortages when the declines of underground water during December–May. Therefore during the dry season, people in travel long distances (3.5to 4km) it takes 1:30 to 2:00 every other day to drink water. Such long- distance trekking undoubtedly hinders household heads or other family members from devoting enough time to other livelihoods and, therefore, incurring further economic losses and making sanitation problems and also responsible for water-borne diseases like typhoid, typhus and giardia. Globally billions of people live in water-stressed regions (Oasis, 2021).

3.4.4. Response to Climate Change on the Zebider Forest Ecosystem

Community Level

The loss of animals was replaced by local community financial aid local named called ‘’edre’’.
FGD participants indicated that almost all people in the surrounding forest area perceived the occurrence of climate change and/or variability especially people who live around lower parts of the mountain in every summer seasons move to other neighboring woreda and keble to save their life from the flood and similarly, nearly most farmers were predominantly cultivating drought resistance root crop like zoom out (Enset).
Implement irrigation agriculture.
Water mansions came from a region with individual level
Tray to control flood within community-level but government support Gabion more effective.

Government Response at zonal level

As FGD Participants indicated that from December to March 2021 food aid to humans and animal-like Food aid, grass and water were supplied by the government for all households.
Woredas water and energy office was limitedly given response to solve the problem which maintains waterway and clean water hole.

To protect the flood impact prepare 3 excavators and avoid sand and stone from the waterway before the beginning of summer rain due to this flood does not occur in 2021(GZDRMO).

The use of solar energy was started 5, 000 people were used modern stove technology like Bio - gaze, solar, power save stove use (2017, Gurage zone annual report).
According to FDEMADRMFSSEWRD, 2019 indicated that effort to mitigate the impact of the anticipated floods and facilitate a timely response, a Flood Contingency Plan is being prepared to outline expected sectorial requirements, as well as preparedness and response activities.
To minimize the likely adverse impacts of flooding, appropriate mitigation and preparedness measures should be undertaken. These activities should include dissemination of early warning information to populations at risk, enhancing communication linkages between woreda officials in highland areas that receive heavy rainfall and those downstream that are at risk of flooding, dam management, strengthening flood protection structures, reactivation of regional flood task forces in areas that are likely to be affected, and preparation of evacuation plans. Moreover, priority should be given to the pre-positioning of food and non-food items, particularly in areas that may become inaccessible.

Government and humanitarian partners are urged to take measures for an appropriate and timely response. The flood taskforce will continue to closely monitor the situation and regularly update the flood alert report and facilitate the revision of the Flood Contingency Plan, as the need arises. The PSNP is a social protection program that the government instruments in drought-prone and food-insecure areas of Ethiopia. Because of the widespread food insecurity, the government has been carrying out the PSNP in the study area.

Table 20 Government responded to people affected by natural disaster and PSNP beneficiary in Gurage zone

Cause to support	**5 Years**	**Clients**	**Types of response**				
			Support in quintal				**Payments**
			Wheat	Oil	pulse	Nutrient	
Response to natural disaster at zonal level	20014-2020	112,682	122,680	132.2	10,205	143.6	7,355,226
PSNP	20015-2021	28,324					198,411,075

Source: Annual reports of GZPED, 2020).

Table 21 Soil and Water conservation

S/N	**Structure**	**Unit**	**Value**	**Year**	**Remark**
1	Society catchments	Number	869	2016 - 2020	
2	Different physical soil and water conservation activities	Hectare	375,300	//	
3	Land closed from human contact	Hectare	85374	//	
4	Different types of structure	K.M	14,554.5	//	
5	Different types of Ki tire	Meter cube	156,508	//	
6	Different types of soil and water conservation re-construction	Hectare	131748	//	
7	Biological work 1.seed collection	Quintal	383.83	//	
	2.plantetion of tree	Million in mill	395.59	//	

Source: GZPED, 2020.



Figure 14 SWC activities in ZFES

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 before 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 a 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** for the equitable sharing of the costs and benefits, arising from them and contributing to the well-being and security of the nation.
- ✓ **Climate change subjects will integrate as a curriculum for the coming few years**

The above-mentioned point indicates the government of Ethiopia gives attention to making environmental protection policy, but weak implementation at the ground level

International Response

- ✓ Ethiopia intends to limit its net greenhouse gas (GHG) emissions in 2030 to 145 Mt CO_2e or lower. This would constitute a 255 $MtCO_2e$ reduction from the projected 'business-as-usual' (BAU) emissions in 2030 or a 64% reduction from the BAU scenario in 2030. Ethiopia also intends to undertake adaptation initiatives to reduce the vulnerability of its population, environment, and economy to the **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

✓

Adverse effects of climate change, based on its Climate Resilient Green Economy Strategy (CRGE). The CRGE is Ethiopia's strategy for addressing both climate change adaptation and mitigation objectives. The implementation of the CRGE would ensure a resilient economic development pathway while decreasing per capita emissions by 64% or more. The CRGE is also integrated into the Second Growth and Transformation Plan (the national development plan). In the long term, Ethiopia intends to achieve its vision of becoming carbon-neutral, with the mid-term goal of attaining middle-income status.

Ethiopia has had a turbulent few months: the COVID-19 pandemic crisis, the desert locust invasion, extreme weather events including floods, as well as simmering tensions related to the national election along with escalating conflict. But even amidst this backdrop, the country has demonstrated its clear commitment to addressing the climate crisis by submitting not only its updated nationally determined contribution (NDC), but also by pursuing practical action through its Green Legacy initiative to plant 20 billion seedlings in four years.

Ethiopia formally submitted an update to its enhanced NDC on July 23, 2021. This set of national climate change commitments and plans is the culmination of months of dedicated analysis and exploration of climate-compatible development in Ethiopia.

Updated NDC: - Improves on a Legacy of Ambition for Climate Compatible Development

- Enhances Ambition on Adaptation
- Aligns Monitoring and Reporting with International and National Processes
- Increases Domestic Financing (Abiyot D. et al. 2021).

3.4.5. OUTLOOK

2011 baseline scenario of MEFCC, 2015 has been estimated that climate change could reduce the country's GDP by up to 10% by 2045.

If the rate of climate change and /or variability increased just like a trend line will continue without implementing the recommended points and other additional research over the next three- decade.

- The situation continues as baseness as usual (BAU) the forest land should be completely loosed.
- According to baseline data of 2019 – 2020 kiremt products was declined by 15.97%, similarly, in the next 30 years, it should be declined by 479% with 5 kinds of crops which are Meal, Vegetable, Root crop, Stimulate Plant, pulse.
- Flood risk will increase significantly.
- The average temperature will be raised by 0.81°**C** in the future 30 years.
- The frequency of drought will be decreased from baseline data of 6 to 3 years.
- Depending on the baseline data of 2015 to 2020 the number of **PSNP** beneficiaries was raised by **1.5%, whereas in the next 30 years** it will be reached **6.44%.**
- CO_2 emission from livestock will be reached at 1.357658148 Mt CO_2 equ.
- CO_2 emission from fertilizer will be reached at 209,952.27 tones.
- N_2O emission from **fertilizer** (N2O) will be reached at 57259.71 tones.
- CO_2 emission from **forest** lose will be reached at 5,680,556.7 tones/ha.
- Lose potential health benefits like increased malaria will rise from the baseline data of 4.7/1000 to the epidemic level and also will increase the death and water-borne disease (Typhoid, and Gardaí), malnutrition cause from 42.6% raised to 85.2%.
- The scarcity of water will be increased significantly.

3.4.6. Recommendation

If the following problem reduction method should be implemented, the environmental change problems may be declined by 50% in the future 30 years.

- Health centers should be cerise attention to family planning from baseline data of 44.6% improved to 100%.
- Water mineral and energy office construct water source and improve water coverage from baseline data of 36% will be reached 100%.
- Adaptation options should focus on reforestation, area closure and cultivating the short growing crop and drought resistance crops should be possible.

- And also ensuring better management of soil and water conservation at the hillsides of Mount Zebider forest area to minimize flood.
- In order to reduce the emission of methane and niters oxide from the atmosphere, it is better to reduce the number of animals and also increase their quality than quantity.

- Zebider forest area will additionally intensify the use of solar energy**.**
- Develop research on the new productivity technology on the crop and animals.
- Improve the integration and coordination between policies across many sectors.
- The study area will intensify the use of **solar energy.**
- Government should be effectively implementing international agreements to reduce CO_2 emissions.
- Carbon-free electricity which is fully electrified transportation system

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