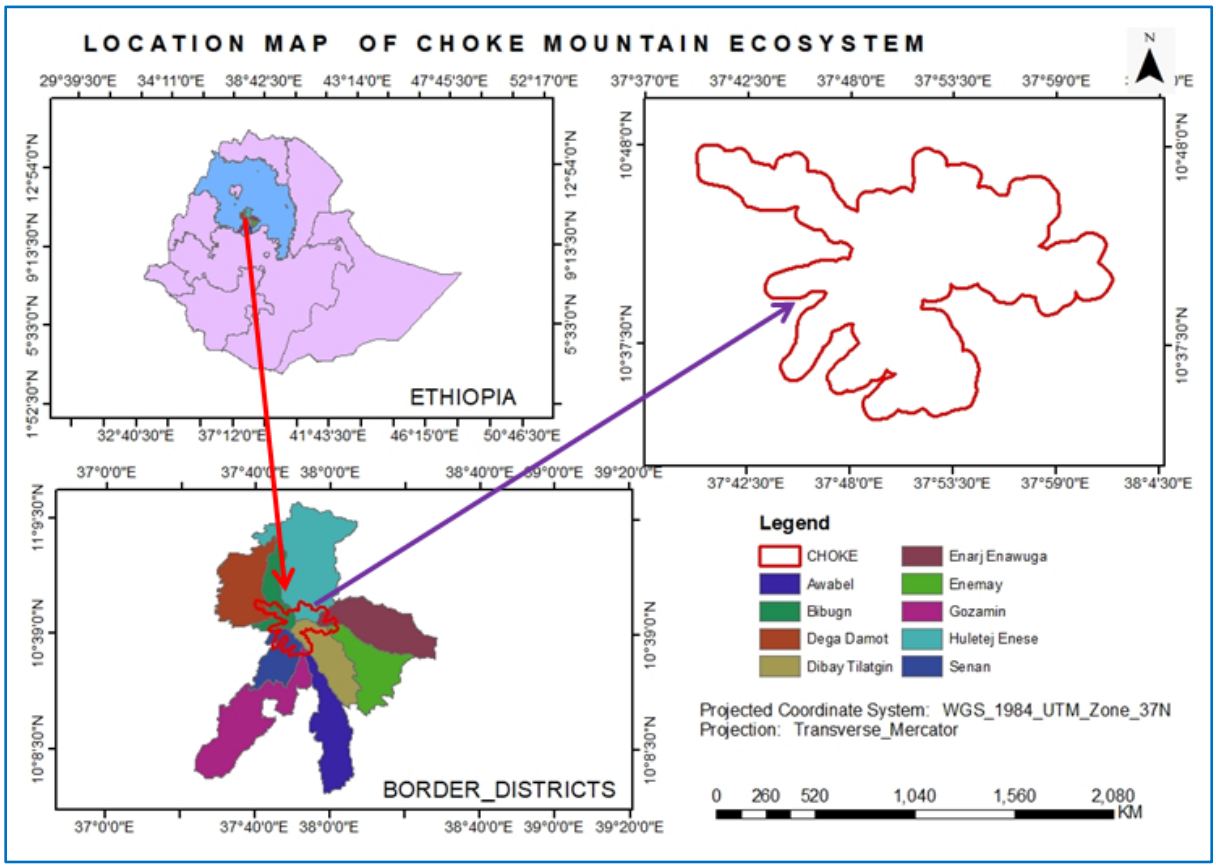
Environment Protection Authority

Environmental Information Management Directorate

Fact Sheet on Choke Mountain Forest Ecosystem In Amhara Region



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Acronym and Abbreviations

ABS: Access and Benefit Sharing

AEO: Africa Environmental Outlook

CBD: Convention on Biological Diversity

CRGE: Climate Resilient Green Economy

CSA: Central Statistics Agency

DPSIR: Driver, Pressure, State, Impact and Response

EBI: Ethiopian Biodiversity Institute

EDRI: Ethiopian development research institute

EFCC: Environment Forest and climate change

EFCCA: Environment Forest and Climate Change Authority

FDRE: Federal Democratic Republic of Ethiopia

FGD: Focus Group Discussion

FGD: Focus Group Discussion

GDP: Gross Domestic Product

GEO: Global Environmental Outlook

GIS: Geographic Information System

IBC: International Broadcasting Convention

IPBES: Intergovernmental Platform on Biodiversity and Ecosystem Services

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation Nature

IUCN: International Union for Conservation of Nature

LD: Land degradation

LULC: Land use land covers change

Max Temp: Maximum Temperature

Min Temp: Minimum Temperature

Mt: Mountain

NAP-ETH: Ethiopia National Adaptation Plan

NBSAP: National Biodiversity Strategies and Action Plans

NGO: Non-Governmental Organization

NP: Nagoya Protocol

NRM: Natural Resource Management

QT: quintal =100kg

Reg: Regular

SDG: Sustainable Development Goals

SPEI: Standardized Precipitation Evapotranspiration Index

UN: United Nations

UNEP: United Nation Environmental protection

UNFCCC: United Nations Framework Convention on Climate Change

WMO: World Meteorological Organization.

1. General Back ground

1.1. Environment for Green Economy Development

Environment is very essential for economic development, which gives inputs for production in many sectors by providing natural resource. While in the reverse many sectors pollute and degraded the environment through unwisely use of natural resources. In the environment there is everything for social and economic development while through time human being used natural resource for Shelter, food, for all basic necessity things but unsustainable use of natural resource that cause environmental degradation this consequences suffering of human beings and affects economic development of the society. Sustainable use of natural resource helps to increase green growth economic development and improving human wellbeing and social equity.

The idea of sustainable development was emerged to satisfy the needs of the expanding global population. The concept of sustainable development takes into account the interlinking of the environment, economic and social issues.

Source:-www.researchgate.net/profile/Naida_Ademovic/pub

Figure 1 the Three Dimensions of Sustainability

Most of Africa countries their economy activity and their livelihood based on natural capital assets in order to raised their economy growth rates they over exploits the natural resource and degraded the environment, change the climate, increases desertification, and increase

environmental risks and resource scarcities due to these most of African countries are face to persistent poverty(UNECA 2012). We also observe that in the Choke mountainous forest ecosystem the society use the forest in unsustainable way as result the environment is degraded, also the society loss the benefit get from Choke forest ecosystem, and increase climate related hazards so, due to these the society face to drought, flood and increase poverty rate.

The green economy, growth is mostly based on the reduction of carbon emissions and pollution and enhances energy and resource efficiency prevents the loss of biodiversity and ecosystem services, while the society who live on the Choke forest their economic growth is not based on the reduction of carbon emissions whereas it accelerate emissions and causes loss of biodiversity and reduce ecosystem services.

One of the activities outlined within the environment sector is the preparation of the State of the Environment Report of the country through undertaking fast assessment and study. To this end, the federal Democratic Republic of Ethiopia of Environment protection authority has conducted assessment on the Choke Forest ecosystem. The study was conducted through a team of multidisciplinary professionals in an integrated approach.

1.2. Frameworks /Approaches

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

For this fact sheet preparation we use DPSIR approaches. It is frame work is a variant of the Pressure – State – Response (PSR) framework was developed by Rapport and Friend (1979) for Statistics Canada and also adopted by other bodies such as UNEP in the GEO and AEO processes. The "DPSIR" framework is multi-scalable and indicates generic cause and effect relations within and among the following.

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

• PRESSURES: The pressure is sometimes referred to as direct drivers as in the Millennium Assessment (MA) framework. It includes in this case the social and economic sectors of society (also sometimes considered as Drivers). Human interventions may be directed towards causing a desired environmental change and may be subject to feed backs in terms of environmental

change, or could be an intentional or un-intentional by-products of other human activities (i.e., pollution);

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

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

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

2 Social and Economic Environment

2.1 Social Environments

In the social environment, the immediate physical and social setting in which people live or in which something happens or develops. It includes the culture that the individual was educated or lives in, and the people and institutions with whom they interact. The interaction may be in person or through communication media, even anonymous or one-way, and may not imply equality of social status. Therefore the social environment is a broader concept than that of social class or social circle (http://www.definitions.net/definition/social environment).

The Choke Mountainous forest is the mountain chain, located in East Gojjam zone, Amhara region located 38 km north-east of Debre Markos city and covering an area of about 17,443 k.m2 /62000 Ha/ and is range 4100 meters high one of the first highest peak in the Zone and It is the fourth highest place in Ethiopia and also it is known to be the water tower of the Nile /abay basin/. It is the source of more than 23 major rivers and as major tributaries for 273 small

streams flowing to Blue Nile /Abay/ and it has three agro-ecological Zones such as Kola, Dega and Woynadega. As we can observe it is a very interesting and beautiful character that satisfies the spirit in its natural appearance.

The Choke mountainous forest rich in biodiversity, with many opportunities for various studies and researches, and there are many indigenous plants in the area and it is bordered by Enmaye and Enarji and Enawga districts to the east, HuletEju Enesse to the northeast, Bibughne to the north, Machakel to the west, Senan to the south and Debaye Tilat to the southeast.

2.1.1 State and Trends of Social and Economic Environment

2.1.1.1 Population

Factors that determine population distributions of Ethiopia are first physical factor like land form and climate second human factor like historical factors and migration and socio economic factor (Aynalem, 2014). The distribution of Ethiopia's population is influenced greatly by altitude, climate, and availability of good soil. Based on the data of Senane Woreda finance and economics office generally, in the Senan Woreda the highlands are densely populated than the lowlands. In 2014 the population is male 61, 241(49.5%) female 62, 357(50.5%) total is 12, 3598, of which 14,320 (11.60%) live in urban areas and 10, 9278 (88.40%) live in rural areas. Similarly, the population is growing by 1.11 percent every year. The working or working age group is 67,449 people between the ages of 15 and 64, which is 54.57% of the total. The age distribution of the district's population is 41.35% of the population aged 14 and under, and 4.08% of the population is 65 and above. Thus, the dependency ratio due to age is 75.77 for children and 7.48 for the elderly. Therefore, the community's age dependency is up to 83.25 percent.

Table 1 Projected Population by Residential Area of Senane Woreda (2010-2014

Residential Area	2010/2018	2011/2019	2012/2020	2013/2021	2014/2022
Urban	12607	13263	13,973	*14320*	*15429*
Rural	105052	105979	106,748	*109278*	*108170*
Total	117659	119242	120,721	*123598*	*123598*

In the Senane Woreda has a total population of 123,598 of whom *61, 241*are male and *62, 357* female in 2013. From figure 2 we can see that population trend is increasing for instance in 2014 the no. of population was 110, 947while in 2022 the no.of population was become 123,598 within 8 years the population number was increased by 12,651 this shows there is high population increment in the areas.

Table 2 Population size and density estimate

Population by sex	2006/ 2014	2007/ 2015	2008/ 2016	2009/ 2017	2010/ 2018	2011/ 2019	2012/ 2020	2013/ 2021	2014/ 2022
Male	55420	56055	57007	57679	58428	59168	59,874	61241	*61241*
Female	55527	56712	57724	58454	59231	60074	60,847	*62357*	*62357*
Total	110947	112767	114731	116133	117659	119242	120,721	123598	123598

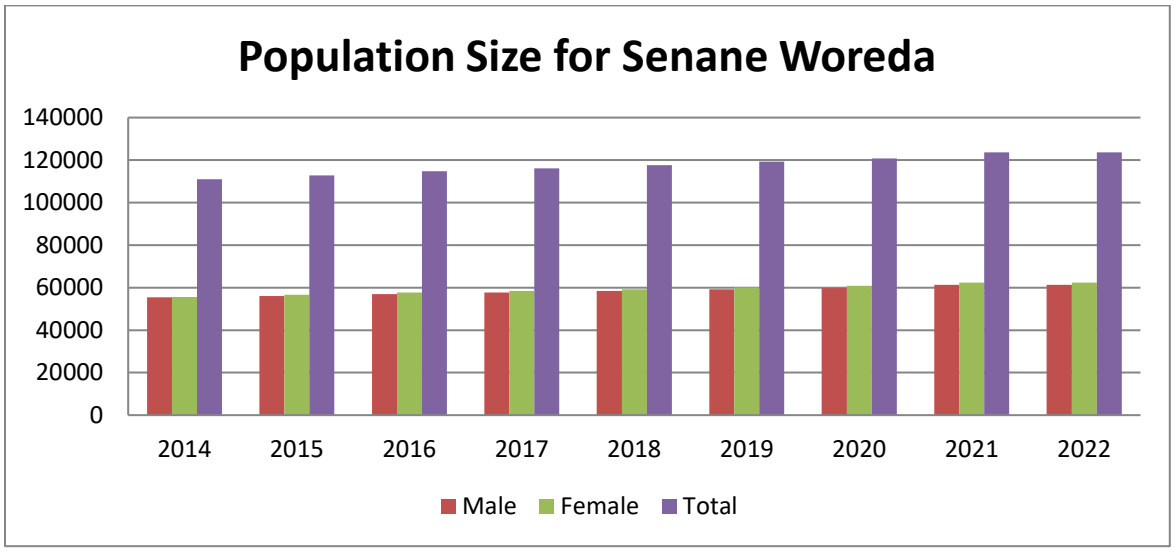

Figure 2 Population Trend in Senane Woreda 1999-2020

As the FGD participants explained that in the previous year's Choke mountainous forest was very dense but due to, different factor like increasing number of population, increasing animal population and unsustainably use of forest for energy, house construction, charcoal production and for agricultural purpose leads the Choke mountainous forest degraded to year to year specially increasing of human population and animal population have great role for the degradation. We can see that from below figure the nine Choke Mountainous forest ecosystem bordering woredas population number.

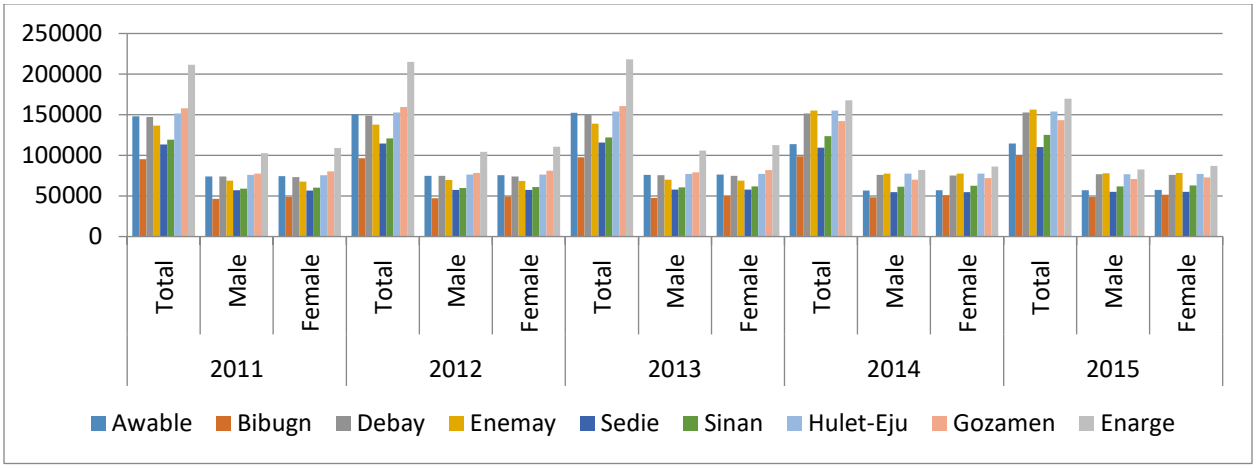

Figure 3 Population numbers of nine Woredas

As we can see from the above figure some Wored like as Sedie, Hulet –Eju, Gozamen and Enarge in total population of 2014 were decreased when compare with 2013 of total population.

2.1.1.2 Education

Education is used as the main tool to get out of poverty by starting development from the person, bringing productivity from the individual and achieving general growth in an accelerated way. Therefore, making the development reliable, building the capacity to bring about growth is a priority task.

Education should be prioritized to accelerate development and reduce poverty; different studies indicate that it is more important to prioritize primary education, especially women's participation.

On the other hand, if the farmer gets the opportunity to learn, it will help him to engage in the work of developing productivity by maintaining the cleanliness of his environment, using agricultural resources and technologies properly, and properly managing his family's income. In addition, it will produce responsible and highly skilled people and help to operate industries that can operate in large numbers of manpower.

Education is brings about an inherent and permanent change in a person's thinking and capacity to do things and it is the most important factor that plays a leading role in human development and it is an instrument to attaining Ethiopia development goals through application of science, technology and innovations and that promotes a productive and informed citizenry and creates opportunities for the socially and economically under privileged section of the society. One of the primary goals of FDRE Ministry of Education is promoting primary education in every corner of the country, based on the motto "education for all". Accordingly in Senane education office data Woreda in 2014 school year, 41 primary schools, 2 general secondary and preparatory schools/9-12/, 14487 primary school students (7126 males and 7361 females), 2955 general secondary and higher education preparatory students are studying in the Senane district. It was possible to reach 46.61 percent of primary education package, and the percentage of girls in primary and secondary schools was 46.38 and 29.84 percent respectively, which shows that there is a small gender gap so, need to do more at all levels of education to bring women to school .

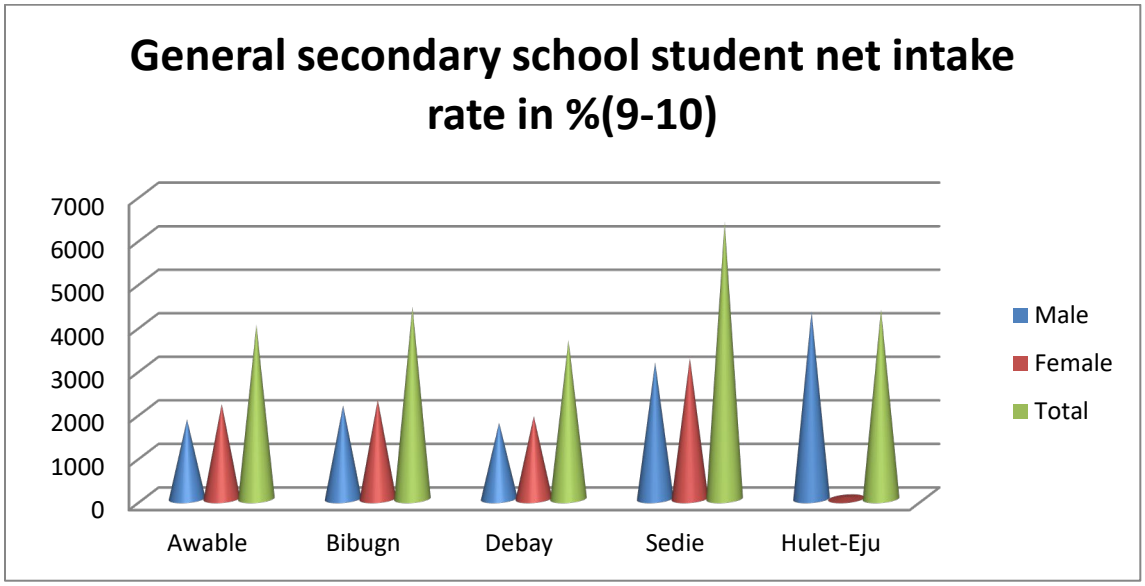

Figure 4 for general secondary school of different Woredas of student net in take rate

As we can see in the above figure in Hulet-Eju Woreda female student involvement is very low when we compare with other Woredas

In addition, in 2014 school year, the teacher student ratio in 1st level (1-8) is 1:21 and the student section ratio (1-8) is 1:35, the overall 2nd level and preparatory (9-12) student ratio is 1:22, the student section ratio is 1:55, and this indicate that efforts should be made to further increase the supply and quality of education.

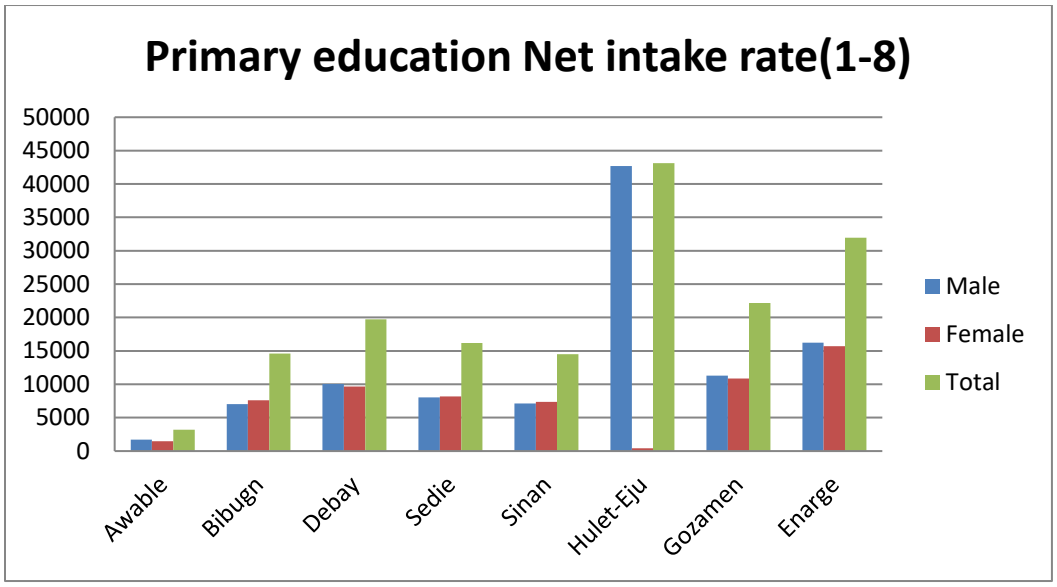

Figure 5 for primary school of different Woredas of student net in take rate

School infrastructures

To educate people School infrastructure is one of the basic necessities.

Number of school institution

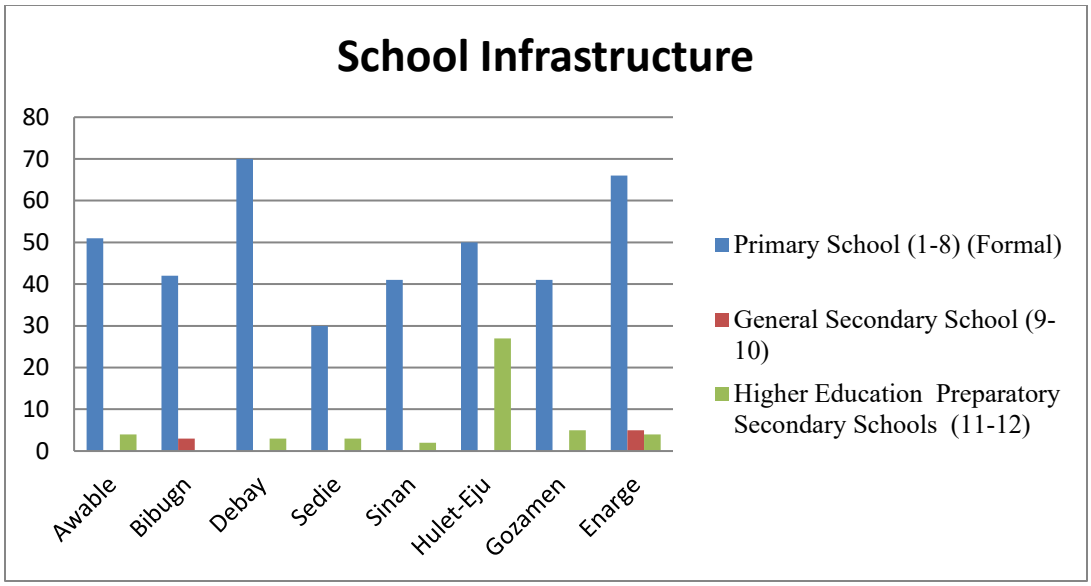

Figure 6 School infrastructures for different Woredas

2.1.1.3 Health

One of the indicators of social development of a country is health. Apart from the fact that access to health services is a human right of citizens, the economic development of a country is also unthinkable without a healthy society. The Health service sector is one of the key sectors of the economy and for human development. Adequate health service is one aspect of social service that communities aspire to get from the government. The government is working on a health strategy focused on prevention and based on that, it is working to increase the health services in our Senane district by focusing on capacity building and prevention of infectious diseases.

Health Institution & Health Coverage

To alleviate health problems, 5 health centers and 21 health posts are providing health services until the end of 2014. Therefore, one health post and One health center for an average of provides services to 5000 and to 25,000 people respectively. Regarding medical professionals, on average, one nurse provide medical assistance to 25,000 people, but so far there are 21 nurses, 20 health officers, 16 pharmacies and 8 laboratories in the Senane district. From this, it can be understood that the scope of the health service has not grown along with the growth of the population as a result; the ratio of health facilities to the population and health professionals to the population is high compared to international standards. As a result, the ratio of health

facilities to the population, as well as the ratio of health professionals to the population, is low compared to international standards.

Table 3: Health Professional-Population Ratio (2009-2014)

Year	List	Health profession					
		Specialist	General Practitioner	Health Officer	Nurse	Pharmacy Technician	Lab Technician
2009	The number of professionals	0	0	23	29	9	5
	Professional population ratio					1:25000	1:125000
2010	The number of professionals	0	0	18	30	13	ND
	Professional population ratio						
2011	The number of professionals	-	-	21	30	14	5
	Professional population ratio			3;25000	8;25000	3;25000	2;25000
2012	The number of professionals						
	Professional population ratio						
2013	The number of professionals			23	29	16	8
	Professional population ratio			3:25000	8: 25000	3:25000	2:25
2014	The number of professionals			20	21	16	8
	Professional population ratio			3:25000	8: 35000	2:1500	1:25000

Based on gathered information from Senane Woreda health office they were describe pneumonia is one top ten diseases in the area. The health coverage is reach 84%.

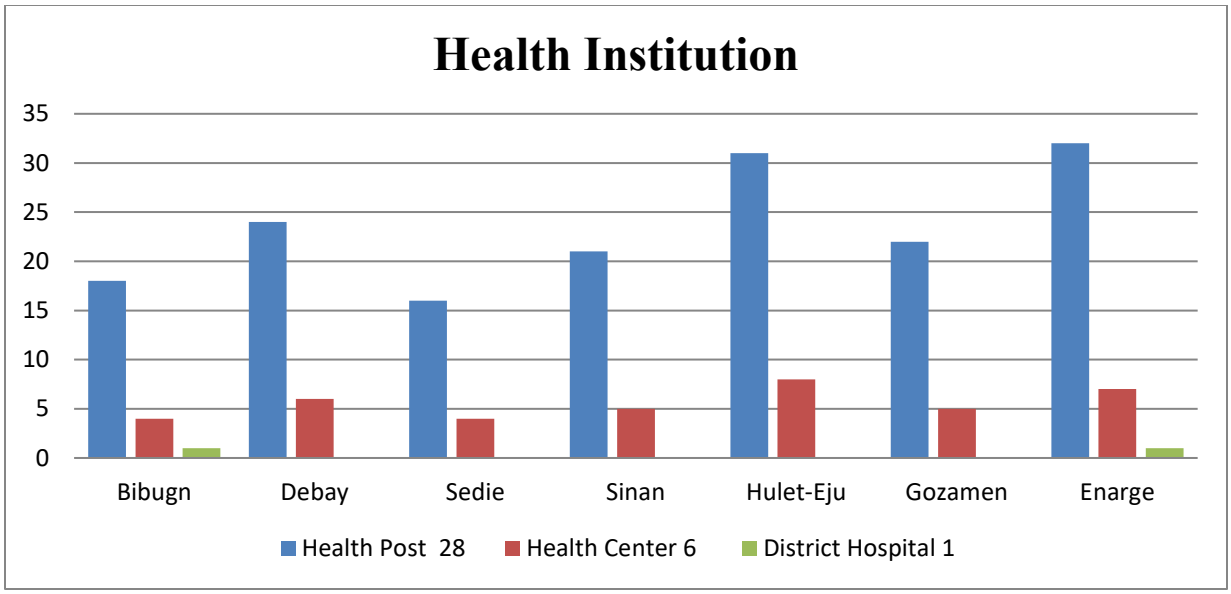

Figure 7 Health institution for different Woredas

Despite this there are growing challenges to the effective delivery of the health services. One of the activities to improve maternal health is family planning services. As a result, 24054 mothers benefited from family planning services and 1810 and 3458 women were able to benefit from prenatal and postnatal services by trained professionals respectively.

2.1.1.4 Infrastructures

The infrastructure supporting human activities includes complex and interrelated physical, social, ecological, economic, and technological systems such as transportation and energy production and distribution; water resources management; waste management; facilities supporting urban and rural communities; communications; sustainable resources development; and environmental protection (American Society of Civil Engineers, 2009).

Road and Transport

Road is an essential infrastructure for a given area for economic and social development. The level of development of transport facilities and services including the road are determining factor for other development activities. Road construction has a great role to realize economic growth and to expand investment activity. In agriculture, Business or other economic and social service activities are directly related to road construction. Roads are important for cultural exchange. To

save road development time; to reduce transportation costs; In business In education. It is important to improve health and other services and to benefit from services. Therefore, to bring about sustainable economic and social development, repair existing roads and raise their standards; new roads need to be built.

Currently, most of the existing kebels have been connected to the main roads, except for the limited kebals. The rural roads authority of the region and the federal government manage 35 km/km. The road is 111.94 kilometers, built by a contractor and managed by the district. In general, the length of road in the district in 2014 is 156.94 km, and 154.44 km of asphalt and 2.5 km. Despite this, many road constructions have been underway in recent years and improvements have been seen. The community's participation in road construction and maintenance is encouraging and should be strengthened.

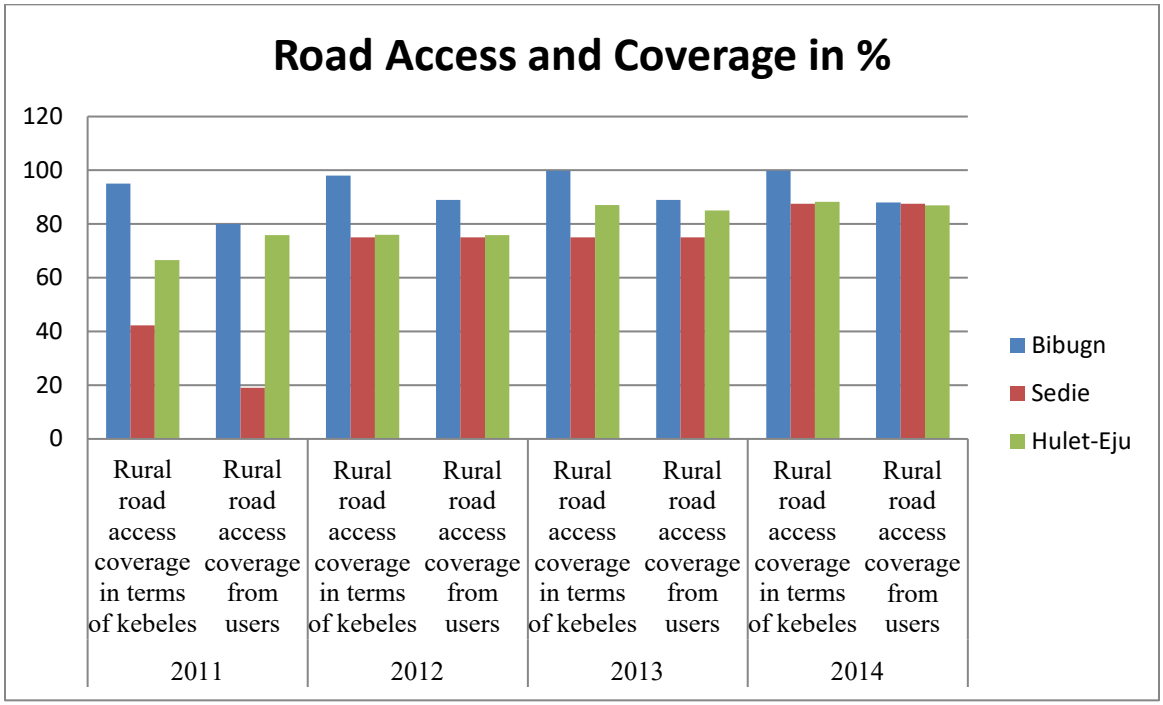

Figure 8 Road access and coverage in %

Water Resource and Supply

Water is one of energetic component for sustainable development. It is known that the district is the owner of vast water resources and it is encouraging to see what has been done so far in terms of providing clean drinking water. According to the data of 2014 fiscal year, the total coverage of clean drinking water in the district is not more than 63.99 percent. This indicates that 79090.36

or 75095.84 in rural areas and 4099.81 in urban areas are not users of clean drinking water. In addition to this, it is estimated that it will be lower than the standard set by the World Health Organization of 45 liters per person per day. As a result, most of the district's population has to use water from unsanitary water sources, such as flowing rivers, ponds, etc. This has made the people of the district vulnerable to water borne diseases. This situation not only affects the family level as well as the government's health service budget, but also has a negative impact on the worsening of poverty as it prevents healthy and productive citizens. In addition, it has contributed to the reduction of women's productivity in the economic field by making rural women bear the burden of traveling long distances to search for water.

Thus, it is estimated that the total supply coverage in the 2014 fiscal year is 67.20 percent (72.26 percent in rural areas and 28.62 percent in urban areas). This coverage does not show growth compared to the 67.2 percent total coverage in 2013. It shows that it is backward in terms of usability.

Table 4: Clean drinking water coverage in percent in Senean district (2009_2014)

Area	Year					
	2009	2010	2011	2012	2013	2014
Urban	32.7	32.71	46.26	28.62	28.63	28.63
Rural	78.05	69.4	75.9	70.87	72.26	68.72
Total	74.73	65.22	73.46	65.43	67.2	63.99

As FGD participants of Dengole Kebele explained that there is scarcity of drinking water and they were use spring river and pump water for drinking purpose. To fetch water woman’s travels long distance takes 1 hour. Due to shortage of water women’s and children they were more suffer and the community affected by different water born disease like Diarrhea.

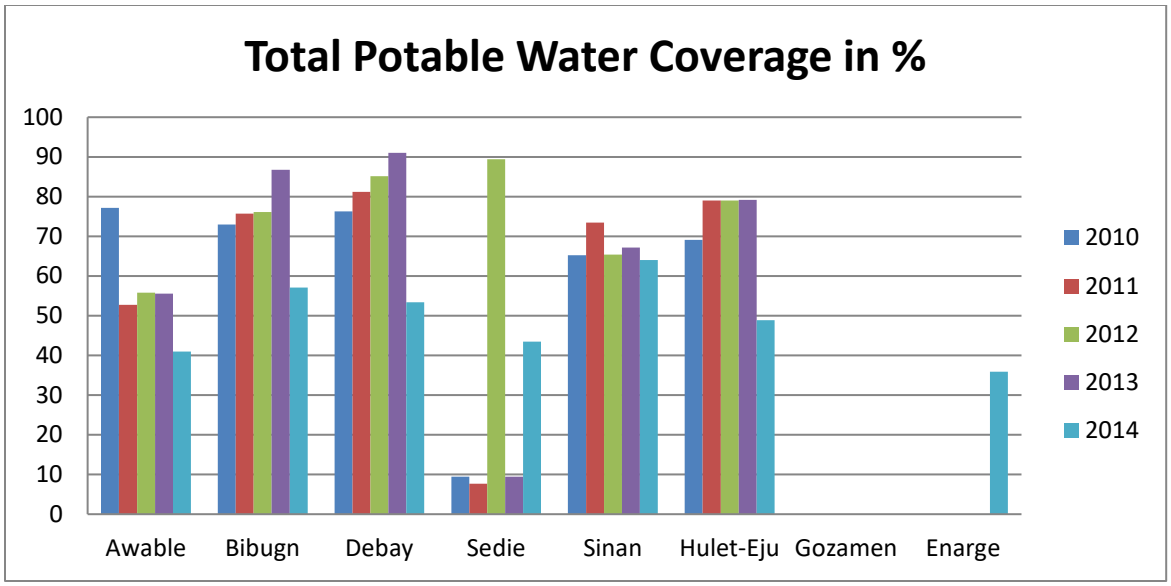

Figure 9 Total potable water coverage for different Woredas

2.1.2. Drivers and Pressure of Social Environment

Increasing of population number

Rapid population growth makes it more difficult for low-income and lower-middle-income society's to improve social environment like education, Health, road and different infrastructure requires sufficient resources. There for increasing the number of population of the surrounding Woredas of Choke mountainous forest leads to deforest Choke forest ecosystem for different purpose like agricultural land expansion, house construction, full wood and charcoal production as energy consumption and also over grazing were factors that contributed to the deterioration for Choke forest ecosystem. Therefor increasing of population growth is one of the main driver and pressure for social environment.

- As FGD participants explained that when the number of family size increased the need of house construction and agricultural land will increase this lead the new generation to get agricultural land and house they were deforest Choke forest
- In the past due to lack of awareness in the society that lead to use natural resources in unsustainable manner especially the surrounding Woredas deforests and degraded the

Choke forest for agricultural land expansion, grazing land expansion and house construction and for various purpose.

- Therefore increasing population number that increase the basic need for living like shelter, food etc… so this things causes pressurizes for social environment.

2.1.3. Impacts of Social Environment

An Increasing of population is cause over exploit of Choke forest ecosystem, which has resulted in degradation the environment and destroying forest resources. In accordance with increasing population in the basic needs for the society will increase similarly the surrounding Woredas of Choke forest the number of population trends increase year to year as are a result to get agricultural land, house and grazing lands they deforest the Choke mountainous forest, which ultimately resulted in deteriorating endemic forest species and loss of wild life, soil nutrient depletion and deteriorating proximate environmental resources and increasing the exposer affected by climate change impact and, there by resulted in food scarcity, and drought.

During FGD the community they were told us even though, they were educated their children up to higher level and graduated by first degree but difficult to get job this cause Increasing unemployment of educated people in the Woreda so, those farmer who educated their children up to higher level they were give up and they worried for their children's. So increasing of the number of youth unemployed that forced to use Choke forest ecosystem to agricultural activity. To make secure social environment in needs to improve health institution with specialist, road infrastructure, and potable water coverage and school infrastructure. From field observation we can see that sick person will carried by traditional way by person till to reach main road due to lack of road network with main road. The ratio of health facilities to the population, as well as the ratio of health professionals to the population, is low compared to international standards this affects different social activities. Even though there is family planning but it needs more effort to minimize population number in the Woredas.

Due to population pressure the benefit get from Choke forest ecosystem decrease like medicinal plants, water source like springs as a result it causes scarcity of drinking water for some Woredas due to these women travels for an hour to fetch water from their residence.

Now due to Choke forest deforestation causes large number of springs dried up, decrease agricultural production and productivity, increase vulnerable society for climate hazard as a consequence increase poverty level and food insecure society as FGD participants explained.

2.1.4. Responses to Social Environmental Change

The community they were participates in different developmental works like in road construction. Soil and water conservation work.

To clothing the gap of increasing population number and the available resource they were use planned reduction of population growth even though contraceptives users are not comparable with the number of women in the Woredas.

Even though there are many potential policy responses to the environmental implications of local population pressure but the policy was not hundred percent implemented in the Choke surrounding Woredas such as, the population policy of Ethiopia aims at

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

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

(iv) Improving the social and economic status of vulnerable groups (women, children and elderly). In line with the policy document, Ethiopia set out a national population program me in accordance with national priorities as stated below for instance in Dengole kebele FGD participant of they were explained that the death of mother during delivery reduced by 95%.

(i) Expansion of population information, education and communication; As FGD participants explained that 80% of the community were educated even though not employed.

(ii) Provision of expanded family planning services;

(iii) Strengthening of training in population;

- Promotion of the status of women.

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

2.1.5. Outlook for Socio-Economic Environment

The largest portion for Choke mountainous forest is found in Senane Woreda as the FGD participant explained that the number of population is increasing when they compare with the previous years. If the population growth rate increased by 1.11% in the Senane Woreda in the coming 20 years the population will increased by 31,628 which will be reached approximately 155,226 correspondingly the demand of food, shelter ,fuel energy and farm land, urban expansion and infrastructure expansion will increase, these will lead to increase competition to use Choke mutinous forest for various purpose and causes conflict b/n bordering Woredas and increase social unsuitability in addition Choke mountainous forest ecosystem will degraded, and decrease the carrying capacity of the environment as well as the whole social and economic activities of the community will become endanger like health facility, infrastructure accessibility and increase poverty level.

Recommendation

In the 2015 as the society of Senan Woreda of Choke community protected area office they were protected some parts of the Choke mountain of Senan Woreda such kinds of conservation practice and participatory forest management must be done in all bordering Woredas in order to minimize the impact of forest and environment degradation on the society like flood and drought. The surrounding society use fuel wood energy, material for house construction and forage for their cattle's from Choke mountainous forest ecosystem in unsustainable way this makes the environment highly degraded, these conditions increase the vulnerability of the society to climate related hazards like flood, drought and land slide. In order to decrease the impact it needs gives awareness to the society about sustainable use of natural resources, it needs increase alternative energy instead deforest trees.

To use man power effectively infrastructure accessibility, hospital and increase access of clean water, electricity, and Closing the gap between high population growth and low economic productivity through planned reduction of population growth.

2.2. Economic Environment

2.2.1. State and trend of the economic Environment

Economically, Ethiopia is one of the world's fastest-growing countries and to reach middle-income status before 2025 through building a green economy by boosting agricultural productivity and strengthening the industrial base.

The main economic activity on the surrounding Choke mountainous forest is mixed farming, agriculture and animal rearing and plays a great role for economic development. As FGD participants explained that most of the society they were engaged by agricultural activity to get income they were sold from their agricultural production. They were follow traditional farming system and also depend on rainfall as a result it affects crop production and animal production was decreased due to shortage of forage as a result the poverty level of the community is increasing as approved by FGD participants for instance at Tacheber and Dengole Kebele the poverty level was increased by 30% and 15% respectively. The major food crops that are abundantly produced in the woreda are cereals, pulses, root crop and oil seed. The main cereals crops are, Teff, Barley, Wheat, Maize and Sorghum. The major cereal were cultivated by QT in 2013/2014 were showed by below figure.

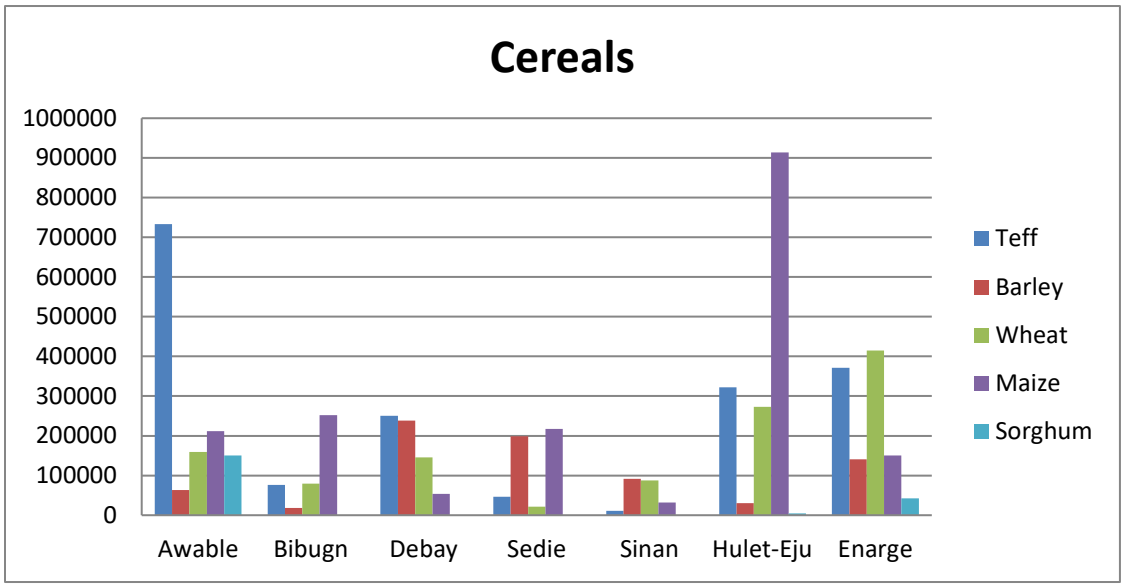

Figure 10 Cereals production in quintal in 2013/2014

Pulses crops mostly cultivated by Choke bordering Woredas are Horse bean, Field peas, Haricot bean, Lentils and Chickpeas.

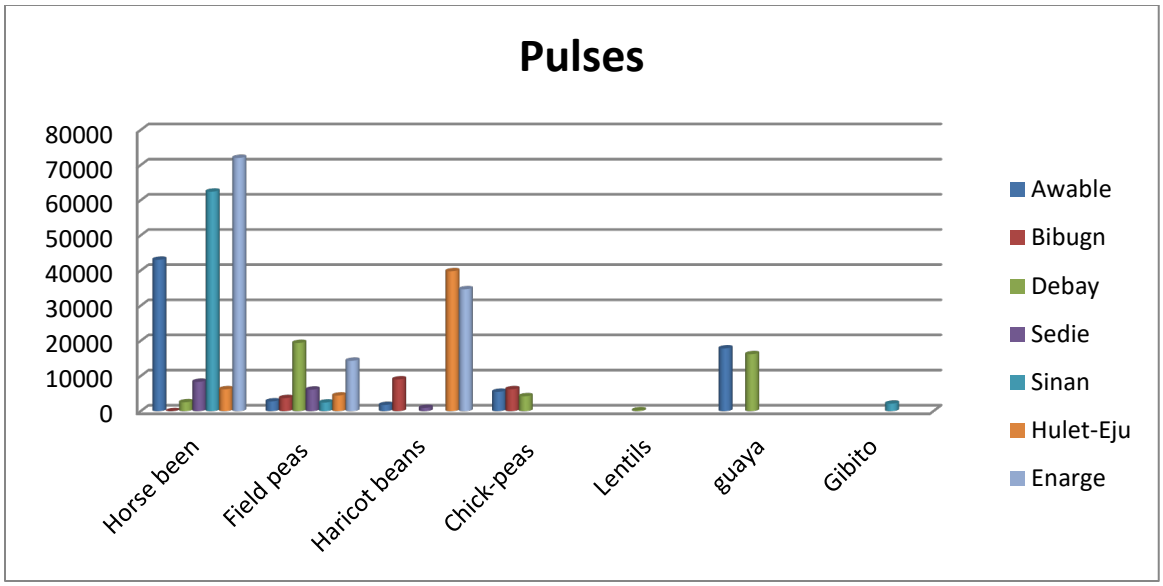

Figure 11 pulse production in quintal in 2013/2014

The major root vegetable is Potato for instance in Sedie and Hulet-Eju Woredas around 639655 and ***38690*** of quintal were produced in 2013/2014.

Nug, Linseed, Groundnut, Sesame and Rapeseed are oil seeds in the Woredas especially as shows from below figure Enarge Woreda produced better oil seed than others Woredas during 2013/2014py.

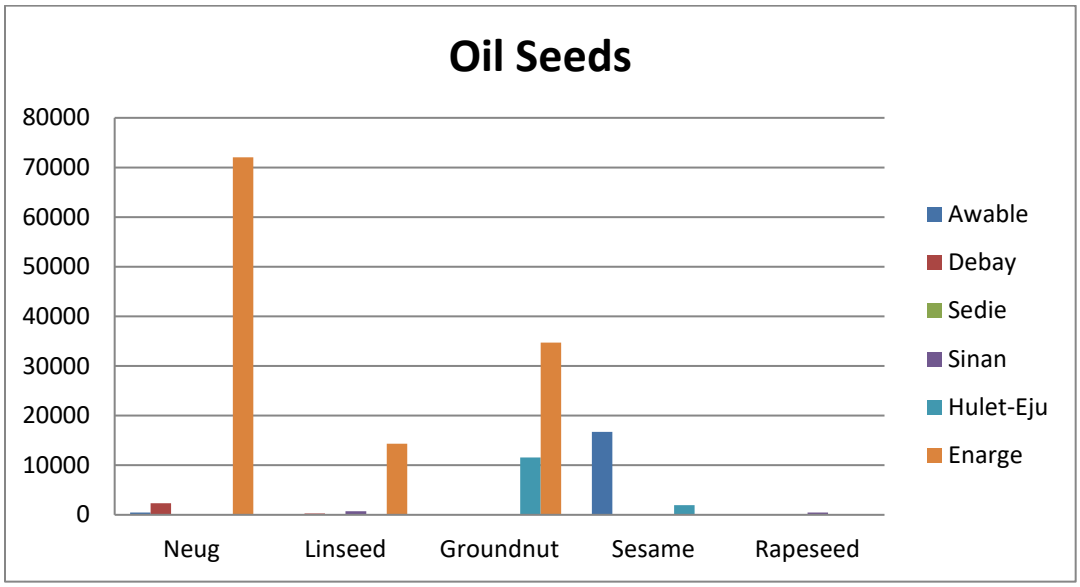

Figure 12 Oil Seeds production in quintal in 2013/2014

Livestock sector is one of a source of livelihoods and income for the society, based on the data gathered from East Misrak Gojjam Zone of plan office data indicated that in 2014 total animals population from six Woreds number of livestock populations were 539**, 372 cattle**, **854,633 sheep**, **133,507 goats**, **51,577, Horse** and **donkey 85,716**.

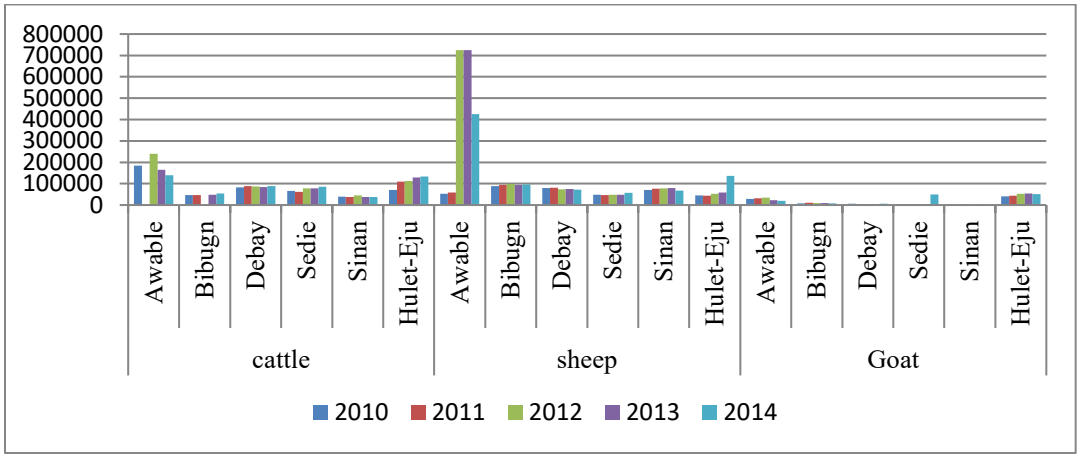

Figure 13 Animal population numbers

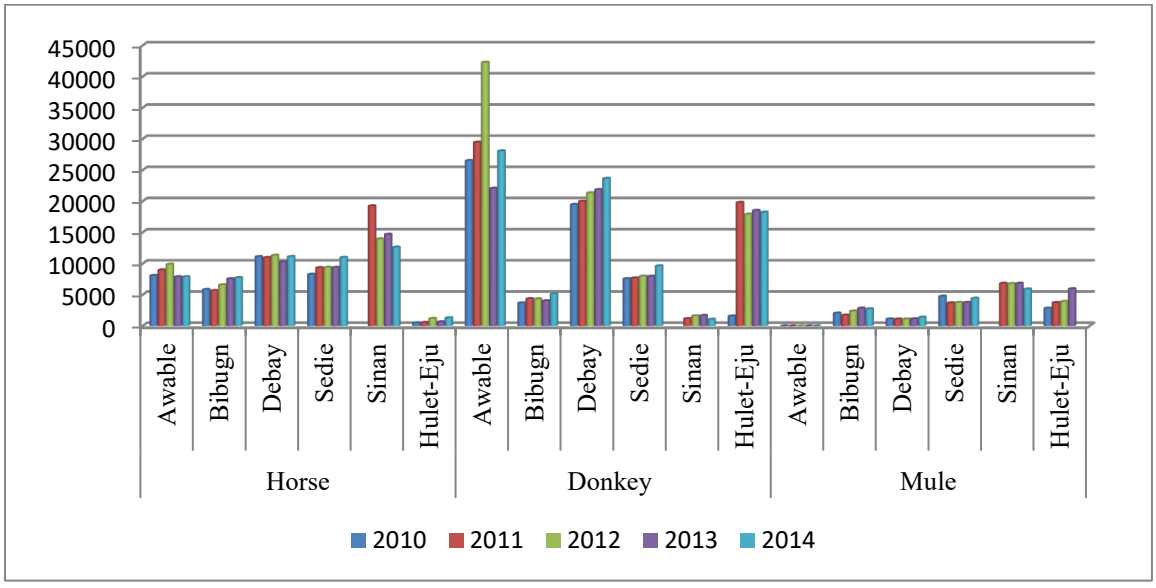

Figure 14 Number of Animals that found in Choke surrounding Woredas from 2010- 2014

The main food crops utilized was Barely and potato. They mainly consume cereal based foods and potato together with vegetables and livestock product.

It is challenging to establish a market linkage with the local villagers due to the diverse Kebeles' low road connectivity. A society's economy is impacted by poor cattle management. Participants in the FGD explained that because there is less animal fodder available, the goods that can be obtained from animals such as milk and butter have also dropped. As a result, less money can be made from the sale of animal products.

Participants in the FGD said that although there are more people with higher levels of education, the employment rate is still low, which has an impact on the economic growth of the districts and causes poverty levels to rise year over year.

2.2.2. Drivers and pressures of the economy

Agriculture is the leading sector in the economy of the district. It provides food; It is a source of raw materials and foreign exchange for domestic industry. As FGD participants explained that their economy activity is relay on the agriculture and animal rearing it is depend on rainfall However, because of climate change, rainfall variability and shortage increased, which led to decreased crop and livestock production, severely affecting their economy. As FGD participants noted, there is an imbalance between the number of educated persons and the employment rate, which has led to an increase in unemployment in the Woreda, so this affect the economic development of the Woreda as well as the country.

increasing of unemployment rate, high population growth in the Choke surrounding Woredas, unimproved technology use for agriculture production and poor livestock management, increasing the demand to satisfy the new comers this causes over exploitation of the available natural resources of Choke forest and impact of climate change are the main driver and pressure of economy development for the surrounding of Choke society.

2.2.3. Impacts due to the Economic Condition

A growing population results in an increase in the demand for resources and the overexploitation of these resources results in a decrease in the carrying capacity of the environment. By 2030, the Climate-Resilient Green Economy (CRGE) will help the country achieve its development goals while reducing GHG emissions to less than 150 Mt CO2e as compared to a conventional development path estimated to produce 250 Mt CO2. The green economy plan is based on four pillars:

1. Improving crop and livestock production practices for higher food security and farmer income while reducing emissions

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

3. Expanding electricity generation from renewable sources of energy for domestic and regional markets

4. Leapfrogging to modern and energy-efficient technologies in transport, indus-trial sectors, and buildings.

There is a gap between population growth and economic development in the Woreda The community use fuel wood and Charcoal as energy source because of Low expansion of electricity generation from renewable sources of energy for domestic and regional markets and lack of modern and energy-efficient technologies these affect Choke forest ecosystem.

Due to lack of accessibility of infrastructure like road, telephone service and electricity that makes difficult to increase market linkage and current market information with in in different Kebeles this affect the income of the society and decrease market competition

Decreasing of agricultural and animal production which decrease the income of the society as well as the Woreda economic development due to this the poverty level is increasing in the Woreda as described by FGD participants.

Not only lack of modern technology but also Climate change affects the economy of the society and drought decrease agricultural productivity and Kills livestock in different year these influence the Woredas economic development.

Livestock's per capita production is very low and decreasing due to limited modern technique application and yield enhancing inputs. Therefore, the current livelihood practice is a challenging task to promote sustainable development by protecting the environment and as well as it will become difficult to increase the income of the society.

2.2.4. Response Measures

For Choke mountainous forest society number population and their economic development are not comparable. The Ethiopian population policy aims to reduce population growth through planned reduction, even though family planning is implemented through all Woredas, but not enough is being done.

The second aims of Ethiopian population policy is to improving the carrying capacity of the environment by taking appropriate environmental protection measures, so in the Choke surrounding Woredas to improve the carrying capacity of the environment different activity was done like participatory soil and water conservation work, Seedling fermentation work and around 6024 ha of Choke mountainous forest is protecting by the community through Choke community protecting area office. As a result of the Choke mountainous forest being protected, the community is able to feed their cattle in shifts and has received ecosystem services like springs and rivers; these improve the economy development of the Woredas.

The third aim of Ethiopian population policy is improving the social and economic status of vulnerable groups (women, children and elderly). The Amhara region, Woredas, Kebele and society have worked together to preserve natural resources sustainably.

Apart from the above major responses by the Government of Ethiopia, a new plan has been coined and put into practice by different components of the government like Growth and Transformation Plan (GTP II). The planning year is between 2015/16 and 2019/20. GTP's vision in the economic sector is "to build an economy which has a modern and productive agricultural sector with enhanced technology and an industrial sector that plays a leading role in the economy; to sustain economic development and Secure social justice; and, increase per capita income of citizens so that it reaches at the level of those in middle-income countries."

The major objectives of GTP are to:-

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

- Ensure growth sustainability by realizing all the above objectives within stable macro-economic framework.

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

- Sustaining faster and equitable economic growth

- Maintaining agriculture as a major source of economic growth

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

- Enhancing expansion and quality of infrastructure development

- Enhancing expansion and quality of social development

- Building capacity and deepen good governance

- Promote women and youth empowerment and equitable benefit

Ethiopian climate-resilient green economy strategy is also one of the responses. Ethiopia aims to achieve middle-income status by 2025 through developing a green economy and build green economy through decreasing, GHG emissions and unsustainable use of natural resources.

2.2.5. Outlook for Economy

If subsistence mode of economic situation, traditional farming and animal husbandry continues as business as usual the economic benefit got from farming and animal husbandry will decline and the community living under poverty level will increase.

If the disproportionate increase in population and natural resources continues in this way, the forest of Choke will be severely depleted, as a result of which the benefits that the community should get from the forest, such as fodder for their cattle, environment service and a healthy climate, will decrease, for this reason undermine economic development of the districts as well as the region and also, increasing the inability of educated manpower to work will increase a negative impact on the economic development of the society as well as for the country.

If community based Choke forest protection done in all the bordering districts, the plants that are degraded will be restored, the springs will flourish and it will contribute greatly to the Renaissance dam of electric power generation and the community will get enough fodder for their cattle this will give bright economic development for the districts as well as for our country.

Recommendation

- The current policies, programs, strategies that are issued by the government are strong instruments for economic development implementing policies and strategies should be ensured.
- Around only 11% of Choke mountainous forest protected by Choke community with in collaboration of Choke community protected area office in 2014 this sows it need more improvement to protect Choke forest 100% by the all bordering district, zone, region and government of Ethiopia
- Choke mountainous forest it is beautiful in nature, it is a refreshing and attractive place for tourists and it can increase the income of the districts through the flow of tourists so it needs more attention of protect the forest from deforestation and settlement.
- Expansion of irrigated agriculture, Introduction of drought tolerant crops environmentally friendly resettlement action plan should be in place, Income diversification such as engaged in off-farm activities, and livestock fattening. Change the cropping pattern to cope up with the rain fall pattern variability due to shifting of seasons.
- To enhance economic development on agriculture it needs integrated and diversified agriculture need to be practiced for instance growing both subsistence and perennial cash crops by using additional technology to increase production and productivity.
- To achieve middle-income status by 2025 in the Choke mountainous forest districts it needs improve, infrastructure, agriculture practice by modern farm technology, expand irrigation activity and improve livestock production.

3. Physical Environment of Choke Mountain

3.1. Land

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

Land use change is one of the challenges that aggravate environmental problems. Understanding the scope of land use change, driving forces, and consequences is very crucial for proper management of land resources. We investigated land use/land cover changes using remote sensing data (for the years 2013, 2018, and 2023), and field observation, key informant interview, and focus group discussion were used to determine the drivers and consequences of land use/land cover changes in Choke Mt. Ethiopia. The Upper Blue Nile is one of the most diverse and very important river basins in Ethiopia (Yalew et al., 2016). The basin experiences serious environmental problems including soil erosion, land degradation, loss of soil fertility and deforestation. Thus, this study was aimed at detecting the magnitude and pattern of land use/land cover changes and assessing drivers of changes over the last three decades (2003–2023) in Choke Mountain. Google earth imageries (2003, 2013, and 2023), secondary data collection, focus group discussion, key informant interview, and field observation were used to detect changes and drivers of changes.

Figure 15 FGDs interviewer during interview at Tachber Kebele.

As you can see on the figure, during the study, we went to the place and had an in-depth discussion with the local residents who were selected by Kebele and we got important

information for our study. In particular, they explained the damage to the ecosystem from ancient times to now.

Geographical environment of the study area

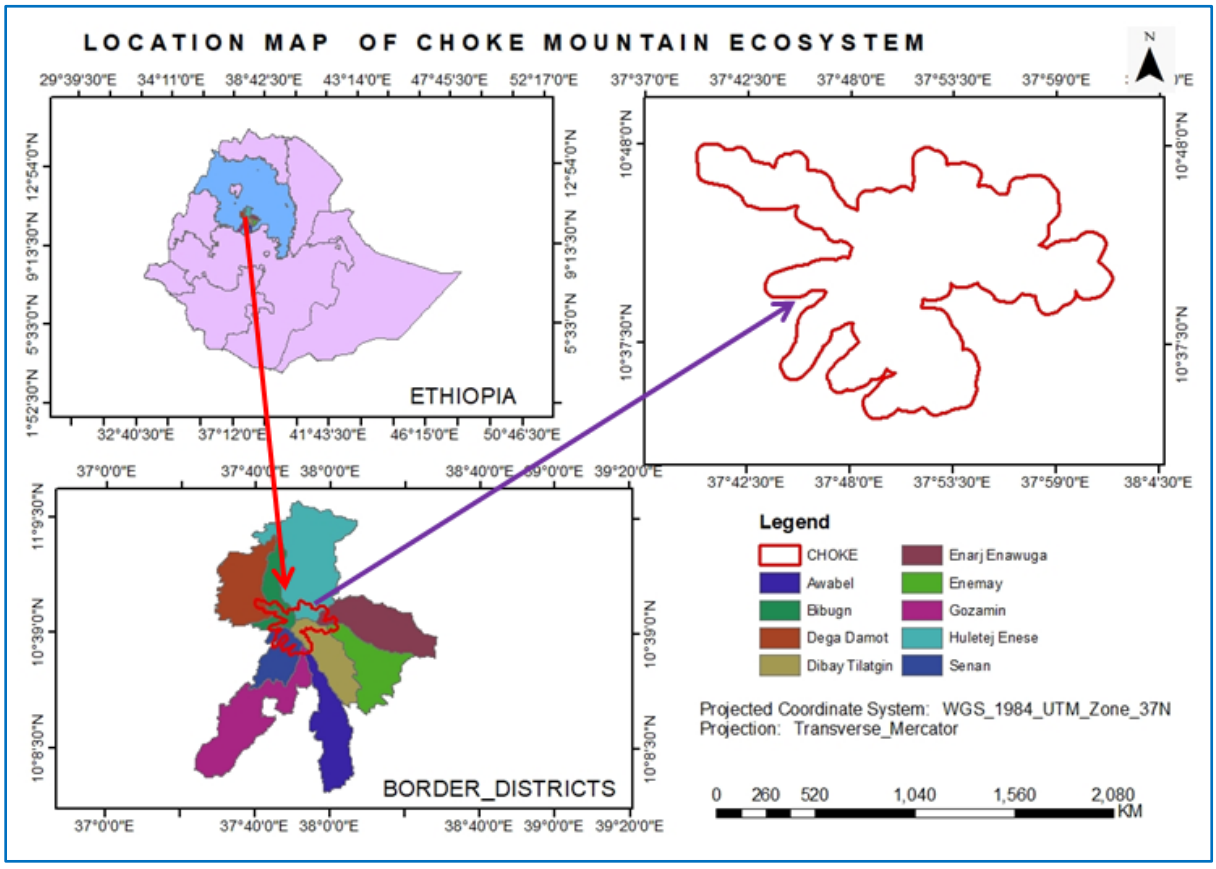

Figure 16 Location map of Choke Mt, forest ecosystem

Choke Mountain is the water tower of the upper Blue Nile River Basin (Abay) highland portions of Ethiopia, in West and East Gojjam zonal administrations Amhara regional state northwest part of Ethiopia. It is the source of more than 23 rivers and 273 small springs (Aserse etal, 2015). Choke Mountain is covering about 50947.3 ha and located at 38 km north-east of the capital city of Gojam, Debre Markos town which is the main tributaries of Upper Blue Nile river basin. The area is located between 37˚39'41" - 38˚2'54"E longitude and 10˚33'27" - 10˚47'56"N latitude and it is 4100 meters above sea level and it is the first place in East Gojam zone and the fourth place in the country. This mountain is bordered by 9 districts, and it is bordered in the north by hulet Eju Ensene and Sede districts, in the south by Gozamen and Debai Tilatgen, in the east by Enarij and Enemay districts, and in the west by Bibune, Degadamot and Sinan districts. Choke Mountain is

a mountain that has 23 big rivers and 273 small springs flowing from its bottom and is very cold in winter and is covered with snow.

Figure 17 current view of Choke Mountain

According to Sinan woreda, Choke community protected area office, 2023 about 86% of the topography of Mount Choke is mountainous, 1.5% is valley and 12.5% is plain. Choke Mountain is also bounded by four sub strategic Mountains, namely

- **Enat Ameba: -** This is the first and largest in height as the name suggests. The lower part of this mountain is surrounded by Agew Kab. At the bottom of the mountain, there are the prayer and cave of the monastery of Aarat Mekerakir Madhanimalem, which emerged from the middle of the rock and heals many sick people.
- **Gemese Ameba**:- As the name suggests, it is natural, so the fathers explain that the name is to express this.
- **Qulit Ameba**:-It got this name because the land where it is situated is high and the mountain is smooth. There are smaller fields at the top of the mountain.
- **Lemat Ameba**:-There is a mountain at the southern end, and the data shows that there is a vegetable garden on the top of the mountain.

The status of land use/cover (LULC) change and key drivers of change over the past 10 years through a combination of satellite remote sensing and surveying of the local understanding of

LULC patterns and drivers. Five major LULC types (forest land, grass land, farm/agriculture land, bush and shrub land and settlement) from Landsat images of 2013, 2018, and 2023 were mapped.

Land use and land cover changes that occurred from 2013 to 2023 in the Choke Mountain, Gojam, in the North-western highlands of Ethiopia, and were monitored using geographic information system (GIS) and a remote sensing approach with field verification. The study area covers 50947.32 ha. However, given the age-old tradition of clearing increasingly steeper land for cultivation and the lack of appropriate land use policies, productivity is currently heavily threatened by soil degradation.

Different land use types had been converted to agricultural lands in various places of the world since time immemorial (FAO 2017). Forestlands/woodlands had been continuously converted to agricultural lands at the highest rate than the other land use types (Gashaw et al. 2018). Similarly, grasslands had also been converted largely to croplands to fulfil the food demand for the increasing population (Mekonnen et al. 2018).

The produced LULC maps of the Choke mountain forest ecosystem for the three reference years (2013, 2018, and 2023) are presented in Fig: 18

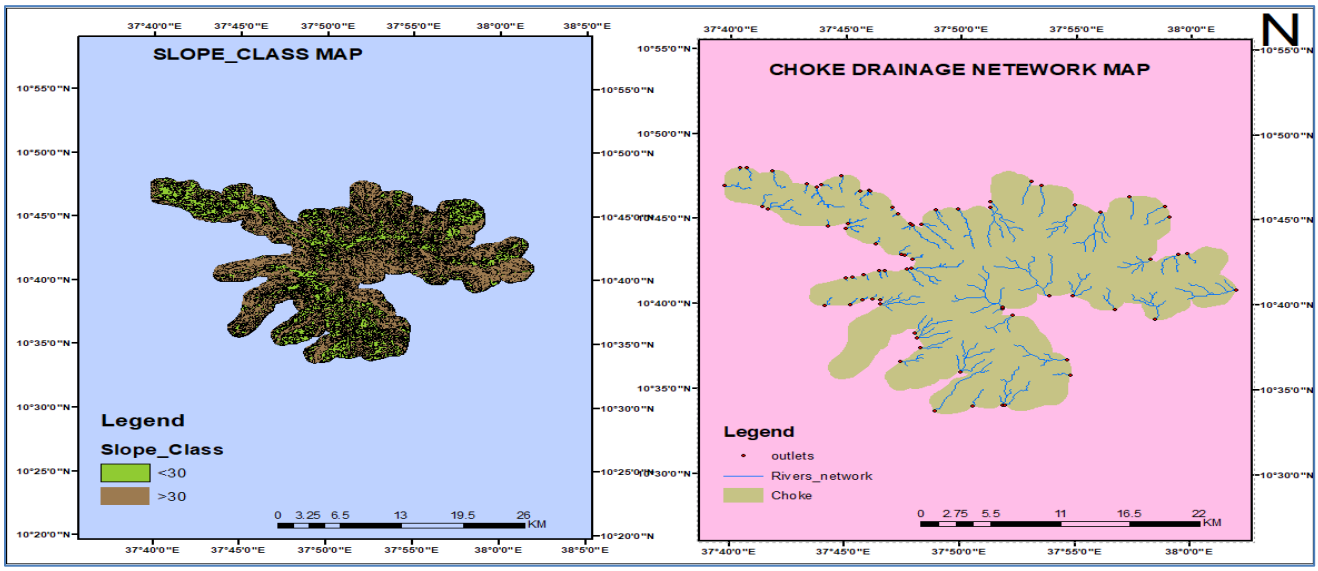

Figure 18Choke slope class &drainage system map

As we can see from the map less than 30% slope of the land measured about 34334.11ha (67.4%) and about 16600.25ha (32.6%) is greater than 30% slope feature.

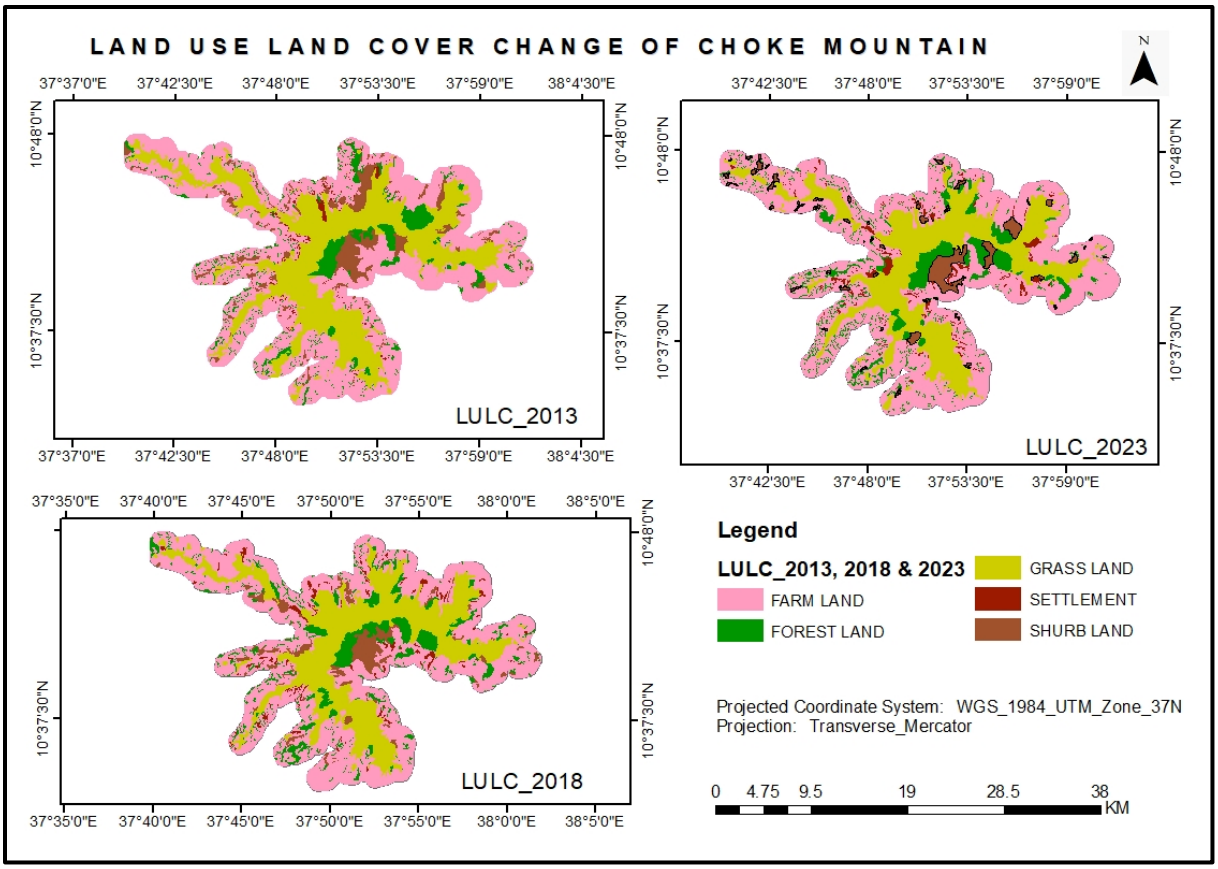

Figure 19 LULCC of Choke mountain ecosystem for 2013, 2018 & 2023

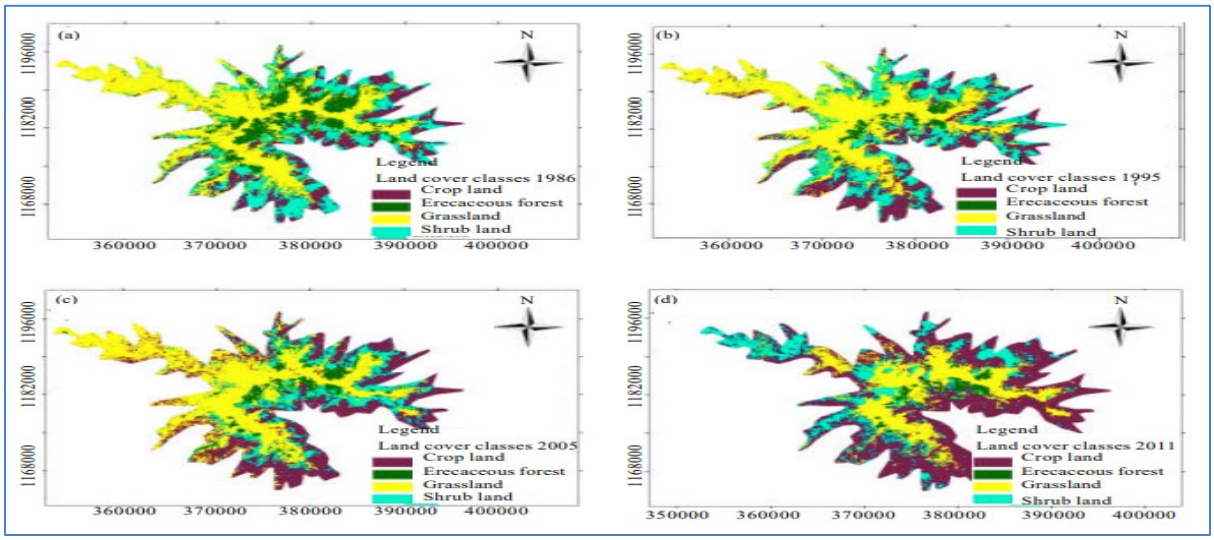

Figure 20 Supported maps taken from journal

Table 1: Land cover classification for 1986, 1995, 2005 and 2011

	1986		1995		2005		2011		Relative change
Land cover class	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	1986-2011 (%)
Crop land	8660	17	13419	26	17770	34	26527	51	206
Ericaceous forest	8513	16	2521	5	1841	4	1807	3	-79
Grassland	22499	43	22685	44	23909	46	13438	26	-40
Shrub land	12466	24	13514	26	8619	17	10367	20	-17
Total area	52139	100	52139	100	52139	100	52139	100	

As we have seen from the figure above, the LULC change of Choke mountain forest ecosystem that occurred over the last fifteen years was analysed. The results of this study revealed that a significant part of LULCC area has been changed from one other during the study period.

Table 5 Major land use/cover classes and their description.

LULC Classes	Description
Farm Land	The area covered with crop cultivation. This land use type includes rural settlements fenced with trees that are commonly found around homesteads and towns. This class also includes homesteads and the scattered trees on farmlands
Grass lands	The area covered by permanent grass that is used for communal and Private grazing lands. This class also includes rangelands.
Forest land	Areas covered by dense natural trees forming closed or nearly closed canopies, mainly growing naturally in the reserved land and along the Riverbanks and the hillsides.
Bush & Shrubs	Land covered by bush and shrub land vegetation. This class also Includes sparse trees on shrub and bush land.

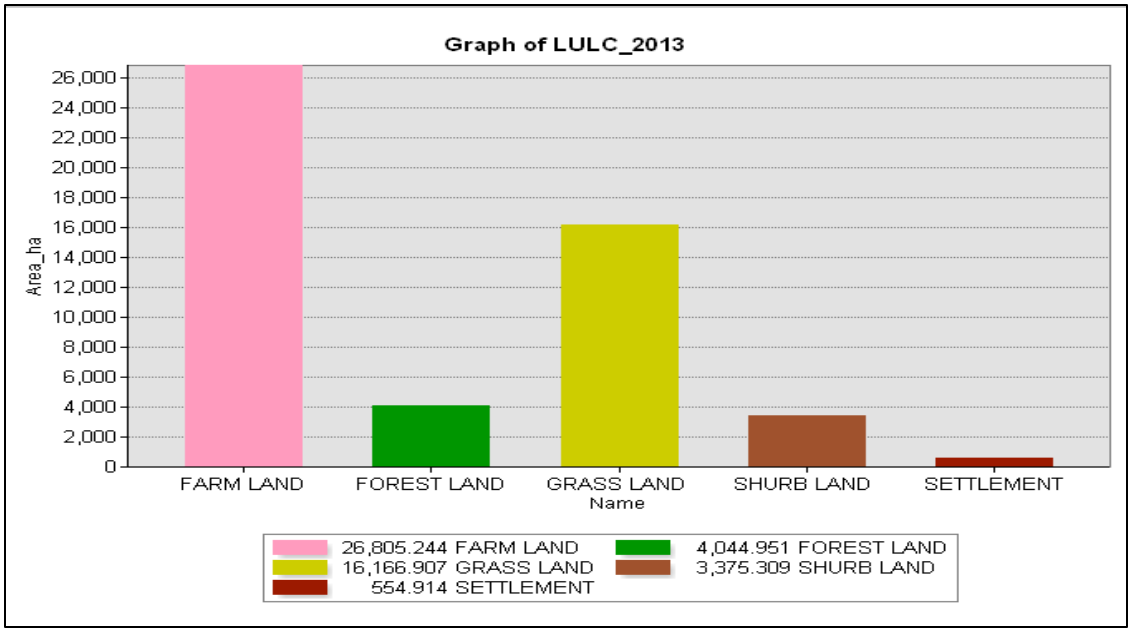

Figure 21 LULCC for 2013

As tried to mention in the graph above, there are five main land uses class in Choke ecosystem, and they are forest land, agricultural land, settlement, grass land and Shrub land, etc were identified in Choke mountain forest ecosystem in 2013. Even if natural forest was decreasing from time to time while, plantation forest (eucalyptus) was increasing. According to Aramede, et al, 2014 the reason might be the government change in 1991 which resulted in mass destruction of Ericaceous forest by the local community for various purposes including agricultural land expansion, fuel wood and construction wood collection.

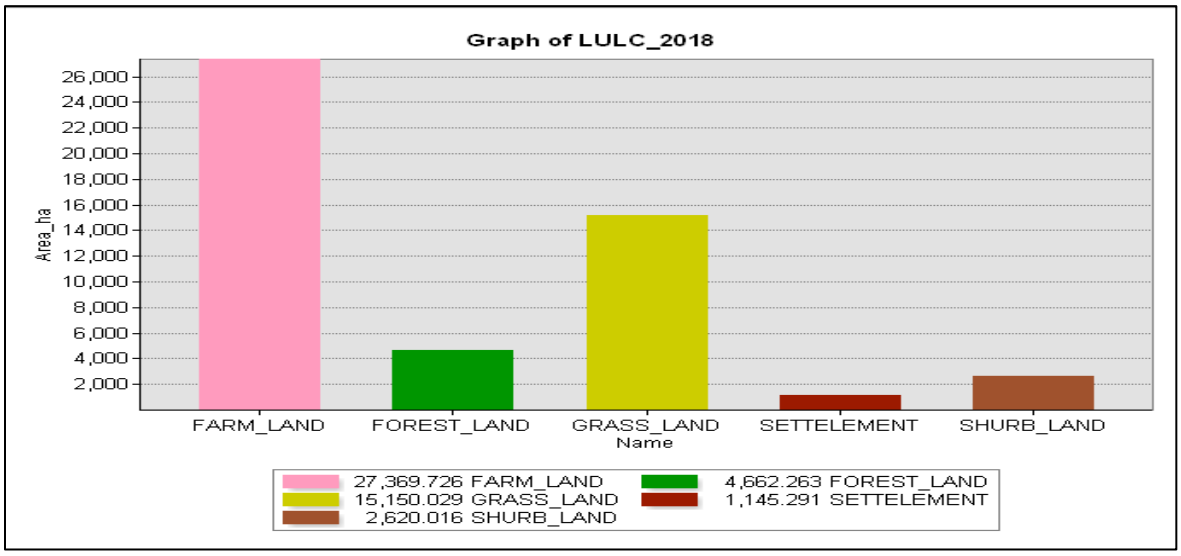

Figure 22 LULCC for 2018

As we have seen from the figure (3), this year, in the same situation with that of year 2013 & there are also five types of land use were identified so the difference is only in size. Thus, farm land is measured from the total 27,369.72 hectare, Grass land is measured 15,150.02 hectare, forest 4,662.26 hectare, shrub land, 2,620.01 hectare & 1,145.29 hectare respectively.

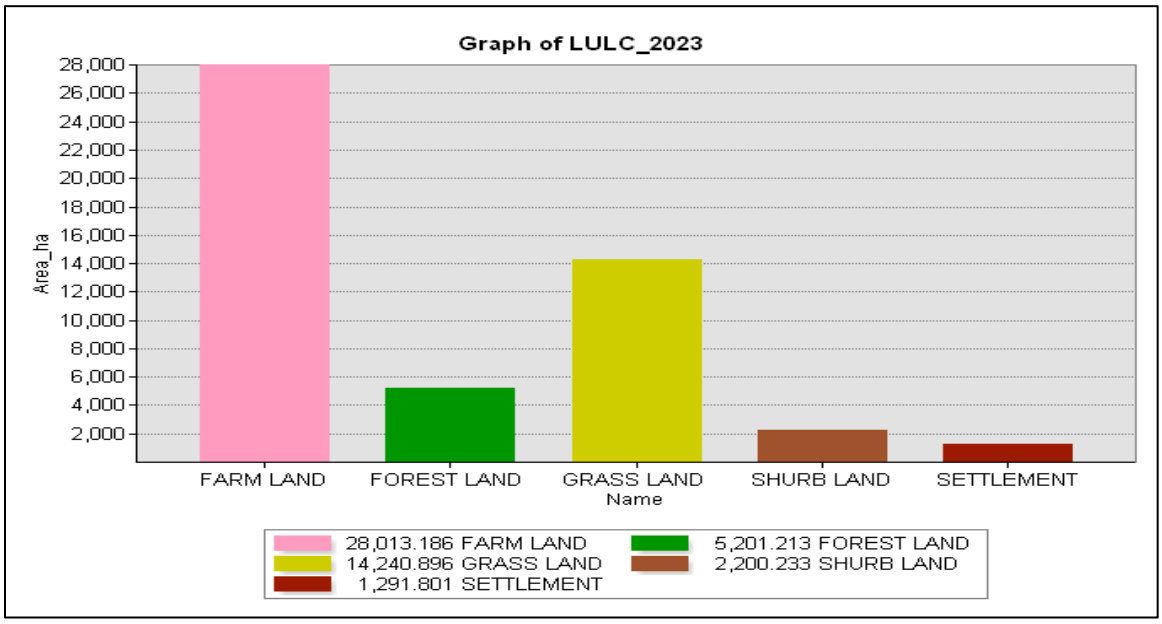

Figure 23 LULCC for 2023

This year, there are also five types of land use were identified, but as mentioned in the 2018 report, agricultural/farm/land occupies the first level of coverage, while grass land has the second level of coverage. However, among the five land uses classes, the Settlement has the lowest coverage. Similar study reported that, the result showed that crop land has continuously increased in area extent as compared to other land use/land cover types between 1986 and 2011 (Aramde etal, 2014). This is attributed to expansion of cultivated land in the Choke Mountain ranges at the expense of alpine vegetation in the region.

Table 6 Land use land covers change & detection analysis from (2018-2013).

No	LAND USE TYPES	Year, 2018	Year, 2013	LULCC (2018-2013)	LULCC IN %
1	FARM LAND	27369.7	26805.24	**564.48**	**2.06**

2	FOREST LAND	4662.3	4044.95	**617.31**	**13.24**
3	GRASS LAND	15150.0	16166.91	**-1016.88**	**-6.71**
4	SHURB LAND	2620.0	3375.31	**-755.30**	**-28.83**
5	SETTLEMENT	1145.3	554.91	**590.38**	**51.55**
	Grand Total	**50947.325**	**50947.325**		

Among the major five land use land cover changes, settlement, forest land & farm land use/cover types increased by 51.55%, 13.24% and 2.06%, respectively. The land use classification results showed that between 2013 and 2018, grass and shrub land area coverage were decreased by by 28.83% & 6.71% respectively over the past 5 years. As we confirmed by going to the place physically, due to the increasing population, the natural forest is decreasing for farming, firewood and house construction. Although the natural forest is decreasing, on the other hand, the farmers have planted artificial forest (eucalyptus) in the backyard, which has increased the overall forest cover in Choke mountain forest ecosystem.

Table 7 Land use land cover change & detection analysis from (2023-2018).

No	LAND USE TYPES	**Year, 2023**	**Year, 2018**	**LULCC (2023-2018)**	**LULCC IN %**
1	FARM LAND	28013.19	27369.73	**643.46**	**2.35**
2	FOREST LAND	5201.213	4662.26	**538.95**	**11.56**
3	GRASS LAND	14240.9	15150.03	**-909.13**	**-6.00**
4	SHURB LAND	2200.233	2620.01	**-419.78**	**-16.02**
5	SETTLEMENT	1291.801	1145.29	**146.51**	**12.79**
	Grand Total	**50947.33**	**50947.32**		

From the year (2023-2018) revealed that, settlement, forest and farm land were decreased by 12.79%, 11.56% and 2.35% respectively. This result showed that, human population increased

from time to time in the study area, this could wide-open for natural resource scrabbling for housing and other multi use proposes. The rates and intensities of LULC dynamics are changing dramatically in Africa, where high population growth associated with the overexploitation of natural resources and low productivity of land is prevalent (Eva et al., 2006).

Table 8 Land use land cover change & detection analysis from (2023-2013).

No	**LAND USE TYPES**	Year, 2023	Year, 2013	LULCC (2023-2013)	**LULCC IN %**
1	FARM LAND	28013.19	26805.24	**1207.94**	4.31
2	FOREST LAND	5201.21	4044.95	**1156.26**	22.23
3	GRASS LAND	14240.90	16166.91	**-1926.01**	-13.52
4	SHURB LAND	2200.23	3375.31	**-1175.08**	-53.41
5	SETTLEMENT	1291.80	554.91	**736.89**	57.04
	Grand Total	**50947.33**	**50947.33**		

As we can see in the above mentioned table, from 2023-2013 for the last ten years, the village /settlement has increased significantly increased by 57.04%, forest by 22.23% and farm land by 4.31% respectively can be seen. On the other hand, shrub land and grass land respectively show a significant decrease by 53.41 &13.52% for the last 10 years. The main reason for this is the increase in population and the corresponding increase in demand for resource. As it is known, Choke Mt is a hilly area bordered by 9 districts, so its experiences show that, it could carry a lot of pressure.

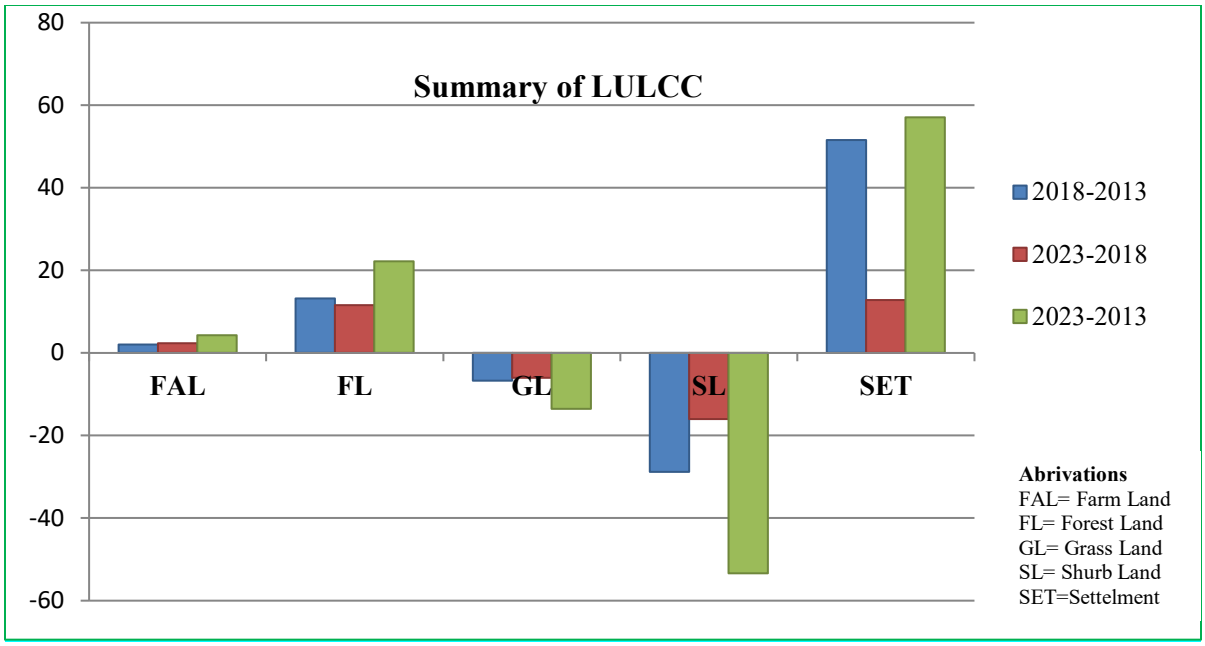

Figure 24 Summary description of LULCC Choke Mountain 2013, 2018&2023

Generally, the results imply that farm land or agricultural expansion increased crop production by increasing farm size, but it is also a result of deforestation and high soil erosion. Similarly, firewood collection and charcoal production are among the sources of livelihood for the rural poor, particularly youths, but they are also a cause of shrubs & forest clearances. Eucalyptus planation is one of the key sources of income for rural smallholders in the study area, but it has negative ecological impacts on water and indigenous trees. The decrease in some percentage change of natural forest land stopped due to the absence of suitable natural forest land for further conversion to agriculture land and settlement land and the implementation of local rules and regulations with respect to forest management.

Figure 25 Scrambling of grass land and shrubs by housing

Generally, the change detection results revealed a significant increasing trend in Settlement, forest and farm land thought the study period in contrast, grassland and shrub lands showed a declining trend even if the magnitude vary from year to year for the last 10 years as indicated in the figure above, as the local residents have widely explained that, the main reason for the increase in forest area for every consecutive years is the spread of artificial forest especially eucalyptus tree and bamboo forest species but, natural forest is still decreasing from time to time.

3.1.2. Drivers and Pressures of Choke Mountain forest ecosystem

The information from the group discussion revealed that the driving forces for the landuse change at Choke Mountains are the complex interactions among the bio-physical, socio-economic and cultural processes operating in the region over time.

Several LULC change studies conducted in Ethiopia related LULC changes with a variety of drivers, which include both proximate and underlying causes such as demographic pressure and associated demand on environmental resources (Mengistu et al., 2012)

According to Kindu et al 2015 in south-central highlands of Ethiopia recognized the expansion of settlement and cutting of trees for fuel wood and charcoal making as proximate causes of LULC change. Slope and the availability of adequate infrastructures such as roads and access to markets were considered as the proximate drivers of LULC changes in the upper Blue Nile basin (Yalew et al., 2016). On the other hand, population growth, climate variability, land tenure

policy, drought, government change, and poverty were recognized as the major underlining drivers of LULC change (Ariti et al., 2015).

The LULCC data analysis results indicated that expansion of cultivated land, cutting of natural trees for fuel wood and construction purposes, population growth, land tenure policy, and climate variability were the most influential drivers of land use/land cover changes in the study area. The findings of this study confirmed that unmanaged land cover conversion led to degradation of natural resources in Choke Mountain. Thus, alternative sources of income for youths and landless peasants, and integrated watershed management, which has paramount importance in maintaining economic and ecological benefits, were suggested to alleviate the adverse effects of land use/land cover changes in Choke Mt. According to the analysis from Landsat images, the field observation and the evidence from the group discussion, the grass land status of Choke Mountain ranges has been rapidly decreasing between 2013 and 2023 due to high pressure from human and livestock in all direction of the alpine regions.

The major drivers of LULCC are:-

- **Expansion of agricultural land**

In Ethiopia where the vast majority of the populations are employed in agriculture, land is an important economic resource for the development of rural livelihoods. Agricultural land in many areas is, however, transformed into built-up or settlement area through horizontal urban expansion that has an effect on land use land cover change value. In recent years Choke has been experiencing rapid expansion of farm land and settlement as confirmed from LULCC of 2013, 2018 &2023, map detection which has led to an ever-increasing demand for land in areas for housing and other agricultural activities that pervades for crop production.

- **Population growth**

Increase in population has implications for land resources as the need to produce food and the demand for settlement and fuel wood increase in response to growing population needs. In other words, the shortage of farm land stimulated by population growth forced local community to clear forest on steep slopes, which aggravated erosion problem and soil fertility decline. Rapid population growth of the study area resulted in expansion of a farmland and threatened the land covered with forest. Fast population growth and the consequent high pressure on resources are expected to have an adverse effect on the existing natural resources of the area.

- **Shortage of farm land**

Over population have the impacts of rapid urbanization/expansion of settlement/ on agricultural activities. Settlement expansion has reduced the areas available for farm land per household, which has seriously impacted upon farmers that are often left with little or no land to cultivate and which has increased their vulnerability. Housing encroachments have been observed to be uncontrolled due to a weak government response to the trend of unplanned city expansion. This has left farmers exposed to the negative shocks of urbanization because significant urbanization-related agricultural land loss has a positive correlation with grain production decrease and high level of Land use land cover change.

- **climate variability**

. LULC change is linked to climate and weather in complex ways and play critical roles in the interaction between the land and the atmosphere (Bekele et al. 2015). Some of the FGDs mentioned that the local climate change rain fall variability is caused by the on-going land use/land cover change. Moreover, the interviewees indicated that LU/LC change and associated climate change over time directly affects the livelihood of the subsistent farmers by affecting crop production, since most of them are completely dependent on rain-fed agriculture.

The major pressures of LULCC of Choke Mountain forest ecosystem.

- **Over grazing**

Ethiopians possess Africa's largest livestock population, and pressures for more grazing and farmland have led to enormous changes in land cover, especially in the Highlands, home to 85% of Ethiopia's people and 75% of its livestock (Kidane, etal 2012). Livestock in the study watershed are extremely important as they have multifaceted roles such as provide food and improve the nutritional status of the people, serve as a source of security at times of crop failure and so on. The major feed resources for livestock are natural pasture.

Figure 26 Free grazing at Choke

As you can see in the graph, there is a lot of free grazing system on Choke mountain forest ecosystem. The local community releases their sheep, goats and horses into the ecosystem. This is the fact that, we were able to confirm this by physically being present at the place of Choke. Several studies also confirmed that livestock grazing is a powerful driver of land cover dynamics and influences the abundance and distribution of the animal and plant communities inhabiting the afroalpine areas (Coppedge et al., 2008).

- **Expansion of Settlement**

Figure 27 Expansion of Settlement

The two red colors on the graph show that, the resident community at the bottom coming up to the grazing land and the community settled on the left and right side of Choke. This has resulted in the reduction of grass land and shrubs due to settlement expansion; therefore, currently the ecosystem has been under severe pressure. Government redistribution of communal grasslands to landless youths is the major cause of the contraction of grassland to farm land. Natural forests have also been lost due to population-associated increased demands for firewood, building materials, and other household furniture and farm equipment.

3.1.3. Impacts of Land/Use Land Cover Change of Choke Mountain Forest Ecosystem

Environmental implications such as climate change, biodiversity loss, scarcity of basic forest products, habitat alteration, and decline in quality and availability of water, and crop yield reduction are resulted from the LU/LC change. If this tendency of LU/LC change continued, it will have serious environmental and economic consequences with impact on livelihood of local people, appropriate measures that ensure wise use of natural resources and efficient utilization of land are very much critical.

- **Biodiversity loss**

Land use/cover and habitat loss are widely recognized as the major drivers of biodiversity depletion in Ethiopia (Nyssen et al. 2004). Changes in land use/cover also results in fragmentation of the landscape which in turn led to the loss of biodiversity as well as change in the structure and function of ecosystem services provision and human dependencies The consequence of the LU/LC change was the loss of biodiversity. Changes in environmental conditions and natural setting of the land and its cover greatly affected the life cycle and the survival of various plants and animals. During the interview key informants said that some species of plants and animals previously found in the study area disappeared mainly as a result of unregulated deforestation and agricultural expansion so that, they believed that the diversity of both plants and animals was declined in Choke Mountain forest ecosystem.

- **Habitat alteration**

Ethiopia's biodiversity is today threatened by rapid human population growth and land use change (William, etal 2005). Ethiopia has Africa's second largest human population despite ranking only 10th in total land area. Over the past 70 years, Ethiopia's population grew from ~18 million to ~123 million and is currently increasing by 2.4% per year (FAO, 2020). As mentioned above, due to the rapid increase in population, rare wild animals and various plants that used to live in the natural forest in the ecosystem are leaving their place and their numbers are decreasing due to the depletion of the natural forest.

- **Decline water resources**

Land use land cover change has the chance for removal and conversion of natural vegetation cover into cultivated land and/or grass lands are commonly practiced in the study area. Depletion of these vegetation covers then reduces protection cover of the soil and leaves the top soil vulnerable to the impacts of rain drops; which may accelerate the detachment, removal, and transport of sediment by running water, which in turn, contributes to land degradation and dramatic declines in land productivity. All these indicate, LULC dynamics has direct implications on the hydrological regime and magnitude of runoff and base flow in the ecosystem. This reasonably calls for the need for more effort on stabilization of the land use/cover change in general and investments on sustainable land management activities in particular so as to regulate the hydrological system of the study area.

- **Decline crop yield production**

Several factors may be affecting the global slowdown in agricultural productivity growth. Land use land cover change and weather shocks associated with a changing climate (such as drought, heat, or flooding) can decrease yields. These effects would be cumulative as further increases in temperature or adverse weather shocks result in larger and more frequent reductions in productivity over time. In addition to lowering overall productivity, climate change may shift global production patterns. In other words, crops that used to be grown productively in one area may no longer be suitable to new agro-ecological conditions, such as changes in seasonality, temperature, and precipitation, and might be more suited to other areas.

- **Scarcity of basic forest products**

Forest products are very essential in the daily life of the inhabitants of Choke Mountain forest ecosystem, since most of them depend on forest products for construction, cooking, heating, and light. However, continuous deforestation of natural forest led to the scarcity of forest products. We have observed the occurrence of scarcity of forest products in the area. Land cover (vegetation cover) highly controls the runoff. Land use/land cover change can influence soil chemical and physical properties because of different anthropogenic factors, namely, deforestation and agricultural expansion associated with intensive cultivation.

3.1.4. Responses taken to improve the status of Choke Mountain forest ecosystem

Regional and woreda level

Land use and land cover change (LULCC) are associated with large negative impacts on ecosystems observed at local, regional and global scales. High rates of water, soil and air pollution are the consequences of observed LULCC. Biodiversity is reduced when land is changed from a relatively undisturbed state to more intensive uses like farming, livestock grazing, selective tree harvesting, etc. (Ellis, 2011). Among the 9 districts bordering of Choke, mainly at Sinan district Amhara national regional state established a new office in 2014 E.c namely Choke community protected area office and was organized to manage this ecosystem only, as a result of which 6248.37 hectares of forest land is being protected by this organization. On the other hand, according to the information we received from the participating farmers, they said that they have been successful in nursery establishment, planting forests, and integrated soil

and water conservation activities supported by agriculture office and Non-Government organizations like safety nets, and Amald. Another 15 hectares of land has been planted with artificial forest to save boreholes.

3.1.5. Outlooks

According to land use land cover change (detection analysis, from 2013- 2023); the farm land or cultivated land expanded by 4.31% and shrub land were declined by 53.41%, settlement by 53%. The population growth of Choke boarding districts was also increased. As the current situation in Choke Mountain (land use land cover detection analysis) shows, the eucalyptus forest is increasing and the natural forest is decreasing through time. Also, if the process of expansion of agricultural land and grazing land continues and if we cannot solve and manage the main problems mentioned above, after a few years there will be a process of destroying the current Choke mountain chain forest ecosystem.

3.1.6. Recommendations

3.1.7. State and Trend of Land Degradation in Choke Mountain Forest Ecosystem

According to FAO's framework for land evaluation (FAO 1981), land is a delineable area of the Earth's terrestrial surface which encompasses the physical environment including soil, spatial variability of landscape, climate, hydrology, vegetation and fauna, as well as land management practices and the influence potentials for land use. In other ways, the term 'land' includes renewable natural resources, i.e. soils, water, vegetation and wildlife, in their terrestrial ecosystems. Land degradation (LD), in turn, includes all processes that diminish the capacity of land resources to perform essential functions and services in these ecological units. In other ways, land degradation includes all process that diminishes the capacity of land resources to perform essential functions and provide ecosystem services (Hurni et al., 2010). It is usually caused by two complex interlocking systems: the natural ecosystem and the human social interaction. The impact of land degradation on livelihood is particularly severe in Sub-Saharan Africa because 65% of the population is rural and the main livelihood of about 90% of the population is agriculture.

Ethiopia is one of the rich countries in Sub-Saharan Africa in terms of natural resources (Gete et al., 2006).37However, natural resource degradation in Ethiopia has been going on for centuries

(Hurni et al., 2010). The problem is getting worst as the population pressure and the demand for food, fuel wood, building materials, and land for cultivation increases (Hurni et al., 2010).

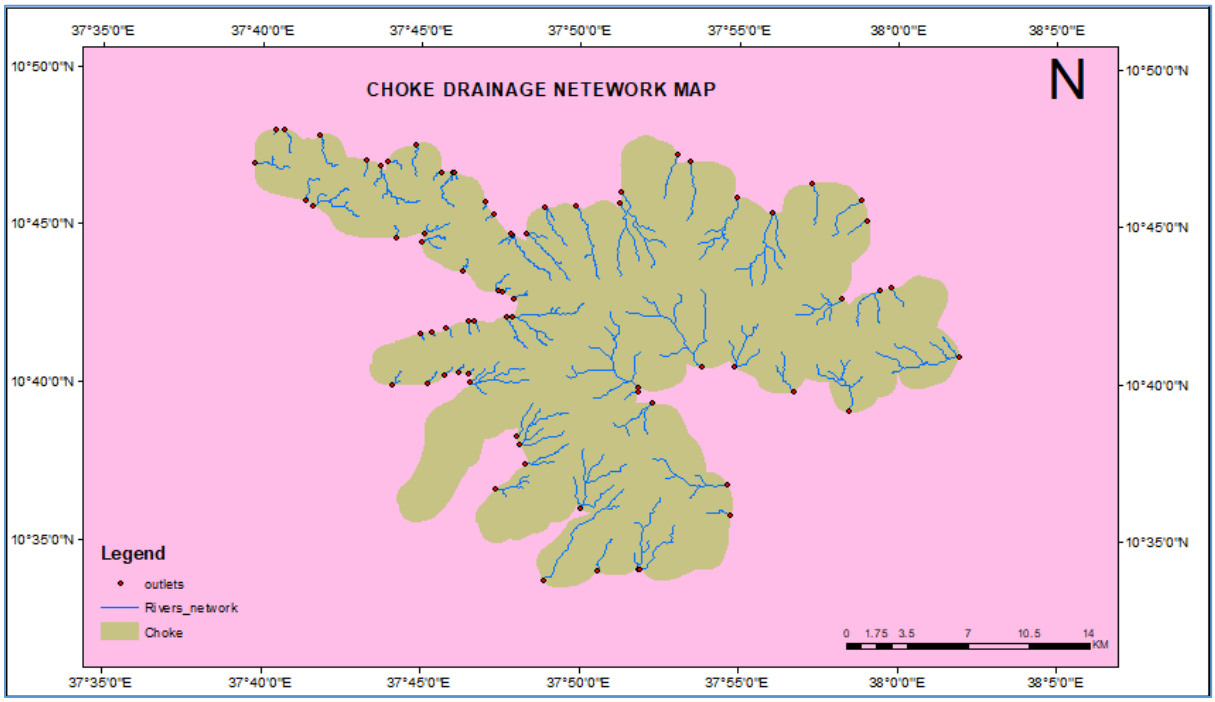

Figure 28 map of Choke drainage system

Choke Mountain and its associated watersheds, located in the Blue Nile highland regions of Ethiopia, is broadly representative of many of the challenges related to land degradation. The Choke Mountain ecosystems are under threat from multiple sources, including the pressure from population growth, soil erosion, deforestation, overgrazing, and decline of soil fertility Simane et al., 2013). In turn, it has affected the livelihood of local communities through mainly reducing water availability, and livestock feed (Simane et al., 2013). To combat land degradation and restore degraded landscapes, the Ethiopian government launched a massive soil and water conservation program particularly, soil and water conservation campaign has been implemented since 2010 to increase agricultural productivity through improved natural resource management (Mekuria et al., 2017).

The area has an inactive volcanic centre composed of basalt with a very thin cover of pyroclastic materials (volcanic ashes). Erosion has resulted in numerous, deeply incised valleys, which were covered with glaciers during the last ice-age. Many small streams originate in the mountains. The most remarkable feature of these mountains is the virtual absence of forest. Land degradation:

Soil erosion in Choke Mountain watersheds is a well-recognized problem, identified as a priority by the local community members. Steep slopes, traditional crisscross ox-drawn tillage systems that promote rapid erosion as well as limited agricultural land use characterize the Choke environment.

Figure 29 land degradation by expansion of settlement

Soil degradation: is the component of land degradation and include a decline in soil fertility, adverse changes in alkalinity, acidity or salinity, extreme flooding, use of toxic soil pollutants, erosion, and deterioration of the soil's structural condition. These elements contribute to a significant amount of soil quality depreciation annually. During the interview, as the local residents told us, the place is located on a steep slope and the fertile soil is being washed away during the summer months due to floods, causing serious problems of soil erosion and land degradation. In the Choke Mountain, soil erosion is a key environmental and socio-economic problem.

Rapid population growth which resulted in rapid agricultural expansion at the expense of natural forest resources and free grazing system aggravates the depletion of the ecosystem including soil erosion and water resources degradation.

Figure 30 Soil degradation by road & grazing

As you can see in the graph above, we have been able to confirm in the field that land degradation due to the construction of pista roads, open grazing and the expansion of villages has led to the depletion of the grasslands and forest land of the Choke MT, ecosystem.

In Choke Mountain forest ecosystem, the majority of local community is landless. However, 50% of it is earned by share cropping, 25% by renting and the remaining 10% by purchasing. On the other hand, the standard of living of the community is low and data indicates that more than 50% of the community is self-sufficient in food or complimentary in food security.

Table 9 border districts land use and topography

District Name	**Land use types (ha)**						**Topography (%)**		
	Farm land	Grazing land	Settlement	Bush & shrub land	Forest Land	Others land	Gentle	Hilly	Gorge
Sinan	22266	7984	2224	5052	2554	884	25	60	15
Bibugn	-	-	-	-	-	-	*29.2*	*69*	-
Enarj	*41846*	*2,316*	*3278*	*2630*	*8502*	*378.25*	-	-	-
Debay	*36516*	*7937.53*	*19458.3*	-	*620*	*68*	65	35	-
Hulet Eju	*35715*	*29687*	*7898*	-	*8485*	*7950*	63	35	2

Gozamin	50084	-	-	-	22080	-	74	10	16
Total	**186427**	**47924.53**	**32858.25**	**7682**	**42241**	**9280.3**	**51.4**	**41.9**	**6.6**

Source: Taken from East Gojam Admin zone districts statically abstract, 2014

Note: the symbol – shows that, the data was not available during the data compilation

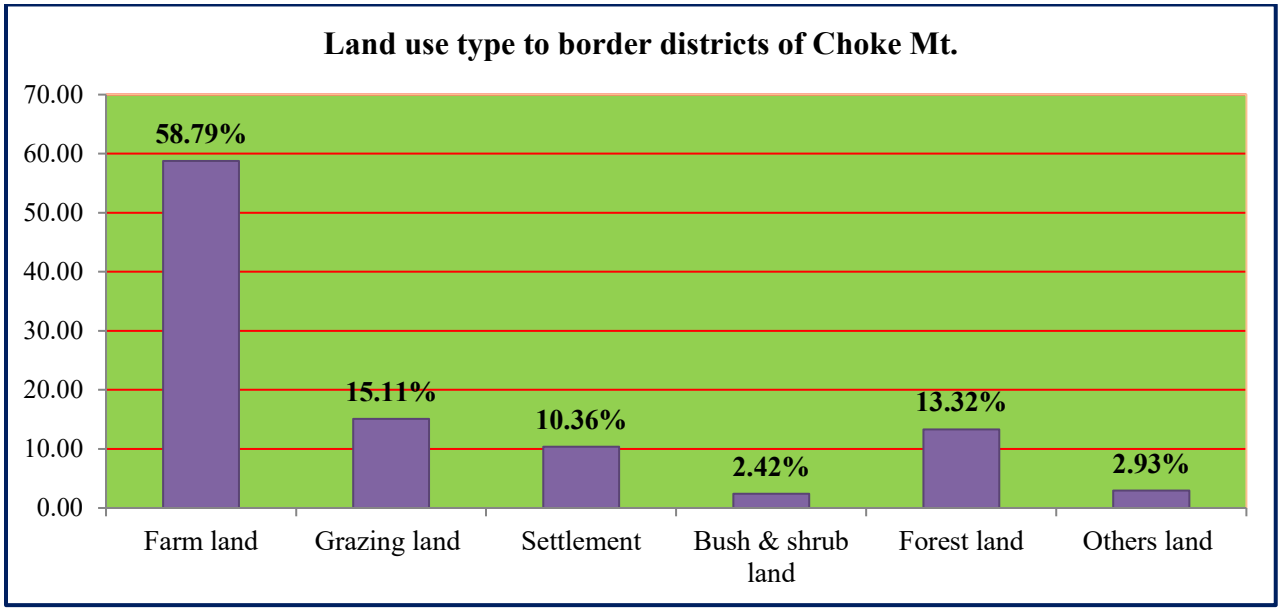

Figure 31 Land use type to border districts of Choke Mountain

According to the data taken from the six districts bordering the area as far as possible to obtain information from the East Gojam administration in 2022, six types of land use have been identified, and the figure shows that farm land covers the largest share of 58.79% followed by grazing land 15.11%, forest land 13.32% and the last smallest land cover is Bush and Shrub land it accounts only 2.42%. However, there are some districts that have filled the information by merging the Shrubs & forest in one. It was also possible to see data management problems.

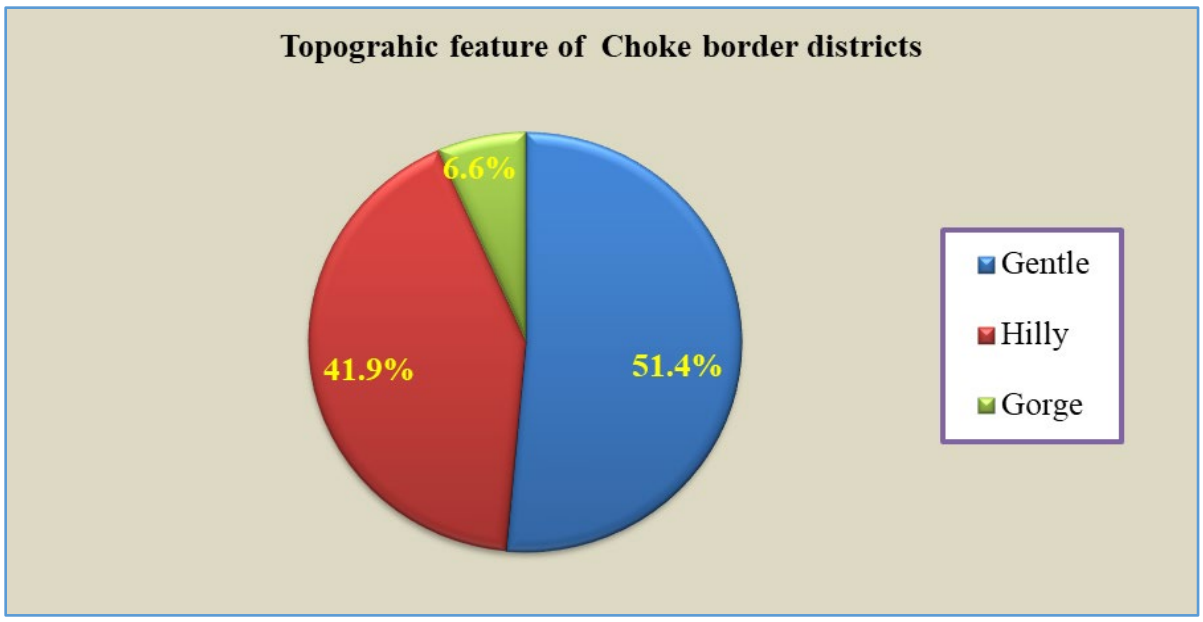

Figure 32 Topography feature of Choke border districts

Topography has a strong influence on aggravating soil erosion. On the other hand, the field observation and key informant confirmed that the implementation of NRM interventions in Choke Mountain is a key to control soil erosion and restore degraded landscapes. Also it is consistent with the perception of local communities; the majority of respondents confirmed the effectiveness of the implemented natural resource management intervention in reducing soil erosion.

When we look at the topography of the bordering districts of Choke, mostly 51.4% is plain, 41.9% is mountainous (hilly) and 6.6% is gorge. So, as we have seen in the figure, due to the fact that the terrain of the Choke Mt, ecosystem is mountainous, which is more than 41.9%, it is vulnerable to high soil erosion by rainfall. This fact was supported by the local people during the interview, as a result, the production and productivity of the area is greatly reduced due to the rain washing away the fertile soil.

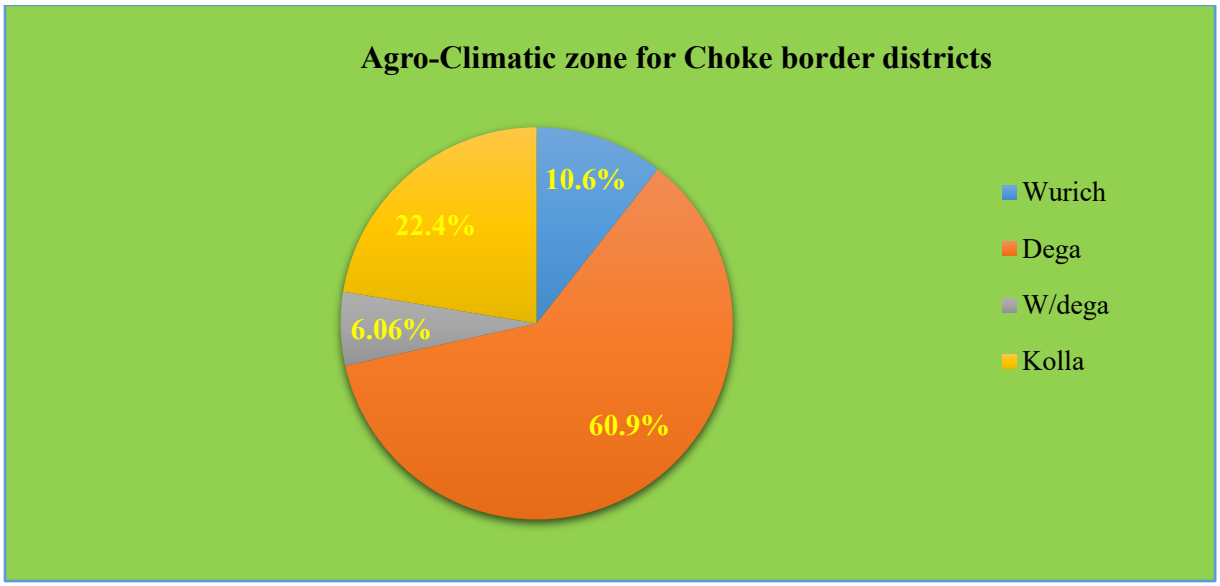

Figure 33 Agro-climatic zone

According to the information we have obtained, when we look at the agro-climatic zone of the bordering districts of Choke, mostly more than 60.9% of the land is covered by highlands, while Kola covers 22.4%. Frost and woyna daga will be covered 10.6%, 6.06% respectively. The main importance of this weather information is to determine the crops to be produced as it is very useful to determine the time of sowing, planting and harvesting.

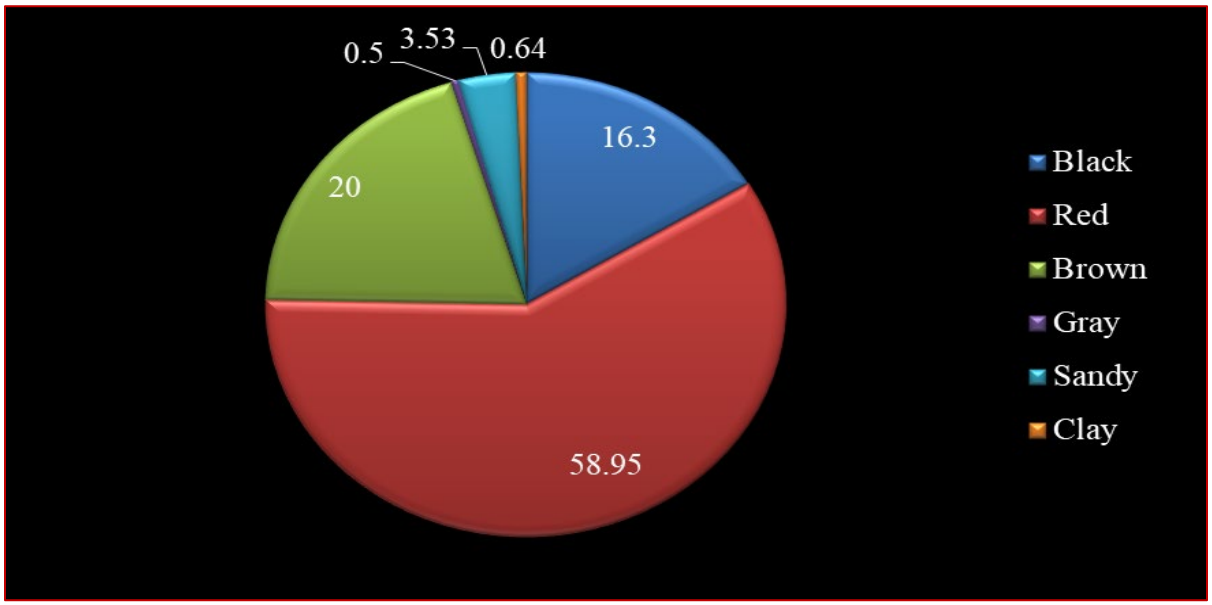

Figure 34 Major soil types

There are six types of soil are found in Choke Mountain ecosystem, these are red soil 58.95%, brown soil 20%, black soil 16.3%, and sandy soil 3.53%, respectively. This is the fact that, as topography soil type is also directly related to soil erosion. For example, red soil contains the highest amount of soil and is easily eroded by rain in nature.

The proportion of land degradation which affected by different factors are: the following

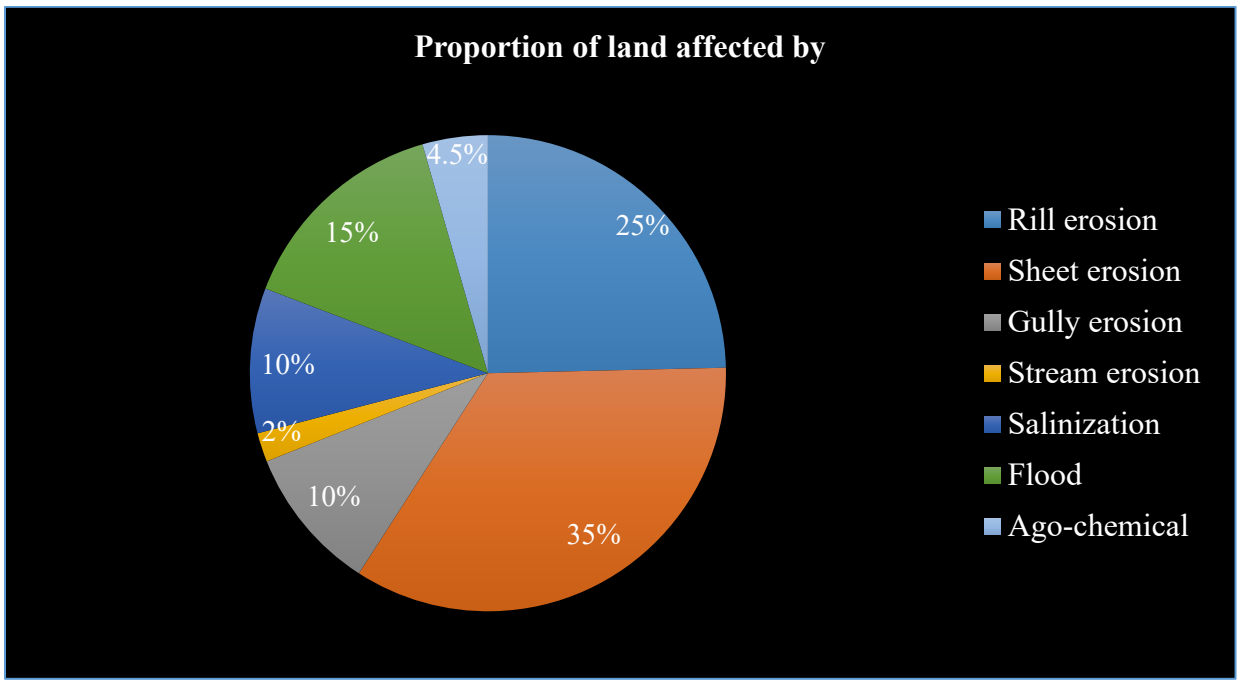

Figure 35 Graphic representation of land degradation by different factors

FGD described us every corner of Choke Mt. in the absence of strong land use planning, land use system many farmers around the area are scrambling the forest ecosystem and other natural resource extracting to expand their farmland. As it can be seen in the figure more than 35% of the land was affected by sheet erosion and 25% of by rill erosion.

According to Ded Eyesus Kebele, selected farmer's interviews, integrated soil and water conservation works have been carried out since 10 years ago. However, since 1989, due to the lack of land surveying and the fact that the land holdings of the farmers are very small and the terrain is sloping, there is a problem of soil erosion. In 2010, flash floods occurred in 3 districts

(Sinan, Bibun and Debatilatgne). Due to the cold climate of the area, only certain crops can be grown, for example, only potatoes, dagusa and barley are grown.

According to the people we interviewed, the number of people living below the poverty line is increasing, and the reasons for this are land degradation, rising fertilizer prices, land scarcity, population growth, market linkage problems, and unemployment. More than 50 percent of the youth in the area are educated and less than 30 percent of the workforce is unemployed. The majority of FGDs perceive that the productivity and the size of their farm land have declined through time. They considered that their farm land is reduced; fertility of agricultural soil and productivity is declined due to increased soil erosion.

Crop production & Productivity in Choke Mt, Ecosystem

As we confirmed from the key informants, the means of livelihood of the community around the Choke Mt. ecosystem is both mixed agriculture type Agriculture in the Choke Mountain watersheds is diverse, but can generally be characterized as crop-livestock mixed systems, practiced by independent farmers on small plots. (i.e animals rearing and crop cultivation). But, animal husbandry especially sheep is one of the predominant economic activities in the area. Therefore, the major cereal crops are potato maize, wheat and barley. Whereas the major rearing animals in the study area are cattle, sheep, horse, mules, donkey and poultry.

The current major problems facing Choke Mt. ecosystem today is land degradation, particularly loss of vegetation cover and soil erosion contribute significantly to low agricultural productivity.

As taken from the two kebeles key informants interviews, the average crop production around the area is 30.2quintal /ha, land productivity also decline due to the unsustainable use of natural resources and nature of steep geographical feature in the area. From the total land owned by the local community, more than 5% was owned by informal ownership holding systems. There were a conflict in resource use among the two districts; however the conflict was resolved by the representatives of the parties. The reduction in agricultural productivity could be attributed to poor land management and land degradation due to soil erosion. The survey respondents have mentioned that they started to use different land management practices such as crop rotation, application of inorganic fertilizers and compost, and fallowing to restore degraded farm lands.

Table 10 Crop production and Crop productivity

Major crops types	production (Quintal) 2020/2021	production (Quintal) 2021/2022	productivity in Q/ha 2020/2021	%	productivity in Q/ha 2021/2022	%
Teff	1395688.2	1783590.4	26.22	15.46	23.6	13.91
Barely	842939	856037.9	34.01	20.05	27.75	16.36
Wheat	1031635	1068571.6	46.9	27.65	41.08	24.22
Maize	770683.5	1789318	62.5	36.84	55.5	32.72

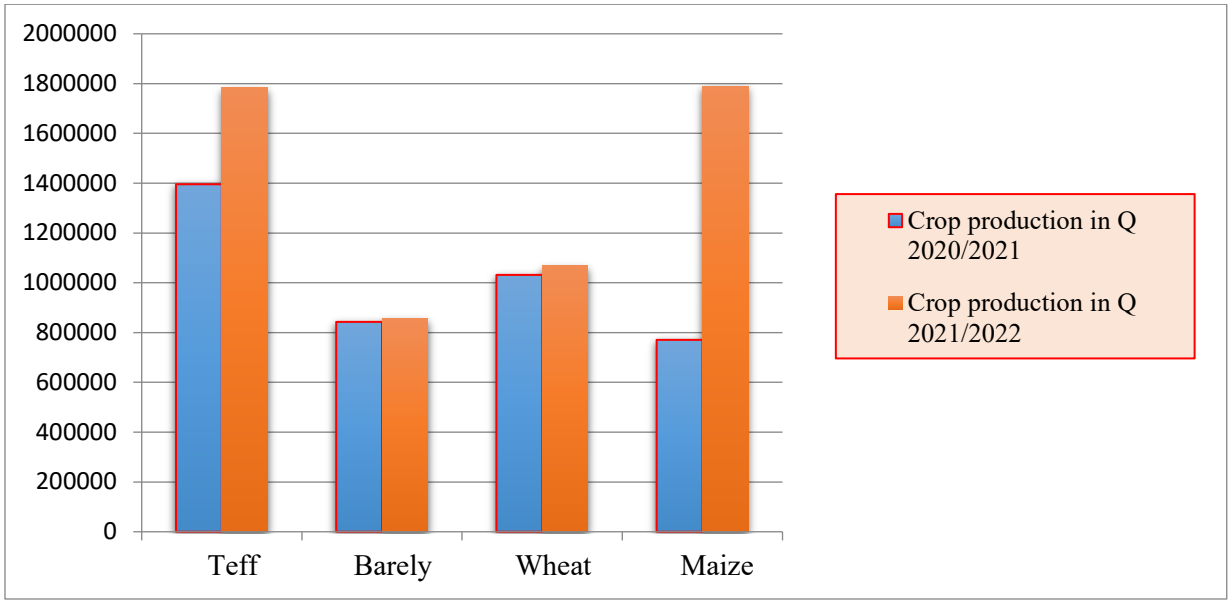

Figure 36 crop production

As can be seen in the graph, the production of four main crops in the last two consecutive years has been put in detail. Therefore, it shows an increase in the overall production situation in the period from 2021-2022. However, productivity has decreased significantly. The reason for this is that there is a situation of bringing new uncultivated land into cultivation, and at the same time, it indicates the expansion of agricultural land and the reduction of the productive capacity of the land.

“The decline in soil fertility and reduced workability of farm lands due to land degradation has led to reduction in crop production. Also, land fragmentation due to land degradation has

resulted in reduced crop production. This, in turn, resulted in food insecurity, reduced income, and poverty". (FGDs, Interview 2023). The reduction in agricultural productivity could be attributed to poor land management and land degradation due to soil erosion. The survey respondents have mentioned that they started to use different land management practices such as crop rotation, application of inorganic fertilizers and compost, and fallowing to restore degraded farm lands.

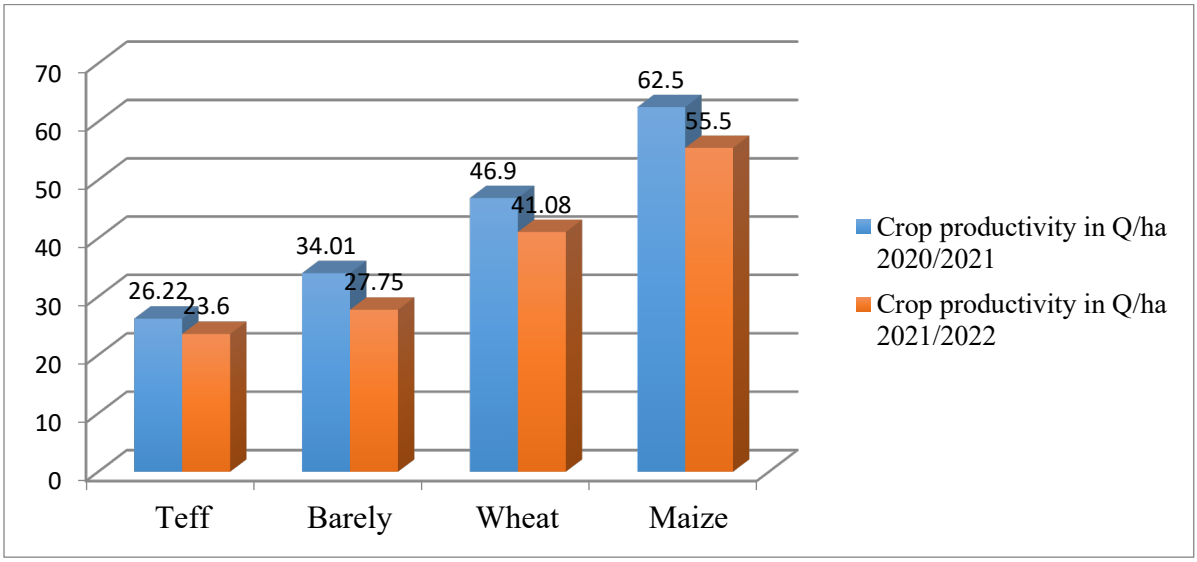

Figure 37 Six districts of major crop productivity in Quintal/ha

As indicated in the graph, within two consecutive years 2012 and 2013 the productivity of major crops taken from the six districts has shown decreasing rate. For instance, Teff decreasing from 26.22-23.6Q/ha, Barely (34.01-27.75Q/ha), wheat (46-41.08 Q/ha)& Maize (62.5-55.5Q/ha) reduced respectively. During the key informant interviews the majority of the community perceive that, the productivity and the size of their farm land per house hold have declined through time. For example, farm land is reduced; because of population, fertility of agricultural soil and productivity is declined due to increased soil erosion, land degradation has resulted in reduced land size and agricultural production.

In Choke Mountain forest ecosystem, soil erosion is a key environmental and socio-economic problem. Topography has a strong influence on aggravating soil erosion. On the other hand, the result indicates that the implementation of NRM interventions in Choke Mountain is a key to control soil erosion and restore degraded landscapes. "The decline in soil fertility and reduced

workability of farm lands due to land degradation has led to reduction in crop production. Also, land fragmentation due to land degradation has resulted in reduced crop production. This, in turn, resulted in food insecurity, reduced income, and poverty". The reduction in agricultural productivity could be attributed to poor land management and land degradation due to soil erosion.

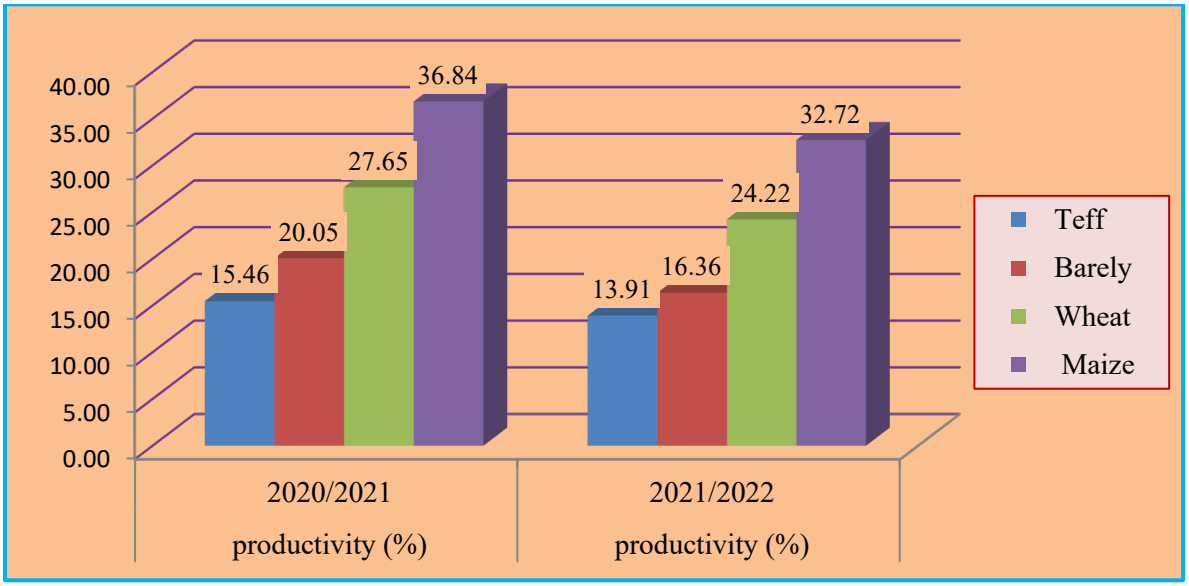

Figure 38 Six major border districts of Choke Mountain main crop productivity in %

The productivity of four main crops in the last two consecutive years (2021-2022) can be seen in the graph, Teff was reduced by 1.55%, Barley 3.69%, Wheat by 3.43% and Maize by 4.12% respectively. This clearly shows that the protected area of Choke Mountain ecosystem is shrinking and soil fertility is decreasing over time.

3.1.8. Driver and pressure for land Degradation

Drivers and pressures part Choke Mountain and its associated watersheds, located in the Blue Nile highland regions of Ethiopia, is broadly representative of many of the challenges related to land degradation. The Choke Mountain ecosystems are under threat from multiple sources, including the pressure from population growth, soil erosion, deforestation, overgrazing, and decline of soil fertility Simane et al., 2013). In turn, it has affected the livelihood of local communities through mainly reducing water availability, and livestock feed (Simane et al., 2013). To combat land degradation and restore degraded landscapes, the Ethiopian government launched a massive soil and water conservation program particularly, soil and water conservation

campaign has been implemented since 2010 to increase agricultural productivity through improved48natural resource management (Mekuria et al., 2017). The dominant agricultural practice in the Choke Mountain watersheds is crop-livestock mixed systems (Simane 2013).

Drivers: FGDS and key informants considered that population pressure and over utilization of natural resources as the main driving forces of land degradation. Road construction and poorly designed diversion ditches as driving forces of land degradation. The results from focus group discussion also confirmed that population pressure, lack of implementation of conservation measures, and poor land management, as the main driving forces of land degradation. Poor implementation of policies related to NRM, lack of awareness raising campaigns towards the implementation of natural resources management interventions and lack of rules and regulation that support the sustainable management of natural resources contributed to land degradation in the study areas.

Pressures on the natural environment FGDS and key informants, and field observation confirmed that deforestation, overgrazing, and high rate of soil erosion are the main pressures on the natural environment that lead to severe land degradation. Overgrazing as the main pressure on natural environment and aggravates soil erosion and land degradation. Similarly, deforestation and overgrazing, as the major pressures In this line, (Simane et al., 2013) indicated that soil erosion in Choke Mountain forest ecosystem is a well-recognized problem and a priority area for intervention.

3.1.9. Impacts of land degradation

The direct consequence of land degradation is declining crop yields which eventually lead to higher rate of poverty amongst the agrarian households (Wassie, 2020). More over UNCCD (2017) report tells us that Ethiopia loss about 30,000 ha of agricultural land every year due to water erosion and over 2 million hectares are degraded each year. Based on experts' opinion, about 20% of the agricultural land in Ethiopia is subject to irreversible soil productivity loss due to water erosion (Wassie, 2020). This shows that Land degradation is a significant contributor to the decline of agricultural production (Mohamed, 2020).

The country loses about $106 million (about 3% of agricultural GDP) annually through soil and nutrient loss through inappropriate use of land contributing to land degradation. Approximately, 17% of the potential agricultural Gross Domestic Product of the country is being lost because of soil degradation. Land degradation has put a substantial threat in agriculture of the country. Out of a total surface area of 112 million hectares, the estimates made in the mid-1980s showed that about 27 million hectares are significantly eroded, 14 million hectares are seriously eroded and 2 million hectares have reached the point of no return (Tsegaye, 2019).

Decline in vegetation composition drought and food insecurity are among the impacts of land degradation. Different studies have revealed that the impacts of land degradation on ecosystem services have direct impacts on human societies (Yazdani et al., 2015). Thus, the prevention of land degradation for sustaining the food security is a significant concern for mankind.

- ✓ A study indicated that soil erosion which is particularly severe in Ethiopia is the major indicator of soil loss and soil fertility decline (Haile et al., 2015).
- ✓ The positive correlation between impact of land degradation on ecosystem service and on human livelihood.
- ✓ When we see the impact of land degradation on Choke Mountain forest ecosystem, more than 5% reduction in agricultural production, more than 10% damage due to salinity, and 15% loss of agricultural production due to land degradation, etc.

3.1.10. Response taken to improve the status of land degradation

- ❖ Reducing land degradation is key to improve the livelihood of rural communities during the filed interviews the key informants said that, “We adopted the construction of terraces and bunds mainly to protect our land from soil erosion and thereby improve the fertility of soil and agricultural productivity. Also, we adopted soil and water conservation measures to harvest water for the dry season, improve water holding capacity of the soil and increase the workability of farm lands as well as enhance the effects of inorganic fertilizers in increasing crop yield”. The majority of the respondents confirmed that they implemented at least one conservation measure to control soil erosion and restore degraded landscapes
- ❖ The local communities perceive that watershed management interventions support to restore ecosystem services and improve livelihood. They are also optimistic that degraded

landscapes can be restored through the implementation of watershed management interventions, and have been contributing to the establishment of watershed management interventions on communal and private lands mainly through providing free labor. Collaboration among local communities, government, and non-governmental organizations is key to sustain the implemented watershed management interventions through the participation of women during camp ions.

- another important responses have taken to protect the land degradation status of Choke mountain forest ecosystem, is among the border of nine districts Bibugne, Enarj, Hult eju and Sedie from (2018-2022) more than 22,695.8ha of bunds construction on farm land, about 2,216.03ha gully rehabilitation and protection and 4323.88ha of land was planted by different trees for the last five years.
- In order to overcome the damage caused by land degradation and soil erosion, it was possible to carry out more than 50% of integrated soil and water conservation works and 90% soil and water conservation with tree planting works in a way that involved all sections of the society.

3.1.11. Outlooks

Land degradation has become a severe concern in Ethiopia, affecting many aspects of the population's social, economic, and political lives. It is one of the country's greatest obstacles to agricultural development and food security.

Based on the information & study conducted, there are widespread problems of land degradation and soil erosion in the mountainous area of Choke. The main evidence for this is that more than 41.9% of the area is hilly land. According to the information we have gathered, from key informants the land has been damaged by 35% sheet erosion, 25% rill erosion, flooding 15% others (agro-chemical, salinization etc.) 15% and gully erosion 10% respectively. The proof of this is that there is a problem of decreasing productivity (Q/ha). For example, Teff has decreased by 1.55%, Barely 3.69%, Wheat 3.43% & Maize by 4.12% in two years. The Amhara National Regional State established an independent office for Choke mountain ecosystem area and started work to protect since 2022, but greater attention is needed. Therefore, I believe that it is an important task to protect and take care of this very fragile ecosystem, which serves as the starting point /source/ of the water tower for the lower stream community including the Blue Nile river basin.

3.1.12. Recommendation

Land degradation is one of a serious agricultural problem that posed severe threat to current and potential food production and the livelihood of peoples in Ethiopia. The shortage of land, rapid growth of population and demand for increased food production intensified the pressure on the land and aggravated the process of land degradation. Based on the information and data gathered through interviews and field observation, I recommend the following points.

- ✓ Implement integrated soil and water conservation efforts. For example, gully rehabilitation check dam construction work.
- ✓ Implement monitoring and support systems to ensure that mining and road construction projects do not negatively impact the environment before they are put into operation.
- ✓ Encourage various non-governmental organizations to engage in rehabilitation of affected areas.
- ✓ Raising public awareness on environmental issues and land degradation
- ✓ Encourage nursery establishment for seedling raise to cover the degraded land
- ✓ The results of study also indicated that different types of natural resource management interventions were adopted in border of Choke districts, and the local communities' example on, crop and animal husbandry systems as well as natural resource considered the implemented natural resource management interventions are effective in restoring degraded landscapes and improving livelihood.
- ✓ The local communities perceived that providing training on afforestation practices, crop production, and animal husbandry systems as well as natural resource management practices could support to enhance the participation of local communities in watershed management activities.
- ✓ Designing mechanisms to enhancing the short-term benefits of natural resource management interventions is key to increase the participation of local communities as well as integrating income generating activities such as livestock fattening and beekeeping could support to sustaining watershed management interventions through generating short-term economic benefits and building a sense of ownership.

3.2. STATE AND TREND OF FOREST DEGRADATION IN CHOKE MOUNTAIN ECOSYSTEM

3.2.1. State and Trends of Forest on Katasa Forest Ecosystem

Forests are one of the vegetation biome dominantly covered by trees of different species that inhabit several biotic lives (Pistorius et al. 2017; Mekonnen et al. 2018). Land spanning more than 0.5 ha with trees higher than 5 m and a canopy cover of more than 10% can be called a forest (FAO 2010). Mountains are hotspots of biological diversity. Many mountain ecosystems have high biodiversity, in terms of species richness and degree of endemism, in comparison with adjacent lowlands (CBD, 2003; Kohler, 2014). Tropical and subtropical mountains are major centres of plant and animal species diversity. In the Ethiopian highlands, overgrazing accounts for 20% of the country's annual soil erosion (Lemlem et al., 2013), and vital plant species are disappearing from pastures mainly because of open-access grazing. Due to their habitat fragmentation, wild animal species also highly threatened. Efforts to better manage access to communal pastures can support biodiversity conservation.

The term '**forest degradation'** refers to a reduction in the capacity of a forest to provide expected goods and services (FAO 2011). **Deforestation** or forest degradation in Ethiopia takes a lead among the major problems that forest resources are encountered. Such degradations are done mainly for fuel wood and agricultural expansion.

The natural vegetation of Ethiopian Highlands has been altered and destroyed by intensive human use over millennia and now only fragments are left. Choke Mountain is one of the areas among the different topographic and climatic varied areas of Ethiopia. It is the main water sheds of Blue Nile where many springs and rainfall water flows towards Blue Nile gorge. However, due to rapid population growth and expansion of farming land, there is high rate of deforestation and soil erosion. This area is also known for its forest coverage and home of Ethiopian endemic red wolf (Belay et al. 2012 But nowadays the forest is changing into farm land.

The area is also home of many afro-alpine and sub-afro-alpine (Aserse etal, 2015) plant species. In Chokie Mountain Watershed around 85 plant species (Robe etal, 2016) are found in the area.

Mainly, KosheshilSa (Acanthus sennii), Korch (Erythrina brucei), Gimy (Euryops pinifolius), Ashengidye (Kniphofia foliosa), and Gibra (Lobelia rhynchopetalum) are endemic for northwest highlands of Ethiopia.

The major natural habitats of the choke mountain are moist moorland, montane grasslands and meadows, cliffs and rocky areas. Choke Mountain harbors more than 85 shrub and tree species. Of which, the dominant plant species are Acanthus sennii, Echinops ellendekii, Eryhrina brucei, Euryops pinifolius, Lobelia rhynchopetalum and Kniphofia foliosa. In the current study, 24 Mammalia species and 52 bird species, three amphibian species and one chameleon species were recorded. There are many unidentified mole rat and rat species in the study area. In addition to the above wild animals, 8 orders from class insect were recorded. Choke Mountain is also the home of many endemic birds. Choke, like other afro alpine mountains of Ethiopia, was the home of Ethiopian wolf which is endemic to Ethiopia. But, now a day due to habitat fragmentation and other factors, it is extinct from the area. The local peoples reported that Ethiopian wolf was extinct about 30 years ago from Choke Mountain.

Choke Mountain ranges are inhabited by nucleated settlement pattern and the land is converted in to field of strips where various cereals are grown on fragmented landscape (Habtamu, 2003). These ranges are the sources of four big rivers namely: Muga, Chemoga, Abeya and Techma and many other small tributaries of the Blue Nile (Abay) River. The area was historically known for dense forest of afroalpine vegetation such as short shrubs and grasslands with mosaic patches of Ericaceous plants which are now highly degraded with overgrazing and crop cultivation (Simane *et al*., 2013). Choke Mountain has the highest peak reaches 4052 masl the area is known to have inactive volcanic centre composed of basalt rock with a very thin cover of pyroclastic materials (Habtamu, 2003).

Plant species composition: A total of 31 plant species belonging to 19 families were identified in the study area of which only four species formed tree layer, whereas the majority vegetation are grasses, shrubs and herbaceous plants. At the family level Asteraceae is the dominant family representing 29% of the total plant family in the study area (Table: 1)

Table 11 List of plant species recorded in the study area

No.	Species name	Family name	Habit
1	*Cardamine oblique* A. Rich.	Brassicaceae	Herb
2	*Carduus nyassanus* (S. Moore) R.E. Fries	Asteraceae	Shrub
3	Carex petitiana A. Rich.	Cyperaceae	Herb
4	*Cerastium octandrum* A. Rich.	Caryophyllaceae	Herb
5	*Cineraria* sp. Sond.	Asteraceae	Herb
6	*Cyanotis barbata* D. Don	Commelinaceae	Herb
7	*Cyperus elegantulus* Steud.	Cyperaceae	Grass
8	*Echinops* sp.	Asteraceae	Shrub
9	*Epilobium stereophyllum* Fresen.	Onagraceae	Herb
10	*Erica arborea* L.	Ericaceae	Tree
11	*Euryops antinorii* (Avetta) S. Moore	Asteraceae	Herb
12	*Festuca abyssinica* Hochst. ex A. Rich.	Poaceae	Grass
13	*Hagenia Abysinica* (Bruce) Gmelin	Rosaceae	Tree
14	*Haplocarpha rueppelli* (Sch. Bip.) Beauv.	Asteraceae	Herb
15	*Hebenstretia angolensis* Rolfe	Scrophulariaceae	Herb
16	*Helichrysum citrispinum* Del.	Asteraceae	Herb
17	*Helichrysum stenopterum* DC	Asteraceae	Herb
18	*Hypericum revolutum* Vahl	Hypericaceae	Tree
19	*Kniphofia foliosa* Hochst.	Asphodilaceae	Herb
20	*Lobelia rhynchopetalum* Hemsl.	Lobeliaceae	Tree
21	*Pimpinela* sp.	Apiaceae	Herb
22	*Ranunculus stagnalis* Hochst. ex A. Rich	Ranunculaceae	Herb
23	*Rhabdotosperma scrophulariifolia* (Hochst. exA. Rich.) Hartl	Scrophulariaceae	Herb
24	*Satureja simensis* (Benth.) Briq.	Lamiaceae	Herb
25	*Satureja sp.* (Benth.) Briq.	Lamiaceae	Herb
26	Senecio farinaceus Sch Bip. ex A. Rich	Asteraceae	Herb
27	*Senecio steudelii* Sch. Bip. ex A. Rich.	Asteraceae	Herb
28	*Silene burchellii* DC.	Caryophyllaceae	Herb
29	*Subilaria monticola*		Herb
30	*Swertia lugardae* Bullock	Gentaniaceae	Herb
31	*Trifolium* sp.	Papilionaceae	Herb

Source: Aramede etal, 2014

Even if more than 31 recorded plant species are found in this ecosystem, most of the faunal and floral resources of afroalpine and sub afroalpine regions of Ethiopia are under high pressures from intensive human land use. Choke afroalpine areas are also severely threatened by the agricultural land expansion and livestock grazing which would ultimately lead to excessive soil erosion and disrupting hydrological system of the area.

Several studies showed that, livestock grazing is a powerful pressure on natural vegetation loss. Land use land cover change dynamics and influence the abundance and distribution of the animal and plant community inhabiting the afroalpine areas.

Figure 39 *Euryops antinorii* (‘Gimiy’ by local name) & *Lobelia rhynchopetalum the two most dominant plant species*

Source: field survey, 2023

Figure: 2 some dominant plant species

Vegetation status:- According to the land use land cover change analysis, the field observation and the evidence from the group discussion, the natural vegetation status of Choke Mountain ranges has been rapidly decreasing between 2013 and 2023 due to high pressure from human and livestock influence in all directions of the alpine regions.

Table 12 Forest & Shrubs of Choke Mountain forest ecosystem

Forest coverage	LULCC, 2013		LULCC, 2018		LULCC,2023	
	Ha	%	Ha	%	Ha	%
Forest	4044.95	7.9	4662.3	9.15	5201.2	10.2
Shrubs	3375.31	6.6	2620	5.14	2200.23	4.32
Total	7420.26	14.5	7282.3	14.29	7401.43	14.52

Between 1990 and 2020, Ethiopia's naturally regenerating forest cover declined by 16% (FAO, 2020). Over the past decade, its annual percentage of forest wood removal (3%) was the highest in Africa. Most of this forest clearance was carried out to facilitate agricultural uses of the land (Tolossa, etal 2017)

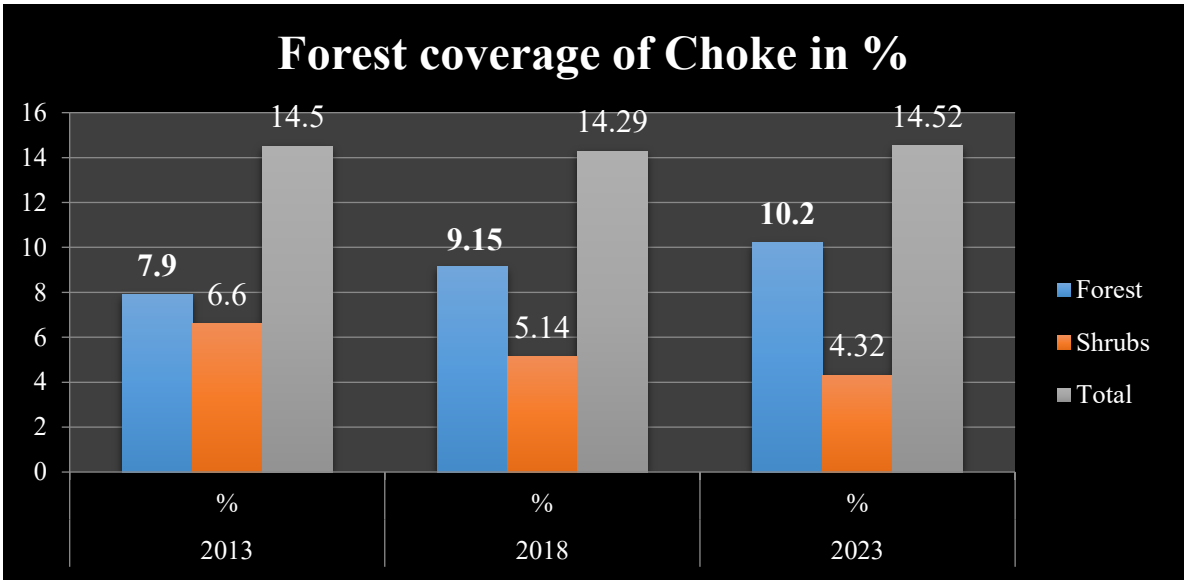

Figure 40 Forest Coverage of Choke Mountain

As tried to prove in the graph above, during the period from (2013-2018), forest land increased by 1.25%, while Shrubs land decreased by 1.46%. From (2018-2023), forest land increased by 1.05%, and Shrubs land decreased by 0.82%, and for the last 10 years from (2013-2023), forest land increased by 2.3% and Shrubs land decreased by 2.38%. Increase in population has implications for land resources as the need to produce food and the demand for settlement and

fuel wood increase in response to growing population needs. In other words, the shortage of farm land stimulated by population growth forced local community to clear forest on steep slopes, which aggravated erosion problem and soil fertility decline.

Rapid population growth of the study area resulted in expansion of a farmland and threatened the land covered with forest. Fast population growth and the consequent high pressure on resources are expected to have an adverse effect on the existing natural resources of the area. According to the ten-year land use land cover change data, the graph shows that the forest cover has increased somewhat for the last five consecutive years. This is due to the fact that the crops that can be grown in the area of Choke are limited and the terrain is not suitable for crop production. Due to the large amount of money earned from the sale of forests, farmers land has shifted from crops to Eucalyptus plantations. As a result, grass land and Shrubs land were reduced and replaced with trees. This could be the reason, natural forest is decreasing and man-made forest is increasing.

Table 13 Estimates of annual economic values of some forest ecosystem services

No.	**Forest service type**	**Values of Ethiopia's forest Ecosystems (million USD)**
1	Climate regulation	892
2	Water regulation	24
3	Water supply	32
4	Erosion control and sediment retention	980
5	Soil formation	40
6	Genetic resources	164
7	Recreation	448
8	Cultural	8
9	Nutrient recycling	3,670,000
	Total	**6,280,000**

Source: Adapted from Forum for Environent (2009)

3.2.2. Drivers and Pressure of Deforestation and Forest Degradation in Choke Mt

The major drivers of deforestation and forest degradation in Ethiopia

The major drivers of deforestation and forest degradation in Choke Mountain ecosystem are Farm land expansion, overexploitation, Population growth, settlement, which are all driven by human population growth. There are a number of challenges/problems/ constraints that are limiting the effectiveness of conservation and management of forest resources.

- **Population growth** key informants considered that population pressure and over utilization of natural resources as the main driving forces of land degradation in Choke Mountain forest ecosystem.
    - **Farm land/ agricultural/ expansion**

Farm land expansion is the most significant driver of deforestation and biodiversity loss in Ethiopia as in most other countries in Africa. An in-depth study of the drivers of deforestation was conducted for the Ethiopia's Forest Reference Level submission to the United Nations Framework Convention on Climate Change (UNFCCC, 2016). This indicates that 53% of the deforestation that takes place is conversion to agriculture and grassland. In Choke Mountain forest ecosystem, there is a rapid change of land use conversion though multiple factors. Such as land holding per house hold is very small, rapid population growth and expansion unemployment rate are the major factors.

Settlement expansion

Nowadays, the most uncontrolled changes in forest land covers are resulting from demographic factors such as population growth in rural settlement. Change in population size affects the fact the resource of the environment particularly, in rural areas where livelihood of the people depends on the natural resources. In Ethiopia, settlements expansion through population growth is identified as one of the major drivers of vegetation or forest cover change. According to Moges et al., (2020) built up lands in many places are more likely to share large agricultural land in the future. Human actions are altering the natural environment and its resources at unprecedented magnitudes and spatial scales. Cultivated land and built up /settlement/ areas have been drastically increased with concomitant shrinkage in Choke to the area coverage of shrubs land, forests and grasslands after the dramatic expansion of rural settlement in four direction of the ecosystem.

- **Overgrazing:** Districts bordering the mountainous area of Choke are causing a lot of damage to the forest by expanding grazing. The proof of this and as we confirmed in the field, we saw a large number of animals in one place.

Major pressures of forest degradation

- **Fuel wood and Charcoal production.**

In Ethiopia majority of the rural population relies on biomass energy sources for every energy necessities. Fuel wood accounts for about 78 % of the total energy needs, whereas animal dung and crop residue share 12 % and 10%, respectively. Almost all of the firewood is collected from natural forests and few of them from homestead trees (Bekere and Megerssa, 2020).

Although use of fuel wood has remained a very important source of energy for the household in Choke mountain forest ecosystem, it has its own contribution to forest degradation. In the area, fuel wood is mainly used for cooking, heating, and lighting through plantation and natural forest deforestation.

3.2.3. Impact of Deforestation & Forest Degradation on Choke Mountain

- **Decreasing of in water bodies**

Trees extract groundwater through their roots and release it into the atmosphere. When part of a forest is removed, the trees no longer evaporate away this water, resulting in a much drier climate which clearly visible in Ethiopia evidenced by the current frequent drought. Deforestation and forest degradation are decreases the content of water in the soil and groundwater as well as atmospheric moisture. Forest improve the recharge of underground bed or layer yielding ground water and springs in some locales; however, deforestation and forest degradation are a major source of layer yielding ground water and springs depletion on most locales (Wassie, 2020). In fact in the present situation, the artificial Eucalyptus forest is increasing from time to time in the Choke Mountain ecosystem, but the natural forest is decreasing over time. However, the nature of Eucalyptus planted trees has the ability to absorb groundwater, so it has reduced the amount of water in the area.

- **Increase Rate of Soil Erosion**

Trees and natural vegetation help to hold soil in place. When they are removed, the nutrient-rich topsoil erodes, and is easily washed away in heavy rains or blown away by wind. The area is more than 50% mountainous and has a high soil erosion problem. In order to solve this problem of soil erosion, integrated soil and water conservation work, as well as decreasing the spread of man-made trees and increasing natural forest, etc., should be done.

- **Increase Loss of Habitat**

Deforestation and forest degradation are resulting land degradation is the global threats for many wild animals with its natural habitat and affects the wild animal's life style in their preferred habitats**.** As a result**,** forests are some of the most diverse ecosystems on Earth, providing homes to trees, plants, animals, insects, microorganisms and carbon-sequestering fungi. Deforestation and forest degradation fragments and degrades this habitat, reducing or destroying its capacity to support other species.

Another consequence of deforestation & forest degradation was the loss of biodiversity. Changes in environmental conditions and natural setting of the land and its cover greatly affected the life cycle and the survival of various plants and animals. FGDs and key informants said that some species of plants and animals previously found in Choke Mountainous area threatened species like Ameja, Koso and Aseta from plants and Lion & Tiger from animals mainly as a result of unregulated deforestation and farm land expansion many people in the area believed that the diversity of both plants and animals was declined over time. Forest products are very essential in the daily life of the inhabitants for border of Choke mountain forest ecosystem, since most of them depend on forest products for construction, cooking, heating, and light. However, continuous deforestation led to the scarcity of forest products.

3.2.4. Response to Reverse the Deforestation & Forest Degradation on Choke Mountain

- **Federal Forest Policy**

The government of Ethiopia has formulated forest development, conservation and utilization policy and passed legislation in 2007. The objective of the policy is to meet public demand in forest products and foster the contribution of forests in enhancing the economy of the country through appropriately conserving and developing forest resources. The policy provisions are designed, among others, to encourage the development of forests by individuals, organizations and government and the designation of protected forests and productive forests to be administered in accordance with laws to be enacted for each. The policy further establishes that forestry research is to be expanded focusing on growing native tree species and their utilization as well as identifying useful exotic species and growing seedlings of such trees for wide dissemination.

- **Forest Legislations**

The Federal Proclamation (542/2007) recognizes two types of forest ownerships: state and private. According to this law, state forests are any protected or productive forests owned by the federal or a regional state. Private forests are forests other than state forests that are developed by any private person and include forests developed by members of a peasant association or by any association organized by private individuals, investors, and governmental and NGOs. In Amara Region, establishment of forestry agency, which is responsible for managing forest resource, is in place recently. Furthermore, most of the regions have issued their own land administration and environmental protection proclamations. All these regional legal documents in one way or the other support the conservation, development and sustainable use of forest resources.

3.2.5. Outlook

Ethiopian forests are already under threat today and the country's growing population will require more wood fuel and food in the future. These demands, in turn, could significantly accelerate deforestation and forest degradation. Projections in the CRGE Strategy indicate that without action to change the country's development path, 90 thousand km2 (56% of total forest area) might be deforested between 2010 and 2030. Over the same period, annual wood fuel consumption could rise by 65%. While protecting the existing 17.35 million hectares of forest, Ethiopia also intends to undertake large-scale afforestation and reforestation to increase total forest cover to 30 per cent by 2030. Under the BAU scenario, the pressure on forests and related increased rate of deforestation and forest degradation will ultimately deplete the natural resource base and negatively affect the performance of the economy in the long-term.

In the bordering districts around Choke Mountain, the cover of sea trees is increasing significantly, but the natural forest is also being cut down and converted into agricultural and grazing land. Therefore, if it continues like this, the natural forest of Choke and its surroundings will be severely depleted.

3.3. State and trend of Biodiversity

3.3.1. **State and Trend of Biodiversity Degradation In Choke Mountain**

Biodiversity is the variety of life on earth; it includes all organisms, species and populations, the genetic variation among these and their complex assemblages of communities and ecosystems.

The level of biodiversity are commonly classified as

- **Genetic diversity**: - is all the different genes contained in all the living species, including individual plants, animals, fungi and microorganisms.
- **Spices diversity**: - is all the different species as well as the differences within and between different species.
- Ecosystem diversity:- is all the different habitats, biological communities and ecological process, as well as variation within individual ecosystems.

Ethiopia is endowed with ten ecosystems, 18 major and 49 minor agro-ecological zones that are inhabited by amazingly great diversity of animal, plant, and microbial genetic resources that make the country one of the biodiversity hotspots of the world. The country possesses an estimated number of 6000 species of higher plants of which 10% are endemic. There are 75 breeds of cattle, sheep, goat, and equines, six species of honey bees, 284 species of wild mammals, 861 species of birds, 201 species of reptiles, 200 species of fish, 63 species of amphibians and 1,225 species of arthropods. Of the wild faunal resources; 29 mammal, 18 bird, 10 reptile, 40 fish, 25 amphibian and seven arthropod species are endemic to the country (EBI, 2022).

Biodiversity in the mountains is one of the most valuable natural resources for humankind (Stone, 1992). The montane and alpine zone together covers nearly 5% of the global terrestrial land area (Korner, 2002). Its conservation provides benefits at various levels-local, national and global. However, it is under imminent threat of environmental degradation and loss. Ethiopia is rich in natural resources, including a vast species of wildlife. Because of its species' richness, endemism and ecosystem diversity, under the Convention on Biological Diversity Ethiopia is categorized as one of the 20's like- minded mega-diverse country.

A combined set of attributes make Ethiopia rich biologically. These include variability in climate, topography, diversity in ecosystems and habitats ranging from mountain ranges (Ras dashen Mountain which is 4620m above sea level) to lowland arid areas (Dallol which is 126m below sea level). Each of these ecosystems requires different conservation priorities and measures. From the total of 320 mammals found in Ethiopia, 55 are endemic to the country (Afework Bekele), 64% of which are specific highland forms. There are about 63 globally recognized endemic bird sites in Ethiopia, mostly in the central highlands, the southern highlands, and the Juba-Sheballe Valley.

According to the report from the Ethiopian Biodiversity Institute (EBI), Ethiopia is endowed with a large variety of native plant and animal species within its diverse climate and topography (EBI 2014). Currently, around 320 species of mammals including 39 endemics, 918 species birds with 19 endemics, 240 species reptiles (16 endemics), 71 species amphibians (30 endemics) and 172species freshwater fishes with 38 endemics and more than 1225 species of insects are scientifically recorded in Ethiopia (EBI 2014).

The Choke Mountains is considered as one of the Ethiopian Biodiversity Hot Spot. The Biodiversity in this geographic region is highly threatened, the vegetation cover and the soil are degraded and the fertility is depleted today grazing land scarcity and reducing of water quality because of long history of human settlement and the ever-mounting population pressure. The status of Choke Mountain, North Western Ethiopia 126 Biological Diversity and Conservation been done on Ethiopian amphibians, there are about 73 species known. Out of this 30 species are endemic to the country and most of them are inhabited with high lands (Abeje K 2014).

Choke is a very interesting and beautiful natural character that satisfies the spirit that nature has poured her beauty without losing its natural appearance. There are 16 animal species (Robe etal, 2016) found in Choke Mountain and its Environs such as Leopard (Panthera pardus), Golden/Common Jackal (Canis aureus), Common Bush Back (Tragelaphus scriptus), AbyssiniaColobus, Common Duiker, Spotted Hyena (Crocuta crocuta), Anubis Baboon (Papio anubis), Bush Pig (Potamochoerus porcus), and Common Duiker (Sylvicapra grimmia).

Due to the abundance of biodiversity in the area of Choke, there are many options for various studies and researches, and there are many types of indigenous plants in the area. Choke area is a natural area with more than 85 plant species. The area mainly embraces the flora of the Afro-alpine ecosystem, among which are Aseta, Amja, Ashgedye, Jibara, Aydagne, Gmyi, Tsed, Kosona and Kosheshle. There are also more than 16 species of mammals and more than 41 species of birds. Like: - leopard, Golden Jackal,common bushbuck, Abyssinian colobus common Duiker, Hyena Baboon and Bushpi are among mammals. Among the places of interest in

Figure 41 vegetation coverage around Choke Mountain

Source: Taken from research, 2014

Table 14 Mammals recorded from Choke Mountain

No.	Common Name	Scientific name
1	Abyssinian Black And White Colobus	Colombus guereza
2	Anubis Baboon	Papio Anubis
3	Ardvark	Orycteropus afer
4	Bat	Different bat sp.
5	Black Back Jackel	Canis mesomelas
6	Bush Pig	Potamochoerus laryatus
7	Caracal	Caracal caracal
8	Common Bushbuck	Tragelaphus scriptus
9	Common Duiker	Sylvicapra grimmia
10	Common Jackal	Canis aureus
11	Egyptian Mongoose	Herpestes ichneumon
12	Hare	Not identified
13	Honey Bagger	Mellivora capensis
14	Klipspringer	Oreotragus oreotragus
15	Leopard	Panthera pardus
16	Mole Rat	Tachyorcyte splendon
17	Porcupine	Hysrix cristata
18	Rat	Different rat sp.
19	Rock Hyrax	Procabia bruceipo
20	Serval	Cat Leptailerus serval
21	Skung	Ictonyx striatus
22	Spotted Hyena	Crocuta crocuta

23	Stripped Hyena	Hyaena hyaena
24	Vervet Monkey	Cercopithecus aethiop

Source: Abeje Kassie Assessment of the wildlife and ecosystem status of Choke Mountain

Table 15 Birds recorded from Choke Mountain

No.	Cmmon Name	Scientific Name
1	Abyssinian Long claw	Macronyx flavisollis*
2	Augur buzzard	Buteo rufofuscus
3	Baglafecht weaver	Ploceus baglafecht
4	Black kite	Milvus migrans
5	Black roughwing bulbul	Psalidoprocne holomelaena
6	Black-winged Lovebird	Agapornis taranta
7	Blue-breasted bee eater	Merops variegarus
8	Brown Capped weaver	Ploceus insignis
9	Brown-rumpped seedeater	Serinus tristriatus
10	Cap rook	Corvus capensis
11	Cattle egret	Bubulcus ibis
12	Cormorant	Phalacrocorax sp.
13	Crested Lark	Galerida cristata
14	Dusky turtle-cove	Streptopelia lugens
15	Egyptian goose	Alopchen aegyptiaca
16	Egyptian Vulture	Neophron percnopterus
17	Erckel's Francilin	Francolinus erckelii
18	Ethiopian Siskin	Serinus nigriceps*
19	Fan-tailed Raven	Corvus rhipidurus
20	Great Spotted Eagle	Clanga clanga
21	Hammerkop Scopus	umbretta
22	Harwood's Francolin	Francolinus harwoodi*
23	Hooded vulture	Necrosyrtus monachus
24	Lammergeyer	Gypaetus barbatus
25	Moorland chat	Cercomela sordid
26	Nyanzna swift	Apus nianse
27	Parasitic weaver	Anomalospiza imberbis
28	Pied crow	Corvus albus
29	Ring-necked dove	Streptopelia capicola
30	Rüeppell´s chat	Myrmecocichla melaena*
31	Rueppell's Robin-chat	Cossypha semirufa
32	Ruppel's long-tailed starling	Lamptornis purpuropterus
33	Ruppel's vulture Gyps	ruppellii
34	Slender-billed starling	Onychognatus tenuirostris
35	Southern banded snake eagle	Circaetus fasciolatus
36	Speckled pigeon	Columba guinea
37	Splendid Glossy Starling	Lamprotornis splendidus
38	Spot-breasted Lapwing	Vanellus melanocephalus*

39	Streaky seedeater	Serinus striolatus
40	Striped swallow	Herundo daurica
41	Swainson's sparrow	Passer swainsonii
42	Tacaz sunbird	Nectarina tacazze
43	Tawny eagle	Aquila rapax
44	Thick billed Raven	Corvus crassirostris
45	Trilling Cisticola	Cisticola woosnami
46	Wattled Ibis	Bostrychia carunculata**
47	White backed vulture	Gyps bengalensis
48	White-Billed Starling	Onychognathus albirostris*
49	White collared pigeon	Columvba albitorques**
50	White fronted bee eater	Merops albicollis
51	Woolly necked stork	Ciconia episcopus
52	Yellow vented bulbul	Pyconotus barbatus
*Endemic ** Near endemi		

3.3.2. DRIVERS AND PRESSURES OF CHOKE MOUNTAIN FOREST ECOSYSTEM

Choke Mountains has suffered huge biodiversity crisis due to uncontrolled anthropogenic resource exploitation and land cover change currently, problems of habitat loss and fragmentation, resource competition by grazing ungulates, are major threat to rodents. The major drivers of biodiversity loss are:-

- **Demographic change**

Population growth is directly correlated with increase in resource consumption. Uncontrolled population growth puts undue pressures on all natural resources of the country. At present, Ethiopia's population has reached to 83.4 million. It has increased over time and 73.8 million in 2007, and is expected to reach 130 million by 2020 (CSA, 2011). The population increase causes expansion and intensification of land use, overutilization of biological resources and exploitation of marginal lands, and the breakdown of traditional resource-management systems. As the result, it is putting undue pressures on all ecosystems and biodiversity of Choke mountain ecosystem.

- **Poverty**

Poverty, particularly in situations where people depend directly upon consumption of biodiversity or other natural resources for survival, is one of the causes of biodiversity loss. Poverty prevents people and nations from assuming long-term economic and environmental

attitudes. There exists a vicious circle of poverty, resource degradation and further impoverishment in different parts of Ethiopia. Poor farmers, fishermen, pastoralists and other users extract whatever they can from the environment to support their families.

- **Lack of awareness**

Contribution of biodiversity and ecosystem services from PAs, forest reserves and wetlands are undervalued, resulting in using the resources in ways that undermine or degrade the provision of such services. Decision makers and the public often influence biodiversity through their actions as a result of lack of awareness on biodiversity values, and there is a lack of continuous information and communication programmes to raise awareness on biodiversity and its values. Biodiversity issues are also not well mainstreamed into the formal education system. Promotion and appreciation for community knowledge on biodiversity, its local uses and management which can also be used as an informal education and awareness means need to be strengthened.
In addition, though there are several stakeholders (institutions, researchers, policy makers and public) working on biodiversity conservation and sustainable utilization, they fail to make tangible impact on minimizing biodiversity loss as a result of low level of awareness to local community.

The major pressures of biodiversity loss of Choke are:-

- ✓ **Habitat conversion**

Conversion of natural forests, grass lands and shrubs land into farm land and settlement are some of the threats to biodiversity of Choke Mountain forest ecosystem. Land use change results in the loss of nearly all species of fauna and flora on-site, and leads to increasing fragmentation of the remaining ecosystems. The continues expansion of farm land and settlement in the ecosystem between years 2013 and 2023 was significant. As a result of this, significant changes of forests and grass lands have been converted into agricultural crop lands. So, the combined mid- and long term negative impacts of land use land cover change include degradation and shrinkage of natural ecosystems, loss of biodiversity and eventual loss of ecosystem services.

- ✓ **Unsustainable utilization**

Unsustainable utilization (over grazing/browsing, harvesting, and hunting) of biological resources is a major threat to biodiversity and ecosystems in Choke. For example, uncontrolled use flora species along with other factors such as over grazing and deforestation have threatened

like Astea and koso trees. Similarly, over harvesting threatens timber tree species and medicinal plants species. Browsing by livestock in many ecosystems, including rangelands has also contributed to the degradation (decreased soil cover, increased erosion, decreased quality and productivity of resources, reduction or elimination of the natural regeneration of plant species) of rangelands and forest ecosystems. The consequence of these impacts includes ecological disturbance, loss of species and ecosystem services; thereby affecting livelihoods of the local communities.

- ✓ **Invasive species**

Invasive species cause biodiversity loss by competing with native species for feed and habitat and altering the physical environment in ways that exclude native species. So far, close to 35 invasive weed species are identified in Ethiopia, and they are posing negative impacts on native biodiversity, agricultural lands, rangelands, national parks, water ways, lakes, rivers, power dams, road sides and urban green spaces with huge economic as well as social consequences.

- ✓ **Climate change**

Climate change has caused adverse ecological, economic and social impacts in the country. One of the impacts is reduction in the length of growing seasons that has resulted in the loss of many long duration varieties as well as force large areas of marginal agriculture out of production.

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

- ➢ **Biodiversity and its threats in Ethiopia**

Ethiopia still has a rich diversity important to the world in both domesticated and wild plant and animal species that occur in variable and unique micro and macro-ecosystems (NBSAP, 2005). These rich biodiversity of the country is under serious threat from deforestation, land degradation, overexploitation, overgrazing, habitat loss and invasive species (Demel Teketay, 2001). In most cases, the major destructive factor of plant diversity is deforestation caused by agricultural expansion and fuel wood scavenging (Ababu Anage, 2009). This could be probably due to an increased human population and their encroachments on natural habitats of every ecosystems on which they depend.

Biodiversity loss has many consequences, not only for the environment, but also for human beings at the economic and health level.

- ✓ **Biodiversity loss or disappearance of biological diversity,** understood as the variety of living things that inhabit the planet, its different levels of biological organization and their respective genetic variability, as well as the natural patterns present in ecosystems. In mid-2019, the United Nations (UN), in collaboration with IPBES, presented an ambitious report on biodiversity warning that out of a total of eight million, one million species are in danger of extinction. Looking at resent assessment by international biodiversity study in 2009, more than one third of species are threatened with extinction.
  According to international union for conservation of nature (IUCN), 2009 of 47,677 red lists of threatened species, 17291 are deemed to be at risk.

- ✓ Displaced or migration of animal species

The alteration and destruction of habitats puts many of species in danger of extinction.eg

- ✓ Threat to human beings

Biodiversity loss endangers human well-being by affecting soil and water, which are fundamental to food production.

- ✓ Increase in CO_2 emissions

The capacity of forests and oceans to absorb CO_2 decreases if their ecosystems are adversely affected. Direct effects include those arising from increased temperature and increased CO2 levels associated with global climate change (Dawson et al. 2011). Climate is an integral part of ecosystem functioning and human health is impacted directly and indirectly by results of climatic conditions upon terrestrial and marine ecosystems. Climate change poses unknown fear and challenge to biodiversity conservation in the 21st century. There is urgent need of mapping of biodiversity in various environments, inventory, monitoring of biodiversity, and global data sharing.

- ✓ The overexploitation of natural resources, that is, their consumption at a speed greater than that of their natural regeneration, has an obvious impact on the planet's flora and fauna.

3.3.4. Responses to Biodiversity Degradation at National Level

National Policy on Biodiversity Conservation and Research (1998)

The mandate of then Institute of Biodiversity conservation and Research (now Ethiopian Biodiversity Institute) is to undertake conservation and promote development and sustainable utilization of the country's biological resources, namely: plants, animals and microbial genetic resources as well as associated community knowledge and the ecosystems. On the basis of national legislation, the institute has the responsibility and duty to implement international conventions, agreements and obligations on biodiversity to which Ethiopia is a party.

National Biodiversity Strategy and Action Plan (IBC, 2005)

The National Biodiversity Conservation and Research Policy (1998) provide guidelines for conservation, development and sustainable use of biodiversity. The policy objectives are ensuring that genetic resources and essential ecosystems of the country are conserved, developed and sustainably used, asserting national sovereignty over genetic resources, enriching the country's biological resources through restoration, integrating biodiversity conservation with sectoral and cross-sectoral strategies and programmes, recognizing and protecting community knowledge, ensuring that the local communities share benefits arising from the use of genetic resources and community knowledge and promoting regional and international cooperation.

- **Putting the laws in place**

The Convention on Biological Diversity (CBD, 1992), and the Nagoya Protocol (NP) on Access and Benefit Sharing (ABS, 2010, 2014) paved the way for Ethiopia's active involvement and action in the international and national movement on biodiversity.

The country is a party to both international treaties, and has put in place institutional and legal frameworks, among others, to facilitate access and ensure fair and equitable benefit sharing of genetic resources and traditional knowledge.

- **Achieving the SDGs**

The importance of the ABS mechanism is not only embodied in the convention and protocol but also in the realization of the Sustainable Development Goals (SDGs), including target 6 of SDG 15: "Ensure fair and equitable sharing of the benefits arising from the utilization of Genetic Resources and promote appropriate access to such resources".

At Region and border of districts

To reverse the degradation of biodiversity in Choke Mountain, many scholars and some university institutions like D/Markos and Bahir dar those conducted findings about the rehabilitation/ conservation of natural resources. In Sinan woreda was established new office in 2014 to conserve and manage the ecosystem by proposed plan through involving community participation. With the integration of 6 districts more than 6248.3 ha of vegetation were protected by this new office. But still a great attention is required, to protect biodiversity loss, better promotion with practical conservation practices, holistic based management approaches and conservation and integration should be implemented throughout the whole resource in Choke mountain forest ecosystem.

3.3.5. Outlook

Biodiversity provides numerous ecosystem services that are crucial to human well-being at present and in the future.

Human activities are disturbing both the structure and functions of ecosystems and altering native biodiversity. Such disturbances reduce the abundance of some organisms, cause population growth in others, modify the interactions among organisms, and alter the interactions between organisms and their physical and chemical environments. According to the East Shoa Zone EFCC Authority biodiversity team template, 2019, the rapid loss of species we are seeing today is estimated to be between 1000 and 10000 times higher than the natural extinction rate. As experts calculated that, between 0.01 and 0.1% of all species will continue to become extinct each year if we carry on with business as usual scenario.

3.3.6. Recommendation

There are a numbers of initiatives aimed at enhancing sustainable development and promoting beneficial conservation of biodiversity in Ethiopia. But their implementations are under problem. So to protect biodiversity species, the following are recommendations are important.

1. Promoting to increase the number, size and connectivity of protected areas both at land and see level.
2. Increase focus on the implementations of multilateral environmental agreements related to biodiversity
3. Increasing, communication, education and public awareness programs related to biodiversity with an aim to related biodiversity to people and their livelihoods

4. Identifying and creating opportunities for rural enterprises based on biodiversity such as eco-tourism
5. Providing important economic and social benefits that provide local communities and incentives for habitat protection
6. Identifying of options for sharing the benefits of conservation and sustainable use with local communities and stockholders.

3.4 State and Trends of Atmosphere

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

Climate

Climate is the average weather in a place over many years typically averaged over 30 years. According to (IPCC,2014) Annex II, Climate defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years.

Climate change

Any systematic change in the long-term statistics of climate variables such as temperature, precipitation, pressure, or wind can be described as climate change. Accordingly, for this fact sheet we use 31 years gridded meteorological data of rainfall, maximum and minimum temperature and 28 years station observatory data for rainfall we use excel for data analysis and R-studio for drought analysis. Gridded meteorological and observatory data for Choke mountainous forest ecosystem were received from EMI of Addis Ababa of Ethiopia. Based on the available data, state and trend of rainfall, maximum and minimum temperature and drought were analyzed. FGD was carried out across four districts such as Dengole, Tacheber, Tachbbe and.

Figure 42 FGD participants For Choke forest ecosystem

State and Trend of Rainfall for Choke Mountainous Forest

Choke mountainous forest ecosystem found in the East Gojam Zone Amhara region of Ethiopia, bordering with nine districts. It has three agro ecological zones such as Dega 44.55 %, Woyinadega 45.77% and Wurch 9.66 %.

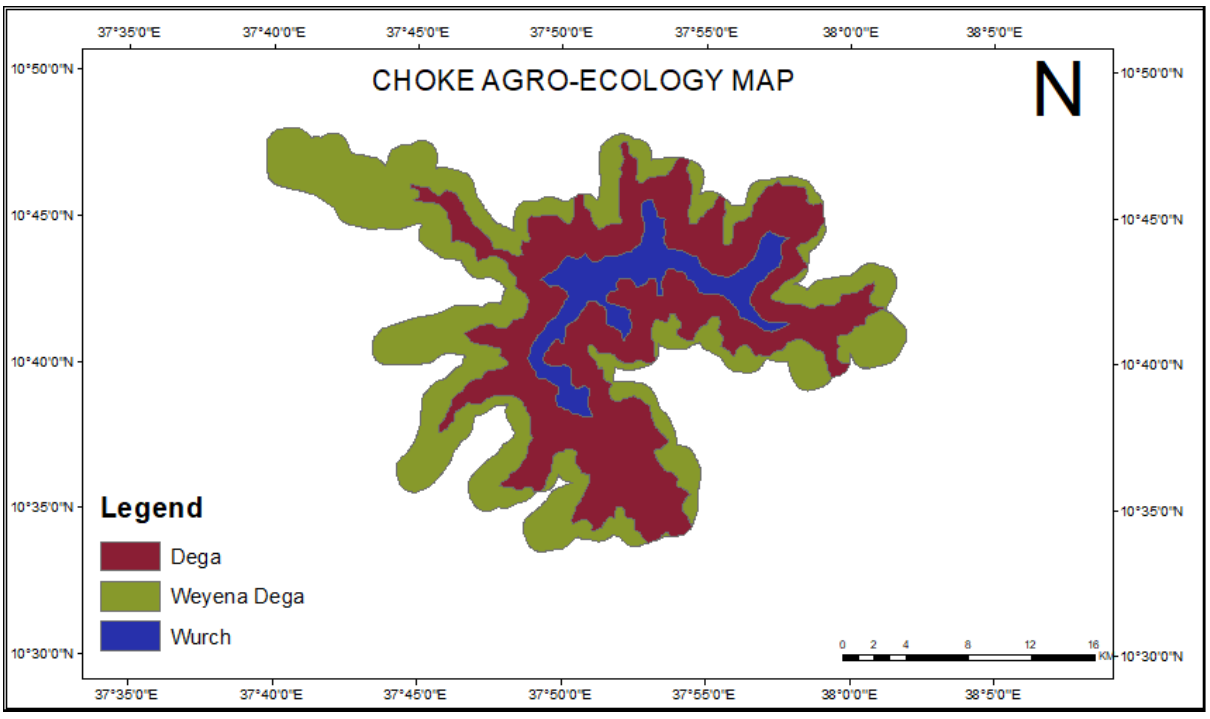

Figure 43 Agro climatic Zone of Choke mountain

According to NMI Ethiopia has three seasons Kiremt, Belg and Bega. Kiremt season which covers from June up to September, Belg season starting from February up to May and Bega which is begging from October up to January. This season influenced by different global and regional rain-bearing factors, such as geographical location and topographic variation. ITCZ, Tropical Easterly Jet (TEJ), Atlantic Ocean and southwest Indian Ocean anticyclone, East African Low Level Jet (EALLJ) or Somali Jet and ENSO are the main features that affect *Kiremt* rain. Particularly ITCZ, Subtropical Westerly Jet (SWJ) stream, Arabian High, the frequency of tropical cyclones over the southwest Indian Ocean and ENSO are affects the global and regional weather features that affect the Belg rain (Dawit, 2010).

Rainfall in the Western part of the country that covers from Southwest to Northwest and has a mono modal rainfall pattern (Februry-November But the rainy period ranges are varied, if we go through southwest to northwest. For the Northwestern part of Ethiopia excess/deficit rainfall are associated with negative/positive height anomalies over Indian Ocean. Regarding the Highs over Atlantic Ocean, for Northwest, west and central regions a strong/weak Azores high (or a positive/negative NAO) is associated with excess/deficit rainfall.

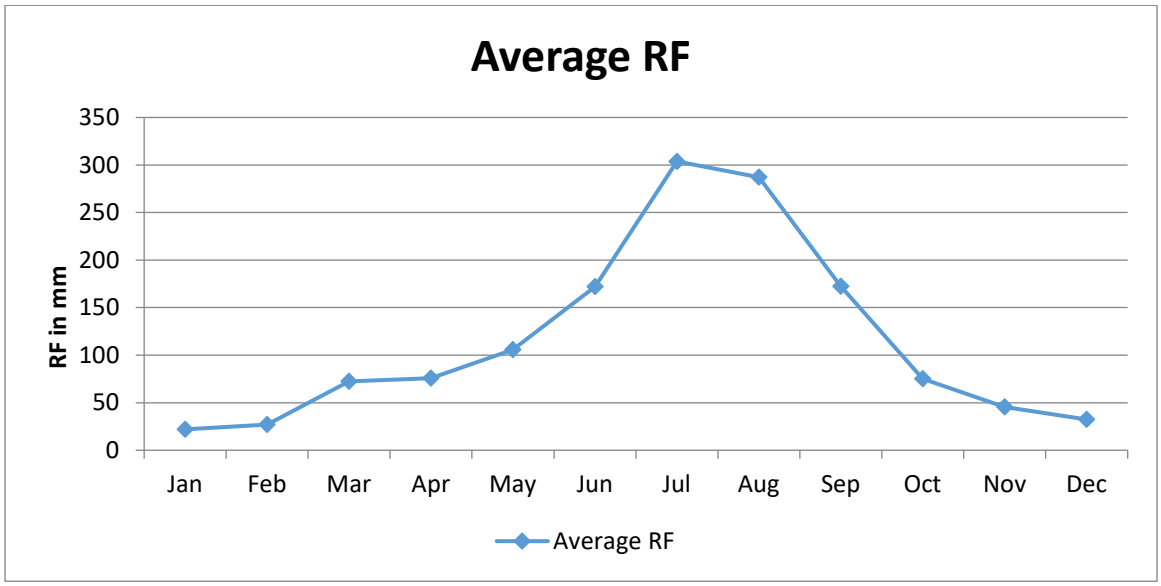

Figure 44 Choke Average Monthly rainfall from 1990-2018

From figure 2 we can see that the highest average monthly sum of rainfall was recorded during July, it was reached around 303.7 mm.

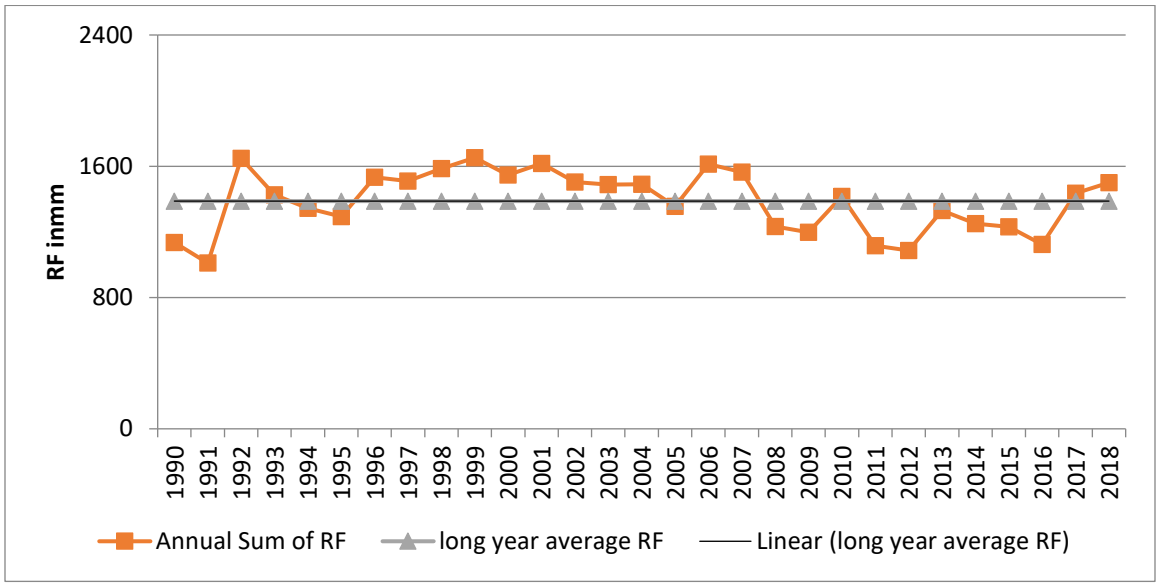

Figure 45 **Choke annual sum of Rainfall from 1990- 2018**

For all regions except for the northwest, southwest, a strong EALLJ is associated with excess rainfall whereas a weaker jet is associated with deficit rainfall.

Figure 3 shows that the amount of annual sum of rainfall was highly variable from year to year. The highest Rainfall was recorded around 1649 mm in 1992 and the lowest rainfall was recorded in 1991 which was around 1010.1mm. From the available data, long year annual average rainfall was 1387.7 mm. During 1990, 1991, 1994, 1995, 2005, 2008, 2009, 2011, 2012, 2013, 2014, 2015 and 2016 rainfall was recorded below the long-year annual average.

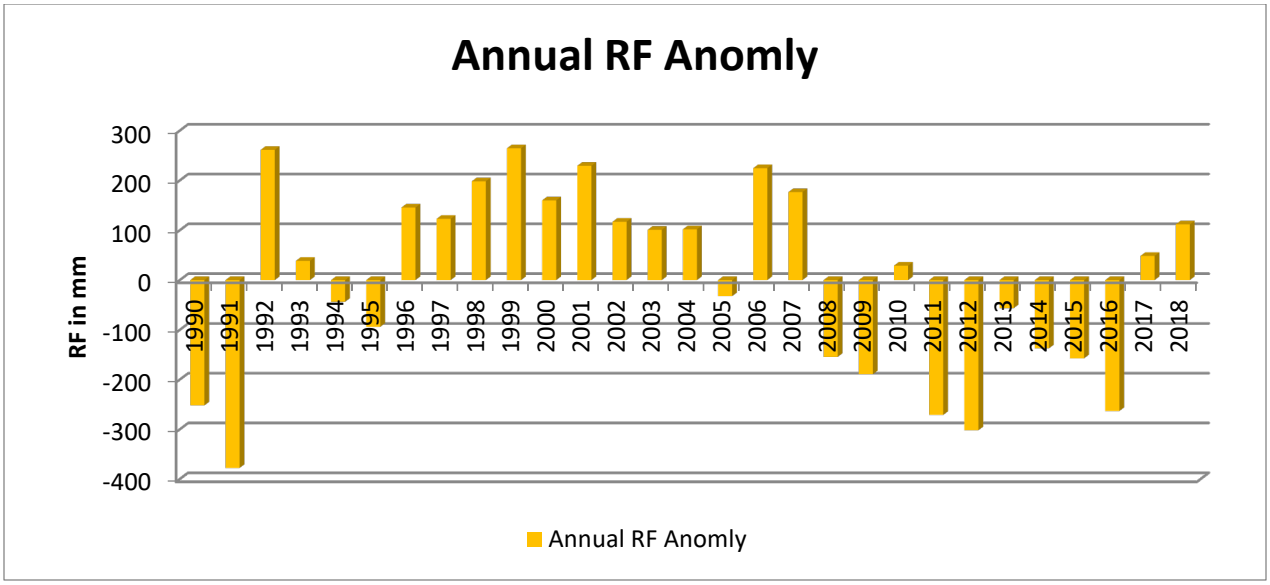

Figure 46 Choke Annual Rainfall Anomaly from 1990-2018

The peak annual negative and positive rainfall anomaly was recorded around -377.6 in 1991 and 261.3 in 1992 respectively. starting from 1996 up to 2007 rainfall was fall above expected except 2005 while from 2008 up to 2016 rain was fall below from anticipated except 2010.

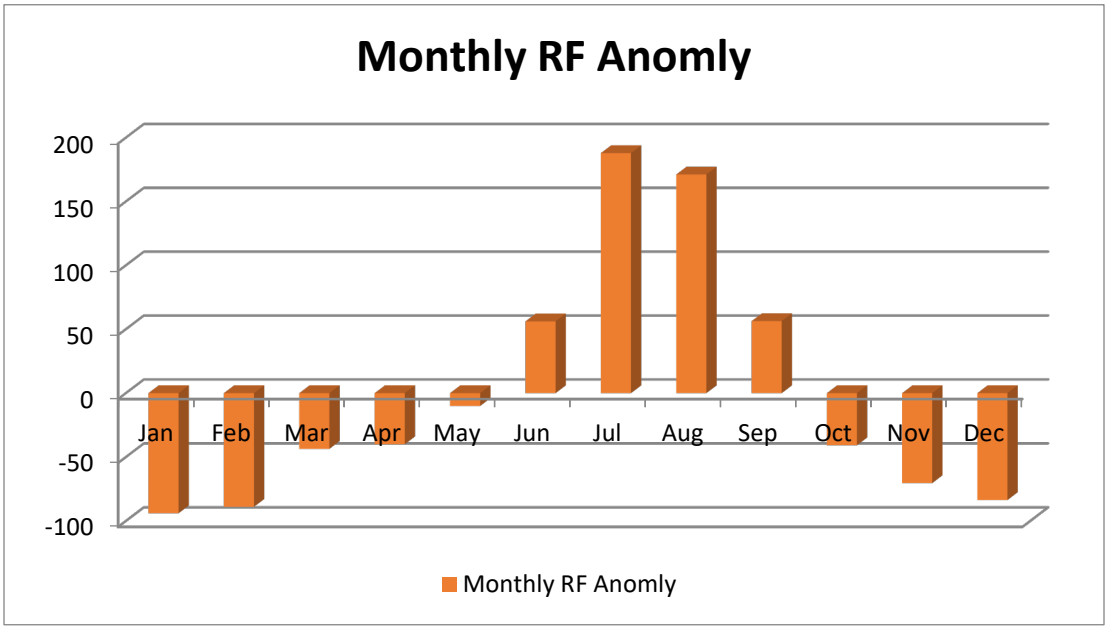

Figure 47 Choke Monthly Rainfall Anomaly from 1988-2018

The highest negative anomaly was -93.3 during January which indicate that in these years the average rainfall received was far below the reference normal. On the other hand, the highest positive rainfall

anomaly was recorded during July which is 454.6 mm above the reference normal as illustrated in Figure below. The positive rainfall anomaly was recorded in June up to September months. The positive sign was an implication that the monthly averages were higher than the 30-year normal. On the other hand, all the other six months have a negative anomaly which means the monthly average rainfall was recorded lower than the 30-year average normal.

State and trend of Temperature for the Choke Mountainous Forest Ecosystem

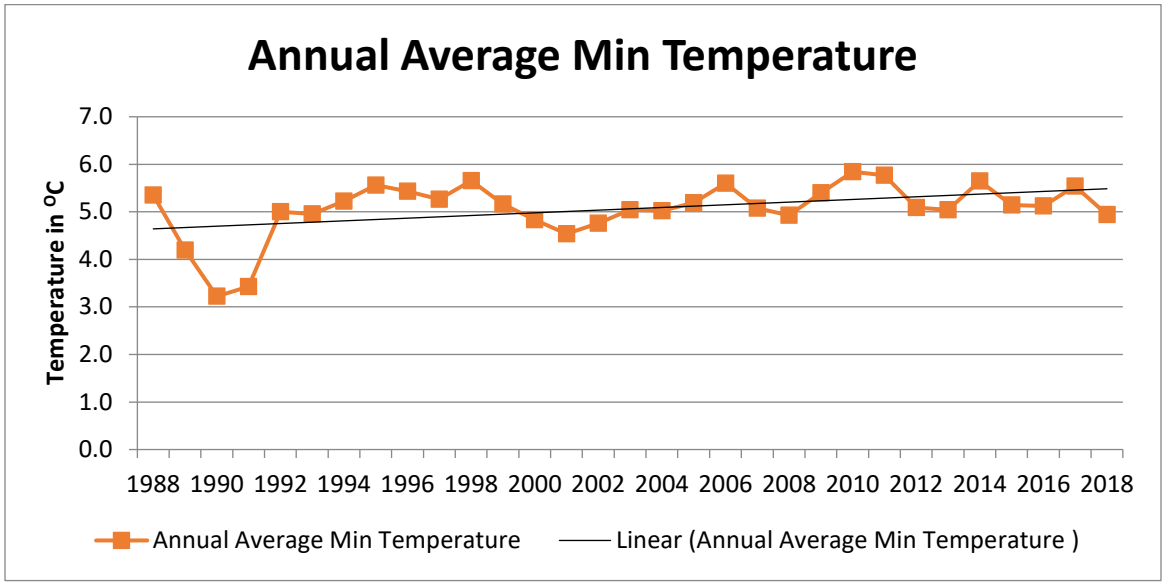

Figure 48 Choke Average Annual Minimum Temperature from 1988-2018

From figure .6 we can see that the lowest annual minimum temperature was 3.2 °C recorded in 1990 and peak value was 5.8 °C recorded in 2010.

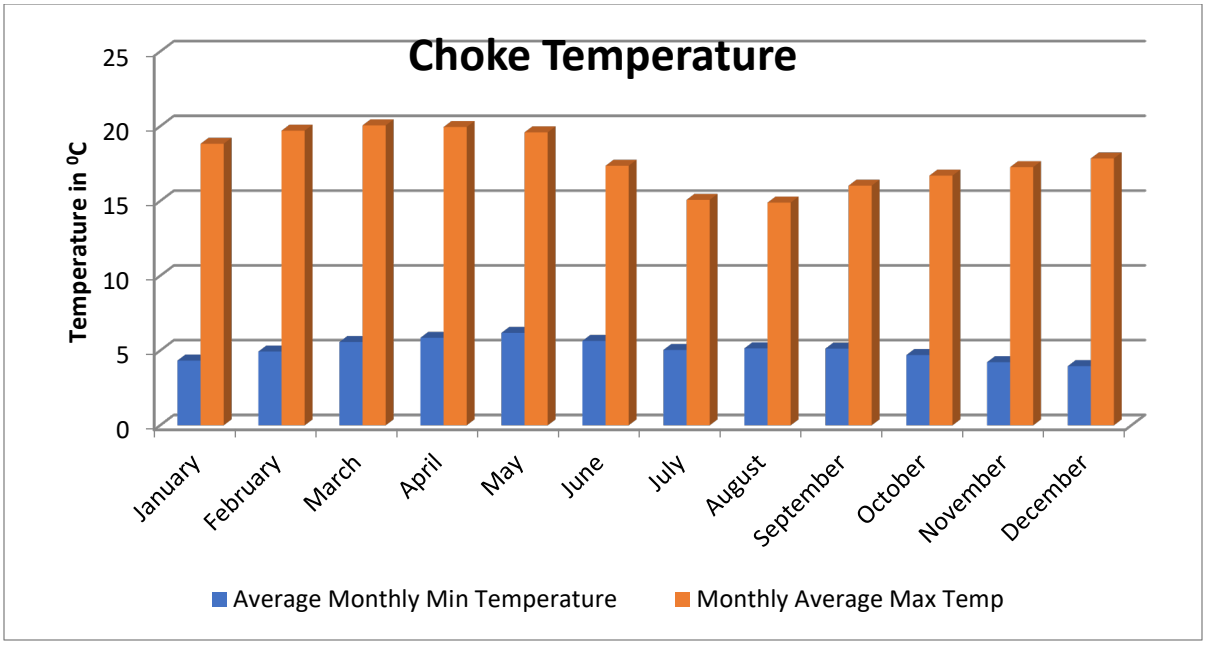

Figure 49 Choke Average Monthly Minimum and Maximum Temperature from 1988-2018

The peak and the lowest average monthly minimum temperature were recorded in May, 6.1^{O}C and 3.9^{O}C in December month respectively and the peak monthly average maximum temperature was recorded in March around 20.1 ^{O}C.

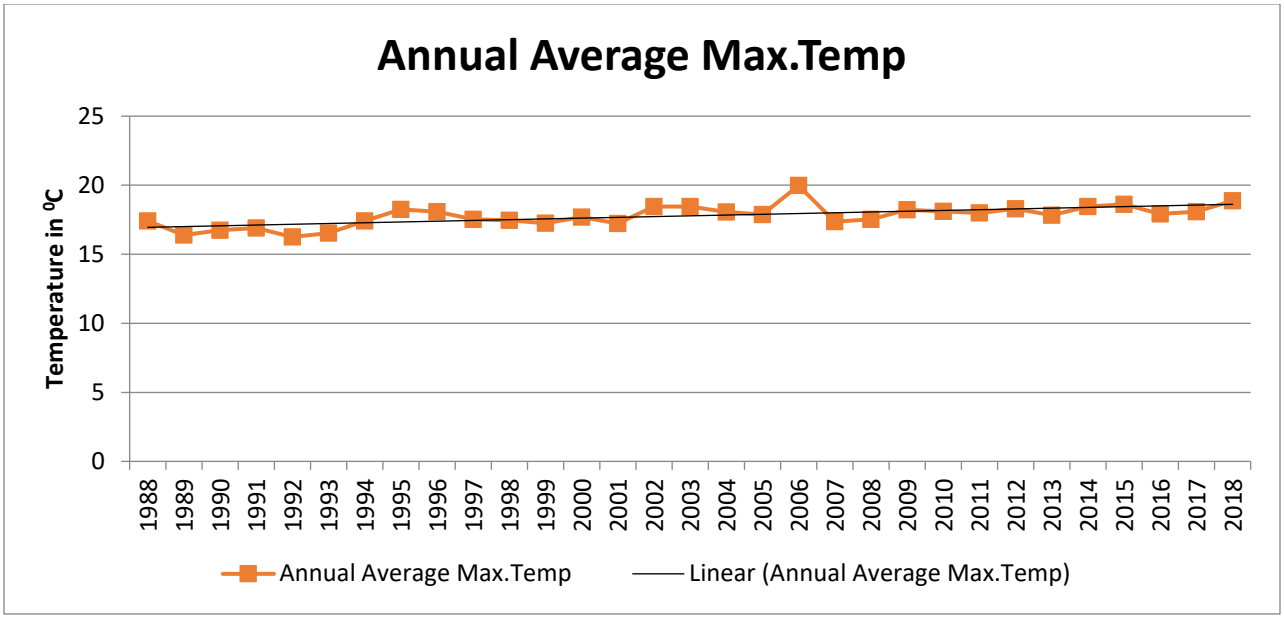

Figure 50Choke Annual Average Maximum Temperature

From figure 8 we can see that the annual average maximum temperature trend was increased. The peak annual average maximum temperature value was 19.9 ºC in 2006 and the lowest value was 16.2 ºC in 1992.

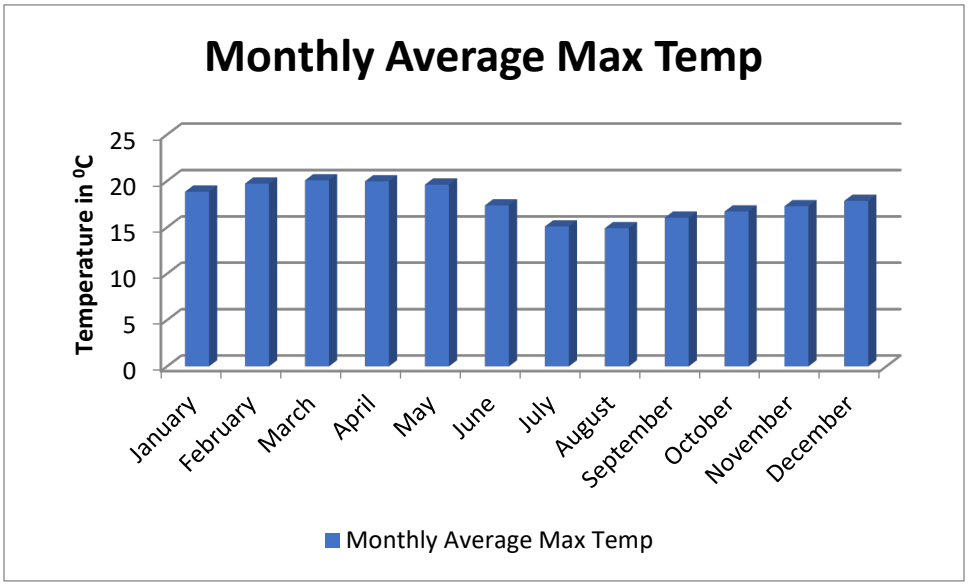

Figure 51 Choke Mean Monthly average Temperature

The average monthly maximum temperature range was between 14.9 ºC up to 20.0ºC.

The lowest and the highest Average monthly maximum temperature value were recorded in August and March month respectively.

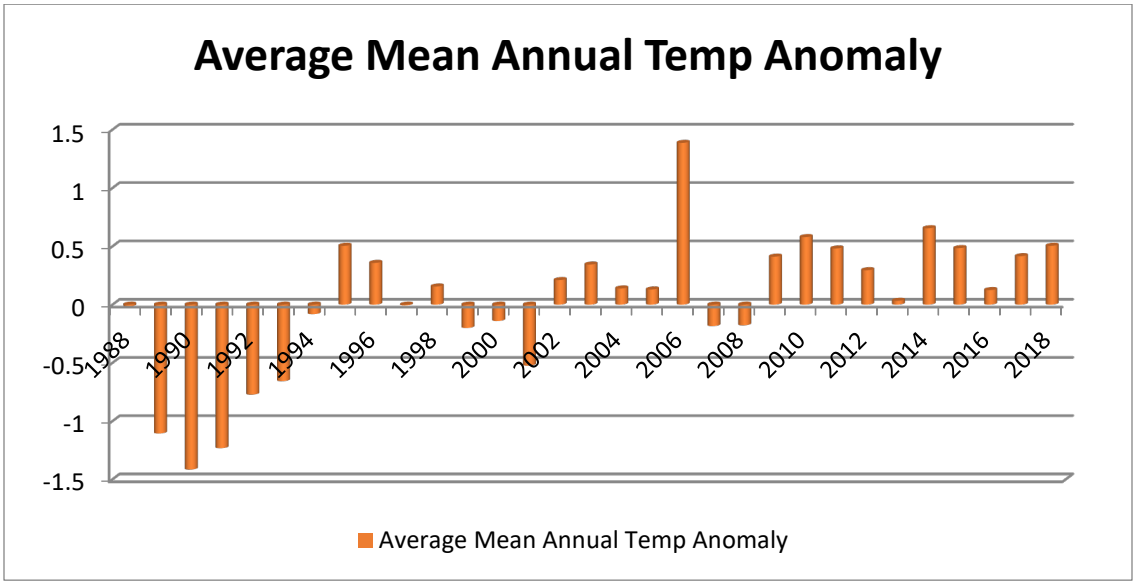

Figure 52 Choke Forest Mean Annual Temperature Anomaly

A **positive anomaly** indicates the observed temperature was **warmer** than the baseline, while a **negative anomaly** indicates the observed temperature was **cooler** than the baseline. In above Figure, the highest negative mean annual temperature anomalies were -1.4°C in 1990 and the highest positive mean annual temperature anomalies were 1.38°C in 2006. The positive anomalies were indications of higher mean annual temperatures than the reference normal while the negative anomaly values indicated the mean annual temperatures were lower than the reference normal.

Within the period of between 1988-2018, the average mean annual temperature recorded was 12.7°C in 2006 with the highest anomaly 1.38°C of considering the reference normal of 11.3°C. While the lowest or coldest year had an average mean annual temperature of 9.9°C an anomaly of -1.4°C decrease from the reference normal of 11.3°C.

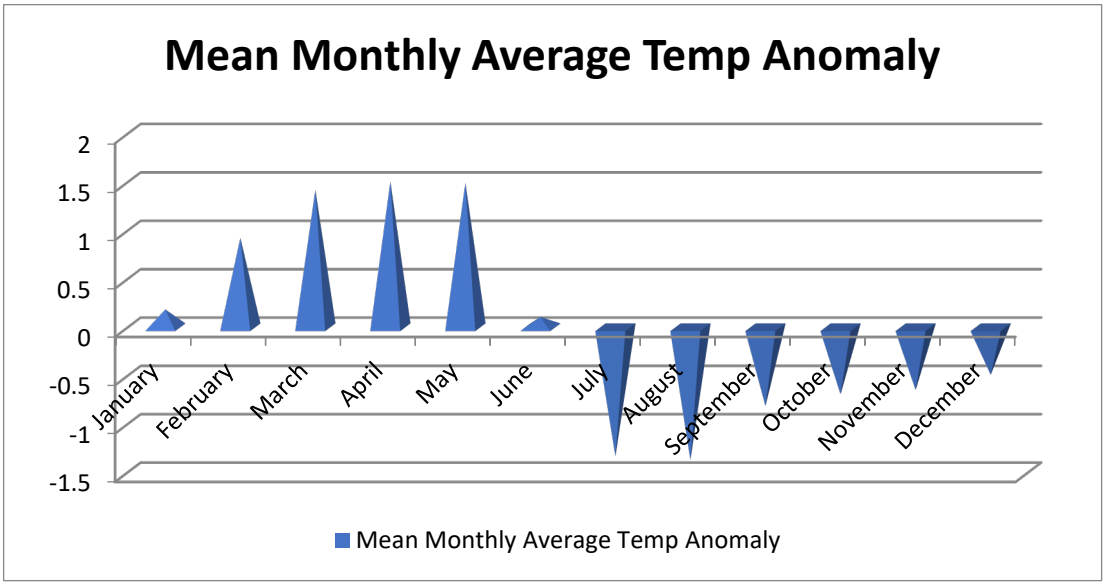

Figure 53 Choke Forest Mean Monthly Temperature Anomaly.

The hottest mean monthly temperature for the 1988-2018 period was the months of April with an average mean monthly temperature of 12.9°C against the normal reference of 11.4°C an increase of 1.5°C while the coldest mean monthly Temperature was the months of August with a maximum average of 10.02°C against the normal reference of 11.39°C decreases of -1.37°C as well. The overall total average mean temperature anomaly for the 1988-2018 periods was 0.02°C.

Based on National Integrated Drought Information System(NIDIS) , Drought is water shortage, due to generally deficiency of precipitation over an extended period of time (usually a season or more).

NOAA's National Weather Service describes drought as a deficiency of moisture resulting in adverse effects on people, animals, or vegetation over a sizeable area. Droughts often lead to famines and result in the deaths of humans, animals, and plants. A list of the different types of droughts and their causes is listed below.

Meteorological/ Climatological Drought

Droughts caused due to dry weather patterns dominate an area meteorological factors are most common in nature and usually precede other types of droughts. Such an event is caused by a prolonged period of low precipitation. Dry weather patterns dominate the area experiencing a climatological drought. The severity of such droughts depends on the magnitude of the shortfall of precipitation, as well as the duration of the shortfall event.

Agricultural Drought

An agricultural drought occurs when crop growth in an area is adversely affected due to drought. Often, meteorological droughts lead to agricultural droughts. Low levels of precipitation over a sustained period of time can lead to crop failure.

Hydrological Drought

Hydrological droughts occur when low water supply becomes evident in the water system likes, lakes, rivers, and reservoirs. Often, meteorological droughts precede hydrological droughts since low levels of rainfall and high temperatures may cause water bodies to dry up. However, changes in weather conditions are not always the cause of hydrological droughts. For example, when a country or region diverts a vital water source towards its own territory, leaving a neighboring country or region dry, it can lead to a drought in the latter area.

Socioeconomic Drought

A socioeconomic drought occurs when the supply and demand of various commodities is affected by drought which means the demand for an economic good is greater than its supply due

to a water deficit created by shortfalls in precipitation and other weather-related adverse changes. Many goods like food grains, fodder, fish, and hydroelectricity need an adequate water supply for sufficient production.

Ecological Drought

A drought can have a negative impact on natural ecosystems. Drought can alter or degrade critical functions of healthy ecosystems, including reduced plant growth, reduction or extinction of local species, and landscape-level transitions (e.g., a forest being replaced by grassland).

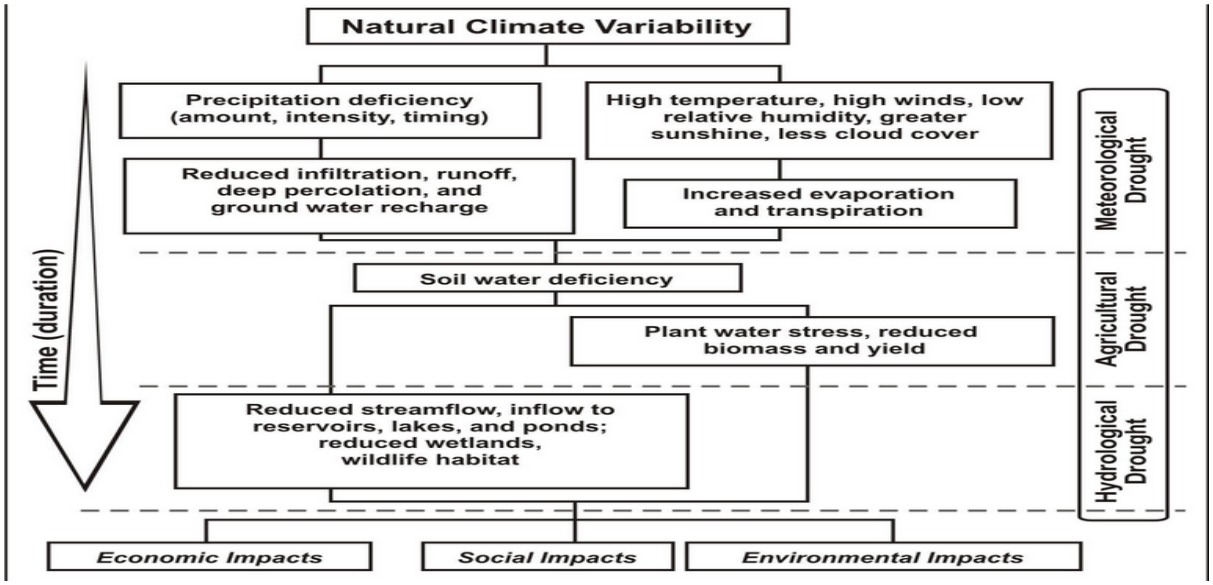

Figure 54 Sequence of drought occurrence and impacts for commonly accepted drought types (Source: NDMC)

For this study we calculate agricultural drought and Hydrological drought using SPEI, which is a multi-scalar drought index based on climatic data. Based on the SPEI value drought can category in to five show table 1

Table 16 **Drought category of SPEI indices**

SPEI Values	Drought Category
2.0 +	Extremely wet
1.5 to 1.99	Very wet

1.0 to 1.49	Moderately wet
-.99 to .99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

Source: (Samuel, 2013)

Meteorological drough of Choke forest ecosystm

All droughts originate from a deficiency of precipitation or meteorological drought but other types of drought and impacts cascade from this deficiency.

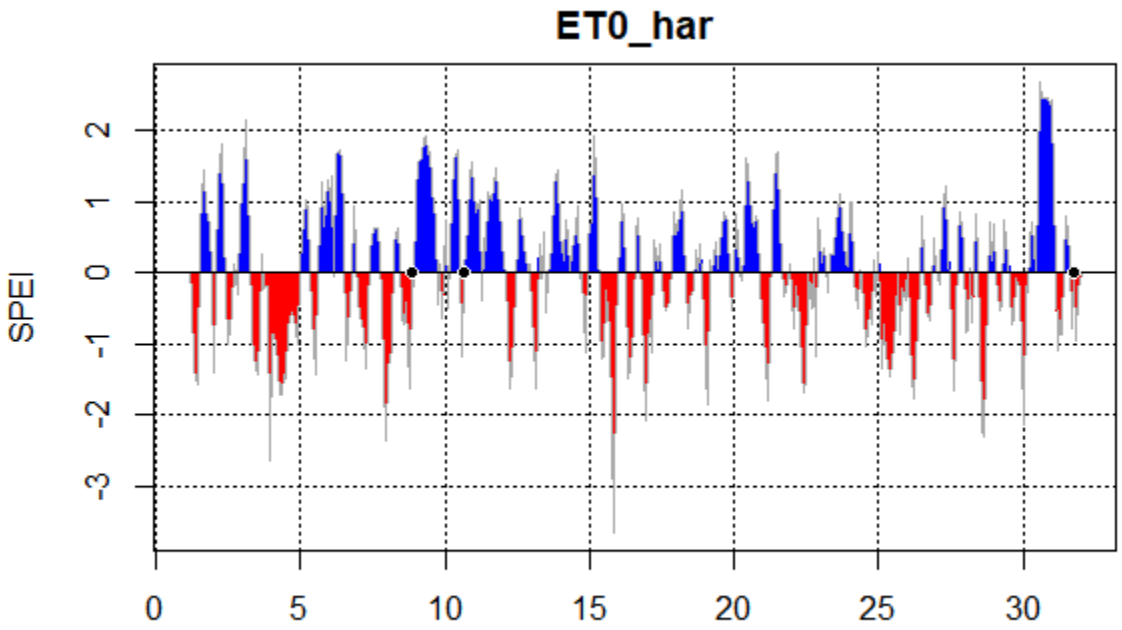

Figure 55 Choke SPEI for 3 months' time scale

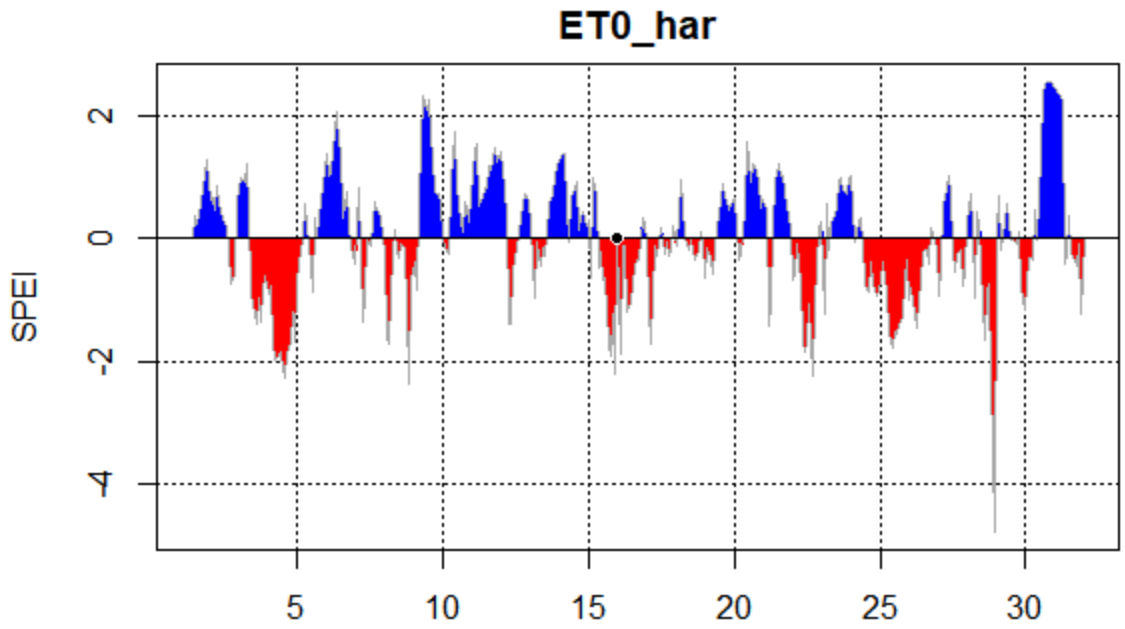

Figure 56 Choke SPEI for 6 months' time scale

From the above figure we can see that starting from 2003 up to 2006 near normal up to severely dry condition was occurred in the study area, which implies that affect agricultural productivity. In the year 1990, 1991, 1992 and 2016 extremely dry condition was occurred. In 1996, 1997 and 2018 extremely wet condition was occurred. Mostly from 1997 up to 2002 from near normal, moderately wet and very wet condition was occurred, which is preferable for agricultural activity.

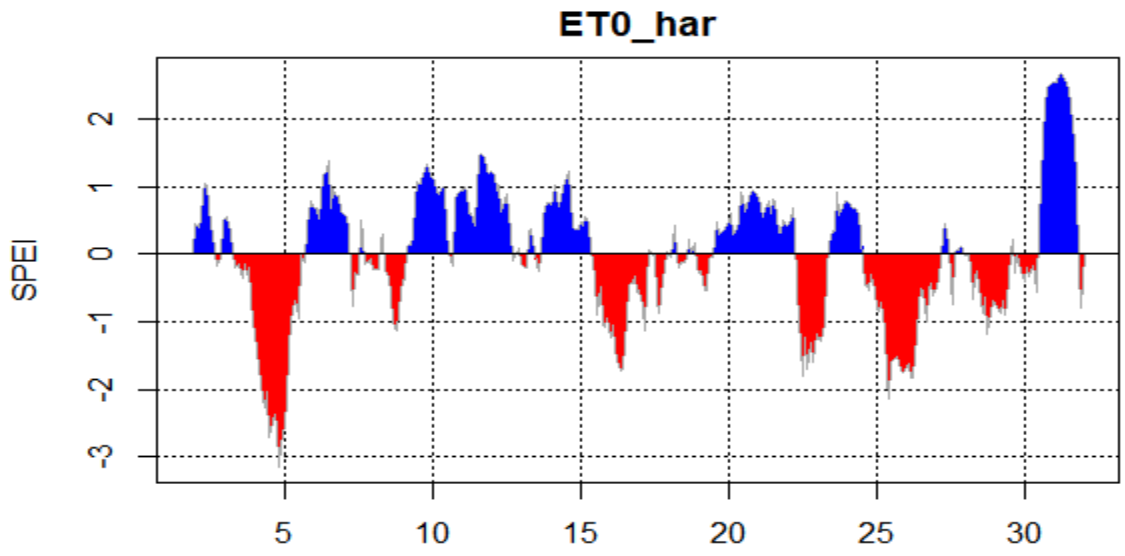

Figure 57 Choke SPEI for 12 months' time scale

From the above figure we can see that the SPEI value starting from 1993 up to 2002, 2007 up to 2010 and 2018 near normal up to moderately wet was occurred in the study area, this shows the water levels for different water bodies like lakes, rivers, springs, and reservoirs was good. In 1991, 1992, 2003 to 2006, 2011 and 2013 to 2017 extremely up to moderate drought conditions were achieved, cause lack of water supply, which affects the level of water in water bodies such as lakes, rivers, and reservoirs. Accordingly in study area during FGD the community describe the number of springs decreased year to year.

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

Participants in the FGD explained that population growth, agricultural expansion, human settlement, livestock pressure, the need for firewood, and overgrazing all contribute to the degradation of Choke forest ecosystem, thus contributing to climate change.

Driver for Climate Change/Variability of Choke Mountainous Forest Ecosystem

Forests are the second largest stores of Carbon next to Oceans. Tropical forests help cool the average global temperature by more than 1 degree Celsius. Forests located from 30° N to 30° S provided alternative benefits that cool the planet by over 0.3 degrees C, about half as much cooling as carbon sequestration provided. And the bulk of that cooling, around 0.2 degrees C, came from forests in the core of the tropics (within 10° of the equator). Canopy topography generally provided the greatest cooling, followed by evapotranspiration and then aerosols (Ogasa, 2022). Trees capture greenhouse gases (GHGs) like carbon dioxide, preventing them from accumulating in the atmosphere and warming our planet.

Forests have a great role for climate change as a sink and source of carbon emissions. Every year Tropical forest absorb up to 1.8 gigatons of carbon from the atmosphere However, agriculture, forestry and other land uses are responsible for nearly a quarter of all man-made greenhouse gas emissions to the atmosphere this also true for Choke mountainous Forest ecosystem (Wright, 2022).

- **Rapid population growth**; on the FGD the participants explained that the population continues to grow, accordingly the need to provide housing, agricultural land expansion and fuel wood consumption also increases in order to fill these, the Community use the forest in unsustainable way, As a result of these exerts pressure on Choke Mountainous forest ecosystem.
- **The huge number of animal population**: Animal agriculture contributes significantly to global warming through ongoing emissions of the potent greenhouse gases methane and nitrous oxide, and displacement of biomass carbon on the land used to support livestock (Eisen MB, 2022). Farming livestock-cattle, sheep goat,

pigs and chickens contributes around 6 billion tons of greenhouse gases (carbon dioxide, methane and nitrous oxide) to the atmosphere each year while estimates vary, this could represent up to 18% of global emissions. Based on the data East Gojjam Zone plane office the number of livestock population in 2022 in different Woredas of bordering with Choke forest were 538,372 C**attle**, **854,633, sheep**, 133,507**goats**, **51,577 Horse, donkey 90,290** and14,751Mule. These animals contribute to increasing greenhouse gas in the atmosphere. the increasing levels of carbon dioxide and other greenhouse gases are directly linked to the increasing global temperatures. Around 1.6-2.7 billion tons of greenhouse gases each year, mostly methane, are produced from livestock digestion. Another 1.3-2 billion tons of nitrous oxide come from producing feed for livestock and the final 1.6 billion tones come from land use change, such as clearing for animal pasture (Mario, 2016)

- **Forest clearing for Agricultural land expansion and Settlement :-** as FGD participants explained that almost 50% of Choke forest was deforested for the purposes of agricultural land and settlement expansion therefore the community change Choke forest land to agricultural land and settlement through by deforested the forest this, release carbon dioxide into the atmosphere through, releases tons of carbon dioxide into the atmosphere. Decaying plant material, including trees and by Living trees absorb carbon dioxide, which is diminishing the number of trees to absorb carbon dioxide, the gas remains in the atmosphere.

Figure 58 Agricultural and Settlement activity on the Choke mountainous forest ecosystem

Source field observation

- **Cutting forests for fuel wood and construction materials:** During FGD, the community members stated that half percent of the forest was cut for house construction, charcoal production, fuel wood production and for other purposes. As a consequence, contributing to forest degradation and exacerbated local climate change by limiting carbon sequestration potential.

Pressure for Climate Change/Variability of Choke Forest Ecosystem

Deforestation: Forests are a stabilizing force for the climate. It regulates ecosystems, plays an integral part in the carbon cycle, support livelihoods, and supply goods and services that can drive sustainable growth (IUCN, 2015). Since 1990, due to human activity including land clearing for agricultural farming and logging 420 million hectares of forest have been lost. Forest cover accounted for 31% of the total land area in 2020 (Lai, 2022)**.** Forests store large amounts of carbon. Trees and other plants absorb carbon dioxide from the atmosphere stored in the plant's branches, leaves, trunks, roots and in the Soil unless carbon remains in the atmosphere in the form of carbon dioxide (CO_2), which causes climate change. Hence during deforestation stored carbon is released into the atmosphere, mainly as carbon dioxide. Averaged over 2015—2017,

global loss of tropical forests contributed about 4.8 billion tons of carbon dioxide release per year (Dean, 2019).

The build-up of carbon dioxide in the atmosphere is driving global warming, as it traps heat in the lower atmosphere.

Forests take in carbon from the air and store it in wood, plant matter and under the soil unless carbon remains in the atmosphere in the form of carbon dioxide (CO_2), which causes climate change. Over the past 8,000 years, half of our planet forest cleared by humans mostly for agriculture purpose. Cutting down or burning forests prevents absorbing more CO_2 in the future. Since 1850, about 30% of all CO_2 emissions have come from deforestation, which can also have more local climate impacts because trees release moisture that cools the air (Melillo, 2021).

There for, Deforestation is one of the most important drivers for climate change and local change in the Choke forest ecosystem**.**

Over Grazing: While some rangeland soils have the capacity to store additional carbon due to livestock grazing, in most cases, livestock grazing will reduce rather than increase carbon storage (Wuerthner, 2021). During enteric fermentation" process allows tend to produce more methane a greenhouse gas with roughly 28 times the warming potential of CO2 over a 100-year time frame. Livestock are also the principal source of GHG emissions in the country and a significant contributor to emissions globally.

Figure 59 Grazing in the Choke surrounding Kebeles

Livestock generates greenhouse gases mainly in the form of methane emissions arising from digestion processes (mostly attributable to ruminant animals like a goat) and nitrous oxide emissions arising from excretions. Livestock emissions are estimated to amount to 65 MtCO2e- 35% of Ethiopia's total emissions today (Ethiopian CRGE, 2011). A large number of livestock causes the depreciated range land vegetation cover. The most important greenhouse gases from animal and agriculture are methane and nitrous oxide. Accordingly in Choke forest based on Woreda animal population data, GHG that emit to the atmosphere through enteric fermentation and manure management were calculated.

Table 17 Summary Table of Emission from Enteric Fermentation (CH4) and Manure Management (CH4 and N2O)

Livestock	**Population**	**Enteric Fermentation**	**Manure Mangement**	
		CH4	**CH4**	**N2O**
Cattle	538372	16689532	538372	542763.77
Sheep	854633	4273165	170926.6	111991.108
Goat	133507	667535	29371.54	21948.5508
Donkey	90290	902900	108348	32396.052
Horse	51577	928386	112953.63	33879.8998
Total		**23461518**	**959971.77**	**742979.38**

Nitrous oxide, arising from manure storage and Use of Organic/inorganic fertilizers, is a molecule with a global warming potential 265 times higher than carbon dioxide (Giampiero Grossi, 2018). Research found that a decrease in vegetation cover reduces Evapotranspiration thereby allowing an increase in local temperature levels (Mingyuan, 2012). From Manure management in the Choke mountainous forest about 742979.38 N_2O was produced.

Table 18 Enteric Fermentation and Manure Management (in CO2 equ)

Livestock	**Population**	**Enteric Fermentation**	**Manure Mangement**		**Total Emission**	
		CO2 equ	**CO2 equ**	**CO2 equ**	**CO2 equ**	**Mt CO2 equ**
Cattle	538372	417238300	13459300	161743603	592441203.3	0.05924412

Sheep	854633	106829125	4273165	33373350.3	144475640.3	0.014447564
Goat	133507	16688375	734288.5	6540668.14	23963331.64	0.002396333
Donkey	90290	22572500	2708700	9654023.5	34935223.5	0.003493522
Horse	51577	23209650	2823840.8	10096210.1	36129700.88	0.00361297
Total		**586537950**	**23999294**	**221407855**	**831945099.6**	**0.08319451**

From enteric fermentation 586537950 CO2equ which is which is 0.058Mt CO2equ amount per year produced and from manure management 245,407,149 CO2equ amount per, which is 0.024Mt CO2equ amount were produced. The Choke forest surrounding Woredas emits about 0.1 metric tons of CO2equ per year as a result of different livestock activity.

Globally increasing GHG: Greenhouse gases warm the planet by trapping heat in the atmosphere, making the average global temperature rise Greenhouse gas emissions include carbon dioxide, methane and nitrous oxide from all sources burning fossil fuels, including agriculture and land use change. Carbon dioxide (CO_2) is released through natural processes (like volcanic eruptions) and through human activities, like burning fossil fuels and deforestation. Human activities have increased the amount of CO_2 in the atmosphere by 50% since the Industrial Revolution began (1750). Anthropogenic greenhouse gas emissions have increased driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years because warming since the mid-20th century**.** The (IEA, 2022) report show that Global energy-related carbon dioxide emissions rose by 6% in 2021 to 36.3 billion tones, their highest ever level. Emissions increased by almost 2.1 Gt from 2020 levels.

3.4.3. Impact of climate change on the Choke Mountain Forest Ecosystem

Based on (IPCC, 2022) report Climate change is already causing widespread disruption in every region in the world with just 1.1 degrees C (2 degrees F) of warming. Droughts, extreme heat and floods already affect food security and livelihoods for millions of people. Since 2008, devastating floods and storms have forced more than 20 million people from their homes each year. Since 1961, crop productivity growth in Africa reduced by a third due to climate change and also harming species and whole ecosystems, some animals extinct and died due to warming world.

Climate change will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity. Changes in rainfall patterns are likely to lead to severe water shortages and/or flooding (UNFCCC, 2007). Global temperature was increasing due to increasing greenhouse gases in the atmosphere this conditions largely affect developing countries like Ethiopia (Gebeyehu, 2016). On the FGD the participants were explained that due to climate change the temperature was increased and rainfall variability increase and the amount and distribution of rainfall vary year to year.

Increasing levels of greenhouse gases in the atmosphere due to human activities are the major driver of climate change since the mid-20th century (WMO, 2020). Also in Choke forest ecosystem human activities like forest degradation, overgrazing and clearing for different purpose which contributes GHG in the atmosphere.

Ethiopia is experiencing to climate change and impacts the livelihoods of the community specially drought More than 8 million people are currently affected across southern and south-eastern parts of the country, including Somali (more than 3.5 million people), Oromia (more than 3.4 million), SNNP (more than 1.1 million), and South West1 (more than 200,000 people) At least 1.5 million livestock have so far died for lack of pasture and water. According to FAO; an additional 10 million livestock are at risk across affected areas. Meanwhile, at least 286,000 people who have the means to travel have migrated in search of water, pasture or assistance. According to a December 2021 FAO assessment found that about 172 000 animals had died, and about two million were in poor health conditions. Crop production in agro-pastoral areas has also

been severely affected. About six million people are facing acute food insecurity because of drought (FAO, 2022).

3.4.4. Response to climate change on the Choke Mountain Forest Ecosystem

The current response measures or practices

Dengole Kebele FGD participants explained that to protect Choke Forest the community begin participatory natural resource conservation work, soil conservation,

Figure 60 Soil conservation activities in the Dengole Kebele

Minimize overgrazing and protecting the forest through rotation and rotation pasture has been done as a result fertility of soil is increasing and rehabilitate common known tree is called Asta.

Figure 61 the protecting part of Choke forest at Senean Woreda

During field observation we can see that there is protecting Choke forest ecosystem and different forest was recover and different springs were also gush out.

Figure 62 Springs in the protecting part of Choke forest ecosystem

As Tachebey FGD participants were explained that around 8ha of degraded land was covered by forest.

In the Dengole Kebele Seedling fermentation work is done and around 6024 ha of Choke mountainous forest is protecting by the community through Choke community protecting area office. As a result of the Choke mountainous forest being protected, the community is able to feed their cattle in shifts.

Figure 63 seedling fermentation in the Dengole Keble

In the case of climate change response, since it is a global phenomenon, it should be started from the global perspective, then regional, national and local climate change response and it becomes effective when it starts from the community. The following responses are national and international responses are available in our country.

National Responses to climate change

Environmental policy of Ethiopia:-

From the perspective of the multi-sectoral impacts of climate change, the environmental policy of Ethiopia is worth considering. The policy was formulated in 1997 and **considers climate change as a cross-cutting issue (EPA, 1997).** The policy underlines the importance of incorporating rural-urban migration, human settlement and environmental health concerns into the regional, district and local level planning and development activities and improved environmental sanitation to the federal and regional agendas for achieving sustainable urban development. The policy gives due attention to industrial water pollution. personal or communal appliances or any other external sources and establish clear linkages between the control of pollution and other policy areas including water resources, agriculture, human settlements, health and disaster prevention and preparedness.

The National Adaptation Program of Action (NAPA, 2007): identified urgent adaptation needs and priority projects.

CRGE (2011):-. Ethiopia is committed to building a Climate-Resilient Green Economy (CRGE) that aims to ensure economic development that pursues a low emissions path while building resilience to adapt to climate change. The green economy strategy focuses primarily on emission-intensive sectors. The climate resilience strategy, on the other hand, tries to address risk reduction by focusing on two aspects – integrated disaster risk reduction and management and sectorial as well as regional climate adaptation strategy and action plans. To avoid the negative impact due to increasing GHG emissions and unsustainable use of natural resources the Federal government of Ethiopia has developed a strategy to enhancing the adaptive capacity and reducing climate variability and change thus, the country's Climate-Resilient Green Economy (CRGE). It is now starting to transform the strategy into action.

The green economy plan is based on four pillars:

1. Improving crop and livestock production practices for higher food security and farmer income while reducing emissions
2. Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks

3. Expanding electricity generation from renewable sources of energy for domestic and regional markets

4. Leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings.

As part of the strategy, the government has selected four initiatives

For fast-track implementation: exploiting the vast hydropower potential; large-scale promotion of advanced rural cooking technologies; efficiency improvements to the livestock value chain; and Reducing Emissions from Deforestation and Forest Degradation (REDD)

The Climate-Resilient Green Economy (CRGE) initiative was started in 2011, giving the initiative three complementary objectives:

1 Fostering economic development and growth

2 Ensuring abatement and avoidance of future emissions, i.e., transition to agreen economy

3 Improving resilience to climate change.

According to UNDP (2011), UNDP Ethiopia is supporting Ethiopia's transition to a climate - resilient green economy in three thematic areas:

i. Cross-cutting Support for Formulation and Piloting of Low-Emission Climate-Resilient Development Strategies

ii. Pursuing a low emission economic growth

ii. Building Resilience through (a) Adaptation and (b) Disaster Risk Management

The Ethiopian Program of Adaptation to Climate Change (EPACC, 2013):- The main objective of EPACC is to create the foundation for a carbon-neutral and climate-resilient path towards sustainable development in the country.

National Adaptation Plan (NAP, 2019): Ethiopia's National Adaptation Plan (NAP-ETH) builds on ongoing efforts to address climate change in the country's development policy framework, the document that enables Ethiopia to approve climate fund support to respond drought. It is a comprehensive document comprised of 18 adaptation initiatives integrating many

of the sectors that have been identified as most vulnerable, namely: agriculture, forestry, health, transport, power, industry, water and urban to implement it .

A Brief on the National Disaster Prevention and Preparedness Strategy for Ethiopia (1989):-the strategy intended to concentrate on how long-term environmentally sustainable approach to greater agricultural productivity, soil and conservation and alternative means of income generation can relate to the short – ter**m** means of disaster preparedness.

National Policy and Strategy on Disaster Risk Management (2013):- The main objective of the Policy is to reduce disaster risks and potential damage caused by a disaster through establishing a comprehensive and coordinated disaster risk management system in the context of sustainable development. To reduce and eventually prevent disaster risk and vulnerability that pose challenges to development through enhancing the culture of integrating disaster risk reduction into development plans and programs as well as by focusing on and implementing activities to be carried out before, during, and after the disaster period to address underlying factors of recurrent disasters. Specifically, In times of disasters, to save lives, protect livelihoods, and ensure all disaster-affected population are provided with recovery and rehabilitation assistance, to reduce dependency on and expectations for relief aid by bringing attitudinal change and building resilience of vulnerable people. Currently, the whole climate actions (Responses) relay on the following two important documents

Updated NDC:- This report builds on Ethiopia's first NDC and provides a robust evidence base for prioritizing the updated NDC's mitigation and adaptation contributions, establishing intermediate indicators to measure progress towards the new NDC targets, and develop recommendations for strengthening the Monitoring Reporting and Verification (MRV) and Monitoring and Evaluation (M&E) systems.1 This technical report also provides a suite of sectorial priority interventions that have informed the enhanced NDC that can guide sector ministries, development partners, development financing institutions, the private sector, and other stakeholders in designing and implementing the enhanced NDC's activities. In determining the mitigation contributions, the following activities were indicated in the report to be implemented within the specified time frame : (i) updating the Business-as-usual (BAU) scenario, (ii) preparing greenhouse gas (GHG) emission pathways to 2030 (national and sectorial), (iii) setting 2025 and 2030 targets consistent with Ethiopia's strong commitment and

readiness to act on climate change, (iv) assessing and prioritizing mitigation interventions and indicator selection through a consultative process, (v) disaggregating conditional and unconditional contributions, and (vi) reviewing the role of carbon markets in the enhanced NDC. All the above responses must be implemented every corner of the country including Choke mountainous Forest Ecosystem.

10-year development plan (2020/21-2029/30)

This plan sets the government's development vision over the decade 2020-2030. It is based on ten pillars. Pillar six is to build a climate resilient, green economy. It seeks to increase basin development efforts to fight land degradation and to reduce pollutions, improve productivity and reduce GHG emissions, increase forest protection and development, increase production of electricity from renewable sources for domestic use and for export, and focus on modern and energy saving technologies.

International level climate change response

UNFCCC

The UNFCCC with its successions (Kyoto Protocol with its Doha amendments and the Paris Agreement) has been ratified and the national government is acting in accordance with the basic principles of the Convention, Common but Differentiated Responsibilities and Respective Capacities.

Ethiopia currently not only participated in annual COPs nationally and as member of African Group, LDC and G77 and China but also leads climate negotiation groups such as LDCs. Ethiopia is also a president for Climate Vulnerable Forum (CVF) which consists of a group of countries that are highly affected by adverse impacts of climate change. This leadership endeavors reflected in the international negotiation arena should be mirrored in the implementation of climate action at the grass root level

Sustainable Development Goals:-

Goal 11, Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 13, Take urgent action to combat climate change and its impacts. Much emphasis should be given to these two goals. (Many targets are there to be implemented by 2030 ready those targets)

3.4.5. Outlook for Climate Change and/or Variability

Based on (Lejeune, 2018), deforestation have dual impacts first rising global temperature through releasing CO2 into the atmosphere during clearing forest second, have local climate impact by interrupt physical process of net warming and cooling effect.

Deforestation is a key contributor to human-caused climate change Clearing, Removing and burning trees also reduce an important carbon "sink" that takes up CO2 from the atmosphere.

As FGD participants explained that almost 50% of Choke mountainous forest was deforested, unless strengthen the current community based Choke forest protection the Choke forest will totally deforested and changed to agricultural land and to settlement, this aggravate to regional climate change as well as increase the vulnerability of the society and the environment to the climate related hazard, this condition will increase losses to property, cause costly disruptions to society economy, livelihood, affect water supplies and water quality and the environment at all.

Climate change is already causing widespread disruption in every region in the world with just 1.1 degrees C (2 degrees F) of warming (IPCC, 2022).

Accordingly based on the available meteorological data in the Choke Mountainous forest area temperature was increased by 0.02ºC. If this condition continuous without any strong mitigation, and adaptation measures in the coming 30 years temperature will increased by 0.6 ºC it will lead to increase climate-related hazards on the livelihood of the society and as well as on the environment.

Unless manage livestock population number on the Choke surrounding areas the emission rate that produce from enteric fermentation and manure management currently emit 0.1 metric tons of CO2equ per year this will increase by 3 Mt CO2equ in the coming 30 years and this leads to increase greenhouse gas in the atmosphere and causes climate change.

Unless, make area enclosures, protect the forest in all the bordering Woredas, substitute house construction material by another, use alternative cooking stoves technology, rehabilitee of forests through afforestation, reforestation, and make participatory forest management practices by all the bordering Woredas of Choke mountainous community and by the concerned body in the

By adding the carbon stocks found in each carbon pool, the total mean carbon stock of the forests was calculated. As a result, the average TCS in Anshirava (protected) was estimated to be 338.18 ± 170.80 t·ha−11241.14 ± 81.20 t·ha−1. In Ziba(high human intervention) , however, the total mean carbon stock was 240.36 ± 66.08 t·ha−1 , with a mean CO2 equivalent of 882.12 ± 36.24 t·ha−1 (Fikirte Asrat , Teshome Soromessa , Tesefaye Bekele, Rama Mohan KurakalvaSravya Sai Guddeti, David Russel Smart, and Kristine Steger , 2022)

This mountain range is the source of the majority of Blue Nile river tributaries. These mountains are the source of four major rivers: Muga, Chemoga, Abeya, and Techma, as well as numerous smaller tributaries of the Blue Nile (Abay)

In the coming 10 years 152 ha the forest coverage will deforested. The mean total carbon stock in Koyesha forest ecosystem in 2014 was 24,143.8 t ha-^{1}, but currently in 2022 the carbon stock we will loss by 9613.6 t ha-^{1} as a result the benefit we get from the forest like clean air, carbon trading schemes, ground water recharging, regulating of hydrological cycle, will be diminish and increase the impact of flood hazards, soil erosion, and loss habitat for different biodiversity in Koysha forest ecosystem.

3.4.6. Recommendation

To maintain and to rehabilitate Choke mountainous forest ecosystem it needs the following measurements: in other way maintaining the forest ecosystem it helps to regulate the climate and the atmosphere, so to reduce the impact of climate change it needs protect the forest ecosystem by doing the following activities

- Community based forest protection must be strengthen through all the bordering Woredas of Choke forest in order to conservation and restoration of the Choke forest.
- Area enclosures
- Substitute house construction material by others instead use forest for construction.
- Use and improve alternative cooking stoves technology and improve electricity accessibility and bio-full gas instead use forest for fuel wood.
- Rehabilitee Choke forest ecosystem through afforestation, reforestation, and by strengthen participatory forest management practices by all the bordering Woreda administrative and by the society.
- To reduce the impact of drought it needs improve drought resistance crop to the area.

- In order to reduce, economic, environmental and societal impact of climate change in the Choke mountainous forest ecosystem it needs to collaboration work of Amhara region, East Gojjam Zone, all the bordering Woreds, Kebele administrative and the society to protect Choke Mountainous forest ecosystem.
- Like Amhara region open an office of Choke community protected area office at the Rebu Gebeya to protect Choke Mountainous forest it needs open different office through all the bordering Woredas.
- Governmental organization and NGO must give attention to choke mountainous forest.

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