Environment, Forest and Climate Change Commission Environmental information Management Directorate

Fact Sheet of Cheleleka Wet land Ecosystem in Sidama Region



Prepared By EIMD

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Acronym and Abbreviations

AIDS: Acquired Immune Deficiency Syndrome

ARHTSCAO _ Assessment Report of Hawela Tula Sub-City agricultural office

CSA: Central Statistical Agency

DPSIR: Driver Pressure State Impact Response

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

FDRE: Federal Democratic Republic of Ethiopia

FGD: Focus Group Discussion

GDP: Growth Domestic Product

GTP: Growth and Transformation Plan

HTSC: Hawella Tulla Sub-City

IBC: Institute of Biodiversity Conservation

IPCC, F, A-R: Intergovernmental Panel on Climate Change Fifth Assessment Report

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

LSICLLCC: Land sat image of land use land cover change

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

Max.: Maximum

Min.: Minimum

NGO: Non-Governmental Organization

NSIDC: National Snow and Ice Data Center

R.F: Rainfall

SDGs: Sustainable Development Goals

Temp.: Temperature

TSCFEO: Tula Sub-City finance and economic office

UNFCCC: United Nation Frame Work on Convention of Climate Change

WHO : World Health Organization

1. Social and Economic Environment

1.1 Environment for Green Economy Development

Human societies of different interests and values, with the objective of using resources, have interacted with the environment throughout history and, in the process; they have altered it. Most African economies depend highly on natural resources, aim to achieve industrialization and economic diversification, and face challenges of poverty and unemployment.

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

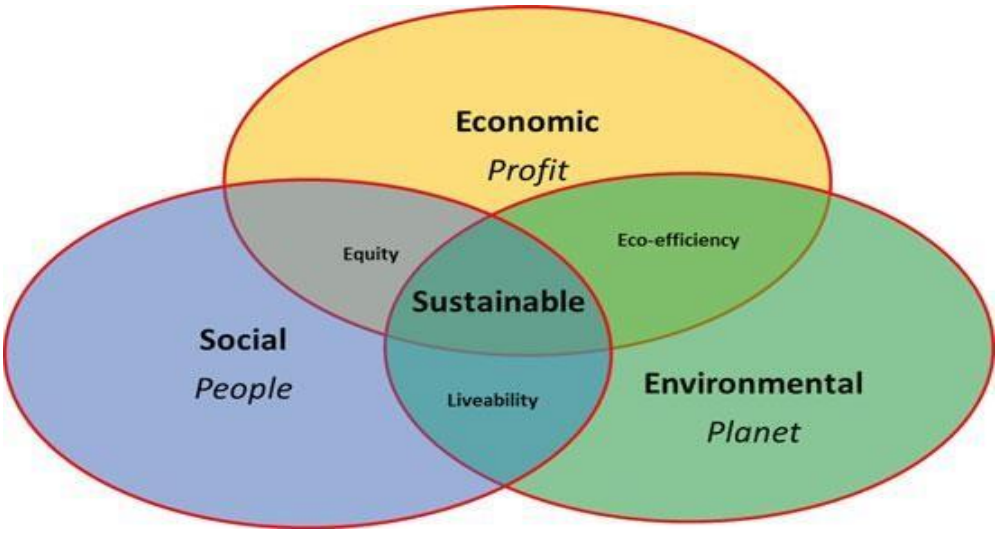


Figure 1: the Three Dimensions of Sustainability (Source: Green Growth, Green Economy and Sustainable Development: Terminological and Relational Discourse 2017)

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

Green Economy*:* A green economy can be defined as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011).

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

The Government of the Federal Democratic Republic of Ethiopia is striving to fulfill their responsibilities to their citizens. The government strives to provide Social services and securities ensure adequate functioning of infrastructure, provide a climate Conducive employment and pay their debts. To be able to achieve the desired social and economic development, the government has already started to pursue its development endeavors following the green growth path.

Accordingly, the country's second 5 years Growth and Transformation Plan II (2015/2016-2019/2020) and the newly 10 year strategic action plan that aims at improving the livelihoods of its people is being implemented.

Furthermore the environmental sector plan is also mainstreamed into the GTP II and the newly 10 year strategic action plan of the country. One of the activities outlined within the environment sector plan of the GTP II is the preparation of Fact sheet of the country through undertaking assessment. To this end, The Environment, Forest and Climate Change Commission of Ethiopia have conducted assessment of Cheleleka wetland ecosystem in Sidama region in an integrated approach to study the status of the wetland.

1.2 Social Environments

The social environment refers to the immediate physical and social setting in which people live or in which something happens or develops. It includes the culture that the individual was educated or lives in, and the people and institutions with whom they interact.

Wetlands are ecosystems or units of the landscape that are found on the interface between land and water. While water is a major factor of wetland definition, soils, vegetation and animal life also contribute to their unique characteristics (IUCN, 2003).

Wetlands have played a noticeable role in the growth of human civilizations and cultural development. This is true globally, where major pre-historic civilizations, including those on the Nile, Euphrates and Tigris, have emerged and developed.

Ethiopia, with its different geological formations and climatic conditions, is endowed with considerable water resources and wetland ecosystems, including twelve river basins, eight major lakes, many swamps, floodplains and man-made reservoirs (Leykun Abunie, 2003)

With the exception of coastal and marine-related wetlands and extensive swamp-forest complexes, all forms of wetlands are represented in Ethiopia. These include alpine formations, riverine, lacustrine, palustrine and floodplain wetlands. Floodplains are found both in Ethiopia's highlands and lowlands, although they are most common in the North-Western and Western Highlands, Rift Valley and Eastern Highlands. Hillman and Abebe (1993) estimate that wetlands cover 1.14% of the total landmass of the country

The Cheleleka wetland watershed, a sub-watershed of Lake Hawassa Catchment that is partially found in the Central Rift Valley Of Ethiopia, 265 km south of Addis Ababa. The study area was located in a watershed where a chain of mountains stretch out and occupy a wide flat marshy land called Cheleleka in Hawela Tula sub city of Hawassa city . Geographically, it is located between 38°37| E to 38°42| E and 7°02| N to 7°07| N (Figure 4). It covers an area of about 27068.94 ha (270.7km square) with wide altitudinal ranges of 1600 to 2700 meters above sea Level.

1.3 State and trends of Social and Economic Environment

1.3.1 Population

Population in urban areas grows more rapidly than rural population worldwide, particularly in developing countries including Ethiopia. According to the population data gathered from the study area the annual population growth rate is around 10% each year.

According to finance and economic development office of Hawela Tula sub city the population number of the sub city was 124987 in the year 2010 and reaches 224532 in 2018.

The Hawela Tula sub city population density was 462 prsons/ square km whereas recently it approaches to 830 persons per km square.

Table 1: Hawela Tula sub city population number

Year	Total population		
	Male	Female	Total
2009	-	-	100121
2010	64432	60555	124987
2011	77630	73954	151584
2012	80124	75405	155529
2013	82514	76616	159130
2014	84980	78982	163962
2015	87341	81207	168548
2016	93142	89170	182312
2017	101200	97340	198540
2018	108802	115730	224532

Source: finance and economic development office of Hawela Tula sub city

The table above indicates, on average almost 12500 persons increases each year. This is high population growth. The population of the study area was 100121 in the year 2009, where as in the year 2018 it reaches 224532. In addition to the fertility rate, it is also due to migration from all Woredas of Sidama region and SNNPRS. The study area is known for religion and ethnic diversity.

1.3.2 Education

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

Table 2: Elementary school enrolment

Class	Education calendar											
	2018			2019			2020			2021		
	Enrolled students			Enrolled students			Enrolled students			Enrolled students		
	m	F	T	m	F	T	M	F	T	m	F	T
1-4	6606	6964	13570	6378	6803	13181	6250	6536	12786	5224	5568	10792
5-8	3819	4245	8064	4046	4435	8481	4092	4317	8409	4323	4810	9133
9-12	1880	1674	3554	1315	1132	2447	2494	2361	4855	1144	1139	2283
Total	12305	12883	25188	11739	12370	24109	12836	13214	26050	10691	11517	22208

Source Hawela Tulu sub city animal and natural resource office

There is some fluctuation of student enrolment for each year, but there is unexpected decrease of student enrolment between 2020 & 2021 is the case of covid-19, many of schools are not opened

Table 3: Governmental schools

Year	Elementary school (1-8)							Secondary school					
	No of school	No of student			No of teachers			No of student			No of teachers		
		M	F	T	M	F	T	M	F	T	M	F	T
2016	20	10969	11478	22447				1830	1754	3584			
2017	20	10909	11521	22430	369	211	580	2009	1841	3850	122	61	183
2018	20	10425	11209	21634	442	264	688	1880	1674	3552	124	63	187
2019	21	10424	11238	21662				1315	1132	2447			
2020	21	11124	11658	22783	494	282	770				115	55	170

Source Hawela Tulu sub city animal and natural resource off

Table 4 :non-Governmental schools

Year	Elementary school (1-8)			
	No of school	No of student		
		M	F	T
2016	15	1811	1530	3341
2017	18	1758	1507	3265
2018	20	2047	1725	3772
2019	24	2164	1887	4051
2020	22	2330	1980	4310

2021				

Source; Hawela Tulu sub city animal and natural resource office

Table 5: Ratio of students to teachers, class and textbook

Year	Teacher student ratio		Student class ratio		Student book ratio	
	1-8	9-12	1-8	9-12	1-8	9-12
2016			58:1	-	1:1	-
2017	1:39	1:21	67:1	-	1:1	-
2018	1:35	1:19	66:1	-	1:1	-
2019				-	1:2	-
2020	1;30	1:17	60:1	-	1:3	-

Source; Hawela Tulu sub city animal and natural resource office

Table above indicated that ratio of students to teachers, sections and textbooks between 2016 and 2020 in the sub city. The national standard for student-teacher ratio is 50:1 for primary and 40:1 for secondary schools. The lower student-teacher ratio the higher the opportunity of contact between the teacher and students, however, very low student-teacher ratio indicates inefficiency of the education system or underutilization of the resources. As indicate above in table, which indicates a very low student-teacher ratio with compared to the standard. This shows underutilization of resources/teachers.

And student-section ratio has similar standards with that of student-teacher ratio. Then, in the above table, which shows above the standard. Therefore, a higher student-section ratio indicates overcrowding of class and hence less interaction between students and teachers as well as among students themselves.

With regarding to student- textbook ratio, it has 1:1 ratio, the previous years which improves the quality of education. But, in 2019 and 2020, it becomes 1:2 and 1:3 which affects the quality of education.

1.3.3 Health

Health is one of the most preeminent social sectors. It can be broadly defined as the state of being well physiologically and psychologically. It also has overarching effect on sustainable socio economic development. Health is a fundamental prerequisite for the successful

achievement of any work which has significant importance for family, organization and for the country in general.

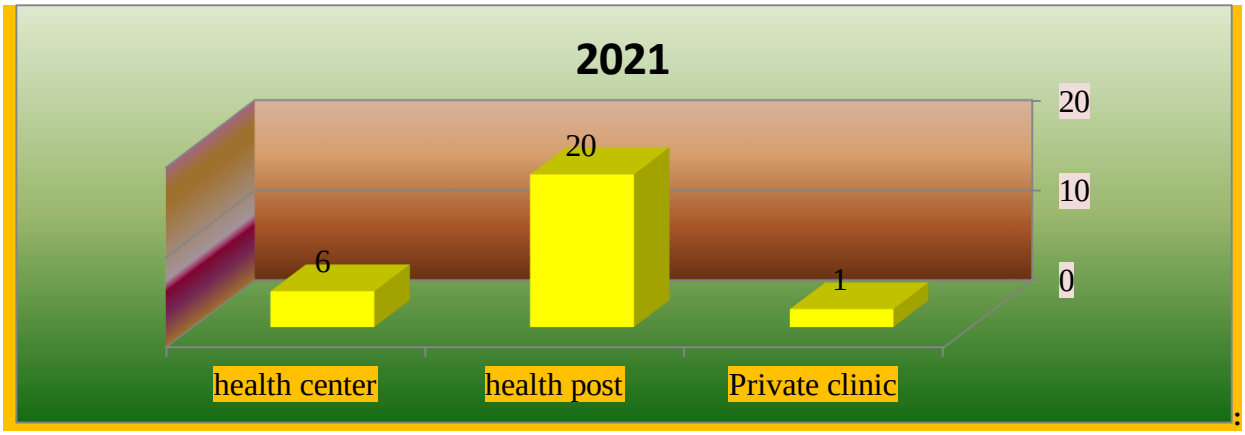


Figure2: Health institutions in Hawela Tulu sub city (Source: Health office of Hawela Tulu sub city)

In the sub city different health facilities, such as health center and health post were constructed between the year 2016 and 2021. However, their functionalities vary in providing the required services such as electricity.

In the sub city all the health centers and hospitals have both electricity and water access. Their main limitation is lack of equipment's, medicines and skilled persons. In contrary to this recently all the health posts in the sub city have no electricity and pure water access. Recently in the sub city there is one (1) health center and 14 private clinics.

According to the assessment made by the health office of the sub city on patients, the most prominent diseases are environmental pollution related diseases, intestinal diseases and global warming diseases

Table 6 :Adult and Children ten top diseases of Hawela tula sub city 2021

Number	Top Ten Diseases	
	Adult	Children
1	Malaria	Malaria
2	Typhus	Pneumonia
3	Typhoid	AURT
4	Pneumonia	Functional Intestinal diseases
5	Functional Intestinal diseases	Acute tonsillitis
6	Helmianthiasis	Helmianthiasis

7	AURT	Fever
8	Dis order of urinary system	Protozoa
9	Diarrhea non blood	Bacterial intestinal disease
10	Acute tonsillitis	Bacteria diseases infection

Source: Health office of Hawela tulu sub city in 2021

1.3.4 Infrastructures

The length of dry and all weather gravel roads in Hawela Tulu sub city is 151.44 km. All is gravel/rural roads which connects Kebele to Kebele and Kebele to the sub city. The. All Kebeles have a road network that provides service all season, nearly 98% of the rural Kebeles of the sub city are accessible.

The water supply source of the sub city, and even Hawassa town is mainly from Cheleleka wet land through springs, surface water, hand Dug wells, shallow wells and spring development. While the total water schemes are not well known, according to the finance and economic office 65% of the sub city communities have clean water problem.

The sub city has 24hrs electric service for the urban and semi urban rural Kebeles, whereas there some Kebeles have not electric service. Instead, they uses fire wood and charcoal for cooking and lighting purpose from the forest. The fire wood used in the house is release carbon mono oxide and exposed the household members for related diseases. According to the sub city finance and economic office, by now the total coverage of electricity of the sub city reaches 50% from the national grid hydropower source of energy.

With regard to communication the Woreda has post office, digital telephone, & mobile telephone services in the Woreda capital & satellite telephones and mobile networks in all the rural Kebeles with 100% coverage (Hawela sub city finance and economy office, 2021).

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

The study area is characterized as agricultural economy where by the main social, and economic aspects are expressed in terms of crop production and animal husbandry. The agricultural production system is mainly mixed farming, including crop and livestock productions. Major

harvests are maize, chat, inset vegetables, sugar cane, fruits and to some extent coffee. And also vegetables, onions, and potatoes have produced. Inset is the dominant crop production in the Cheleleka wetland watershed.

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

Now a days the wetland becomes shrinkage due to many reasons; expansion of agriculture, settlement, industrialization and plantation of eucalyptus, it was source of drinking water and grass for their livestock. The FGD participants named that, they are force to decrease their cattle number and lose they get from them.

1.4 Drivers & Pressure of Social and Economic Environment Change

The causes of environmental change are complex and there are numerous factors that lead to change ecosystems of Cheleleka wetland resource.

1.4.1 Land use change

Replacement of forest and grasslands areas by croplands and eucalyptus as reported by Negash (2004). Landscape changes included a reduction in field sizes and an increase of perennial crops (chat and enset) at the expense of annual crops, grasslands, and bare soil. The main consequences of the landscape changes are habitat loss for wildlife and a decrease in water availability (Yodit kebede, 2019). In Wondo Genet, the expansion of the chat resulted in a decline of natural forests and an associated forest fragmentation in major chat producing areas, a decline in food crop production, and soil erosion from steep land cultivation. Farmers reported that attacks on their maize fields by baboons were one of the reasons they decreased maize production. The decrease in water availability has been reported by previous studies which investigated the effect of land cover/land use change on the hydraulic regime and water volume of Cheleleka wetland

1.4.2 Mechanized and small holding agricultures

Major socio-economic activities in and around the wetland are mechanized and small holding agricultures and quarry activities. Agricultural development interventions which had been started since 1950 in the area primarily initiated extensive maize crop production. Chemical fertilizers such as DAP, UREA, different types of pesticides and herbicides are applied in the farm while

multiplying seeds. An official from Bishan Guracha town municipality indicated that close to Shallo basic seed farm there are individual small holdings estimated to be about 10 hectares of land. These small holdings also use inorganic agricultural inputs. Similarly, ELFORA Private Farm is located around the wetland. The farm has provided job opportunities for 400-600 seasonal and 55 permanent employees. The farm allows free access to the local farmers to use the crop aftermath for their livestock feed. However, the farm does not have any mechanism to control agricultural inputs/chemicals from its direct flow to the wetland and thereby to the lake. During the rainy seasons, the flood from this farm easily enters the lake ((Interviewed in April 2017). These intensive farming activities have created pressure on resource degradation of the wetland. Years back, these production activities made large grazing land under cultivation. Through creating employment opportunities for the local people, these again initiated irregular settlements in and around the wetland. Most of the settlers in the wetland are those who are working as seasonal laborers in this Private Farms.

1.4.3 Deforestation and Farmland expansion

Smallholding agricultural and deforestation are other prominent activities in the catchments of Cheleleka wetland. These activities have been practiced around the wetland where Wondo Genet area has taken much of the land share. Hence, the wetland gets much of its water from Wendo Genet catchment. The catchment had been covered with natural forest. However, expansion of farm land coupled with the rise in the demand of its products at the nearby urban centers such as Hawassa and Shashemene are responsible for continues decline of the forest cover in the area. These activities, in turn, have affected the quantity and quality of water flows towards the wetland. Regarding this, one of the informants in the area states, ' the amount of the river water that come from Wendo Genet area and enter into the wetland have declined."

1.4.4 Irrigation activities

Another important activity in the catchment is irrigated agriculture. It has been reported that people in Wendo Genet Woreda (particularly in such areas like Edo, Basha, Busa, and Elala) engaged in intensive irrigated agriculture for growing khat, sugar cane and vegetables which seriously affected the amount of inflow of water into the wetland. Similarly, in the northern part of the wetland where Tulu spring is located, farmers are growing vegetables. They grow potato,

onion, tomato and cabbage. These crops are important sources of income for the new settlers of the area. Farm expansions into the wetland are observable phenomenon. Unlike the vegetable production, it has been irrigated with polluted water coming from factories. Indeed, polluted water could damage plants. Farmers experienced the negative effects of waste on their farms.

1.4.5 Irregular settlement and land encroachments

Another important feature that has been affecting the wetland is irregular settlement. This settlement is targeted to get land access for animal grazing and cultivation of crops during the dry and wet seasons. According to (Dagne Shibru, 2019), at Cheleleka wetland, over 500 housing units have been constructed and so many new huts have been still under construction. Currently, the total human populations resided in the area are estimated to be 2500 formally and informally.

Eucalyptus tree has been used as strategic plant in encroaching the wetland. People use this tree for drying the wetland and preparing it for crop cultivation. It' is because of high water absorbing potential, large tract of land has been incorporated into the farming activities. Similarly, it has served as setting boundary to ensure encroached tract of land as legitimate claim. Besides, eucalyptus tree has been used to generate substantial amount of income for the people through supplying it for construction and domestic energy sources in the nearby rural and urban areas. However, eucalyptus tree negatively affects the wetland ecology by absorbing large amount of water.

Expansion of Hawassa city also seriously impacted on the wetland size. Most people have strong belief that the wetland is a natural resource open access for housing and farming activities, though the Kebele administrations around have some control over the land. The Kebeles in collaboration with Tula Sub-city and police force made a survey around the wetland and found large number of individuals involved in the irregular settlement and land encroachments. Hence, they have recently accused about 400 persons who have involved in irregular house construction and farming activities in and around the wetland

1.4.6 Emergence of social institutions

Institutions (formal and informal) in and around the Cheleleka wetland, are working concurrently, though the formal relations are dominating the informal ones. Road is construction at the upstream northwest and northeast of the wetland, joins the new settlements with Hawassa- Shashemene asphalted highway. It transforms temporary settlements into permanent ones. And the pressure of permanent settlers is like too.

Tutu spring is one of water sources coming out of the foot of a big mountain in the northern part of the wetland. The spring has been built and developed to provide drinking water for human and domestic animals, and washing cloth for the community living in the area. Some people also come to fetch the spring water from such distant areas. At close proximity to Tulu spring, we find newly established elementary school, mosque and protestant church. In addition, the lowest government structures (Kebeles) of the Oromia and SSNPR States are in place.

1.4.7 Industrial Effluent

The wetland has been a direct contact with discharges from factories operating in the area. These industries have been releasing effluent since their establishment in 1980s. Although several industries such as beverage, soap, textile, plastic, meat processing and many others are operating in the area, it was evident that the brewery factory, has prominently discharged its waste. The nature and amount of waste discharged are not adequately studied. Its impacts could be many. Some literatures indicates that: the industrial effluents coming from Brewery and Hawassa Textile Factory have caused several health and economic problems on humans and animals. The community have a direct contact with the waste. They have been suffering from skin irritation and respiratory diseases due to direct contact and pungent smell. Children are affected by the waste, which smells alcohol, while they often use it for swimming during the rainy season. Animals have been contaminated and drink when they cross the industrial effluent to grazing field. The waste cause's fetal abortion, reduces milk production, discolors milk and emaciates animals. Occasionally, it leads to the death of animals. The local communities indicate that the industrial waste has been used for different purposes. People use the waste for domestic and vegetable productions. Children who fetch the waste water (for the construction of mud houses) are direct victims.

1.4.8 Degradation of catchment areas

The water catchment areas of the Cheleleka wetland range from an altitude of 1600 to 2600 masl. The causes of the basin's degradation are generally the same for all of Ethiopia's catchments. The major ones are deforestation mainly for agricultural purposes, encroachment and settlement as a result of population pressure and the need for grazing land, over-grazing as a consequence of overstocking and soil erosion and land degradation.

1.4.9 Demographic pressure:

High population pressure and urbanization in developing countries increases the demand for land, encourages deforestation, increases pollution and promotes the trade of species in danger of extinction. The driver of environmental change is mainly the results of population growth. In the last two decades basically due to a number of reasons the populations of the Hawela Hula sub city increase rapidly. Some of the following reasons are the important ones,

- ✓ As the sub city part of the Hawassa town, there is high labor demand, the surrounding communities especially the youths migrates to the sub city for casual labor.
- ✓ Lack of awareness on contraceptive methods contributes to high birth rates. Even though, currently much attention is given to the provision of primary health care in the households, the provision of family planning services are still low. As a result, there is much more delivery and an increase to the existing population.

1.5 Impacts of Social and Economic Environment Change

Two hundred years ago, Malthus predicted that the power of population is indefinitely greater than the power of the earth to produce subsistence for man.

With high population growth rate, there is a very high demand over the available natural resources to satisfy the increasing demand by cultivating the wetland (ecologically fragile) which exacerbated the condition of environmental degradation. Population growth cause scrambling of the Cheleleka wetland for cultivation, grazing and settlement.

Temporally and spatially extensive drainage affects the water level in wetlands and, in turn, the groundwater level in the surrounding areas. The loss of nearby spring water has had a number of serious impacts, including greater time and labor effort for women to collect water from more distant springs. This increase to the women's workload may have an impact upon their other activities leading to less attention to other domestic, family and agricultural tasks. In extreme cases, greater time requirements on one activity may lead to increased child malnutrition if attention to children is reduced. Alternative responses to the loss of local springs may be to use streams as sources of water, which are likely to be more polluted, increasing being unhealthy, especially amongst children. In turn, this being unhealthy can affect farming and other domestic and economic activities, reducing food security and economic well-being.

1.6 Responses to Social and Economic Environment Change

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

  - ✓ Closing the gap between high population growth and low economic productivity through planned reduction of population growth;
  - ✓ Improving the carrying capacity of the environment by taking appropriate environmental protection measures; and
  - ✓ Improving the social and economic status of vulnerable groups (Women, Children & Elderly).

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

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

- Environmental Impact Assessment of new development projects in the catchment;
- Incorporating environmental education into the national curricula;
- Empowering local communities to conserve and protect their wetlands;

- Providing incentives for human activity that embraces ecological considerations;
- Placing reasonable pollution charges against polluters;
- Enhancing stakeholder awareness through programs in the media, workshops, short courses,
- Catchment treatment and promoting conservation-sensitive cultivation practices.
- To reduce the problem and provide quality education at primary school level, schools were constructed at village level, teachers were trained and placed, and girl's participation was increased in some extent. In recent years as a part of Growth and transformation plan, health service coverage and school enrolment at all levels improved remarkably as human capital development also received significant attention from the Ethiopian government.
- The government by allocating budget for various sectors, such as agriculture, education, health, and water and road development has shown promising effort in eradicating poverty in the Woreda. As a part of government health policy document health professionals in the Woreda are working on maternal and child care, immunization, control of basic infectious diseases, epidemic and sexually transmitted diseases and specially malaria. In the implementation of the health policy, the involvements of private sectors are also great in the delivery of health services.

1.7 Recommendation

Develop a national policy and legal framework for the conservation, management and wise use of wetlands, ratify conventions and agreements on waterfowl and wetlands of international importance, promote the wise use of wetlands, create wetland reserves, and liase with other parties on issues of wetland conservation. As Ethiopia still needs to make progress addressing wetland issues, it is recommended that the following activities take place in the very near future:

Raise Public Awareness

In order to alert the public to the values and functions of wetlands and the need for their wise use, a series of public awareness campaigns are needed. These should include the production and distribution of awareness materials (posters, leaflets and fact sheets), involve the mass media to carry features on wetlands and conduct a series of awareness raising seminars and workshops.

Play Advocacy Roles

Develop a national policy and legal framework for the conservation, management and wise use of wetlands, ratify conventions and agreements on waterfowl and wetlands of international importance,

promote the wise use of wetlands, and create wetland reserves, and lease with other parties on issues of wetland conservation.

Assessment of Wetlands Resource Base

Conduct surveys and compile a preliminary inventory of wetlands, that is, develop a computer database for sites in the inventory.

Prepare an action plan

An action plan for wetlands should be prepared that considers, amongst others, the identification of areas important for biological diversity, unique flora and fauna, endangered species, or those that are of national or international importance and make recommendations for their protection (through law enforcement). The plan should also seek the improved management of wetlands so that the various uses can be retained without conflict. An increasingly vital aspect is the participatory approach, which seeks to involve and directly benefit local people in wetlands conservation. If this is not achieved, conservation objectives will be unattainable, especially in Ethiopia, with its alarming human population growth rate. Last but not least, rehabilitation activities in water catchment areas will ensure that functions and benefits from wetland resources are maintained well into the future.

Conduct Research and Monitoring at selected wetlands

Identify and prioritize wetlands for research and monitoring activities. Involve the site adjacent community in the research and monitoring activities to make them aware of the importance of the target wetlands. Incorporate the outputs of the research and monitoring into existing community traditional knowledge to come up with wetland management plans.

A Focal Institution for wetlands

This institution could be a government body or made up of a number of different bodies in the form of a national steering committee. Its task will be to lead the cause for wetlands in the country and, amongst other things, will look at issues of wise use, management, research, monitoring and networking. Wetlands occupy less than 7% of the earth's surface, but their importance is disproportionately much greater. Wetlands are often shared by different countries making them inherently international in scope. As a result, a collective, collaborative approach is essential if efforts for their conservation are to succeed (Wetlands International, 1998). Although wetlands management and conservation are local issues, most water birds use many wetlands, travelling between local wetlands and across national boundaries during the course of their annual cycle. So how do we match the need for the wise use of local wetlands with those of internationally migrating birds? The big challenge is to identify best practice approaches and

priorities for the conservation of water birds and their wetland habitats within the overall context of sustainable development.

Full attention should be paid

In order to develop and use these wetland resources wisely, therefore, full attention should be paid to understanding the dilemmas that they face and identifying ways to conserve them. The past and present status of these resources must be carefully and regularly monitored, assessed and identified. Harmful trends that impair the natural qualities of these wetlands must be reversed using appropriate strategies and pertinent laws must be reinforced by involving all stakeholders in their design and implementation.

- The management and conservation of wetlands should be based on research, planning and monitoring.
- The coordination of wetland management requires the signing of memoranda of understanding between the Ministry of Agriculture, Ministry of Water Resources, Environmental Protection Authority, Biodiversity Institute, Ethiopian Agricultural Research Organisation and the Ethiopian Wildlife Conservation Organization and the Regional States. This would demonstrate the recognition of multi-sectorial interest in wetlands.
- An Environmental Impact Assessment should be carried out before undertaking any development that involves wetlands.

2.LAND USE LAND COVER CHANGE OF CHELELEKA WETLAND ECOSYSTEM

2.1. State and Trend of Land Use land cover Change of Cheleleka Wet Land Ecosystem

Wetland is a term that has been developed to describe a range of situations where land is affected by water. As cited by Adrian wood, Davies indicated the importance of water in the following definition of wetlands: Wetlands are ecosystems or units of the landscape that are found on the interface between land and water.

"*Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by shallow water."* (Adrian, 2001). He also noted the different components of wetlands considering always water is a dominant feature of wetlands. *"Wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent*

or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." (Adrian, 2001).



Figure 3: partial view of Cheleleka wetland

Cheleleka wetland and its threat

The most common threats to wetlands are the result of a combination of social, economic and climatic factors, which have increased pressure on the natural resources in Cheleleka wetlands. Wetlands are being transformed and altered at a significant rate into what many people consider better alternative uses.

Salinization, a widespread threat to the structure and ecological functioning of Cheleleka wetlands, is currently occurring at an unprecedented rate and geographic scale. The causes of salinization are diverse and include alterations to freshwater flows, land-clearance, and irrigation, disposal of wastewater effluent, sea level rise, storm surges, and applications of de-icing salts. Climate change and anthropogenic modifications to the hydrologic cycle are expected to further increase the extent and severity of wetland salinization. Salinization alters the fundamental physicochemical nature of the soil-water environment, increasing ionic concentrations and altering chemical and mineral solubility.

Wetlands are dynamic systems, continually undergoing natural change due to subsidence, drought, sea-level rise, or infilling with sediment or organic material. Thus, many wetlands are only temporary features of the landscape and will be expected to change and eventually

disappear, whilst new wetlands are created elsewhere. Direct and indirect human activity has considerably altered the rate of change of Cheleleka wetlands. The view that wetlands are wastelands, resulting from ignorance or misunderstanding of the value of the goods and services available, has led to their conversion to intensive agricultural, industrial or residential uses. Individual desires of farmers or developers have been supported by government policy and subsidies. Land use within both the wetland and its catchment influence the ecological functioning of the wetland and the products it produces (Afework, 2001). Despite all this and other indispensable values, these wetlands are under severe pressure and degradation.



Figure 4: land-use change as a result of Eucalyptus tree plantations

The people who live in the wetland plant eucalyptus trees and destroyed the water bodies because of land use/land cover (LULC) change is one of the challenges which strongly influence the process of agricultural development and wetland resource management. The study projected to carry out land use /land cover changes, trends, and their extent of Cheleleka wetland over the last 20 years using different mapping. For the identification of land use/ land, cover change

Landsat imagery of 2000, 2010, and 2020 were used to determine the change in land use/land cover based classification.

The main objective of this study was to show the future challenges and opportunities for sustainable land management of Cheleleka wetland. It believes that the number of barriers and root causes contributes to serious wetland degradation in the area. Ever-increasing unwise utilization of resources coupled with land-use changes, agricultural intensification, rapid population growth, and urbanization with its proximity in particular and watershed in general have become severe threats to the long-term survival of the wetland. Lack of integrated watershed/landscape management and lack of proper land use planning and clarity in the procedures for, and jurisdictions over, resource utilization of the wetland and its associated industries have also been contributory causes.

Land use and Land cover Changes

The definition of land use and land cover has been used interchangeably in the land use research community because of the availability of many existing information systems. However, these two terms explain two different issues and meanings. **Land cover** refers to the observed biophysical cover on the earth's surface including vegetation, bare soil, hard surfaces, and water bodies. Whereas **land use** is the utilization of land cover type by human activities for agriculture, forestry, settlement, and pasture by altering land surface processes including biogeochemistry, hydrology, and biodiversity (Di Gregorio and Jansen, 2000). Land use and land cover changes became prominent as a research topic on the global environmental change several decades ago with the idea of processes in the earth's surface influence climate.

Changes in land use and land cover are caused by direct and indirect consequences of human activities on the environment to have a better life. One of the direct impacts of humans is population growth where its increase and decrease have effects on land use, especially in the developing world at longer time scales. According to Lambin et al (2003), it can also be caused by the mutual interactions between environmental and social factors at different spatial and temporal scales as land use and land cover change is a complex process.

Land use / Land cover change plays a vital role in the study of global change. Land use / Land cover and human or natural modification have largely resulted in deforestation, biodiversity loss, global warming, and an increase in natural flooding. Thus environmental problems are often related to Land use/ Land cover change. The land use/land cover pattern of a region is an

outcome of natural and socio-economic factors and their utilization by the man in time and space. The land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning, and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting from changing demands of the increasing population.



Figure 5: land use change from (wet land to eucalyptus tree plantation)

Methods of fact sheet preparation

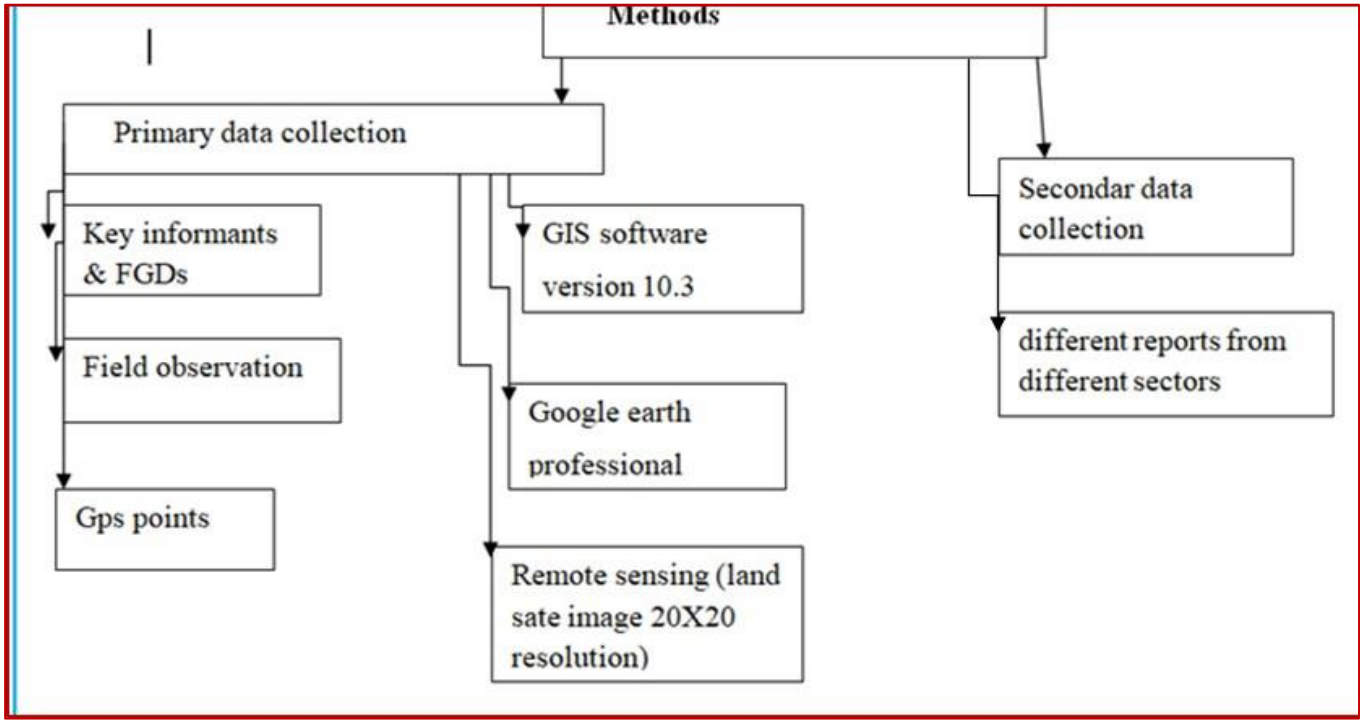


Figure 6: Summarized diagram representation of methods that used to extract Cheleleka wetland

To extract the land use land cover change of Cheleleka wetland, the following tools were used. Field observation was carried out based on checklists designed in advance to observe the situation in the ecosystem, and photographs of important sites were taken to enrich the study. With the aid of field observation, information from experts, and review of documents, and sectorial reports from different government sectors, Land sat images, Arc Gis 10.3 version, and remote sensing ERDAS 15 were used.

During the main field survey, data and information were collected correspondingly with physical field observation by conducting key informant interviewing of elders and technical persons from development agents up to Woreda technical experts for further analysis. Based on image-based land cover classification results, different land cover types were addressed and more than 20 GPS points (ground truth and associated descriptions) were collected during the main field survey.

Landsat is a readily and freely available multispectral dataset in the medium spatial resolution ranges that are widely used for land use and land cover mapping. Hence, to derive the land use

and land cover information, Landsat satellite images of 2000, 2010, and 2020 were used to analyze temporal and spatial changes in the study area.

Description of the Study Area

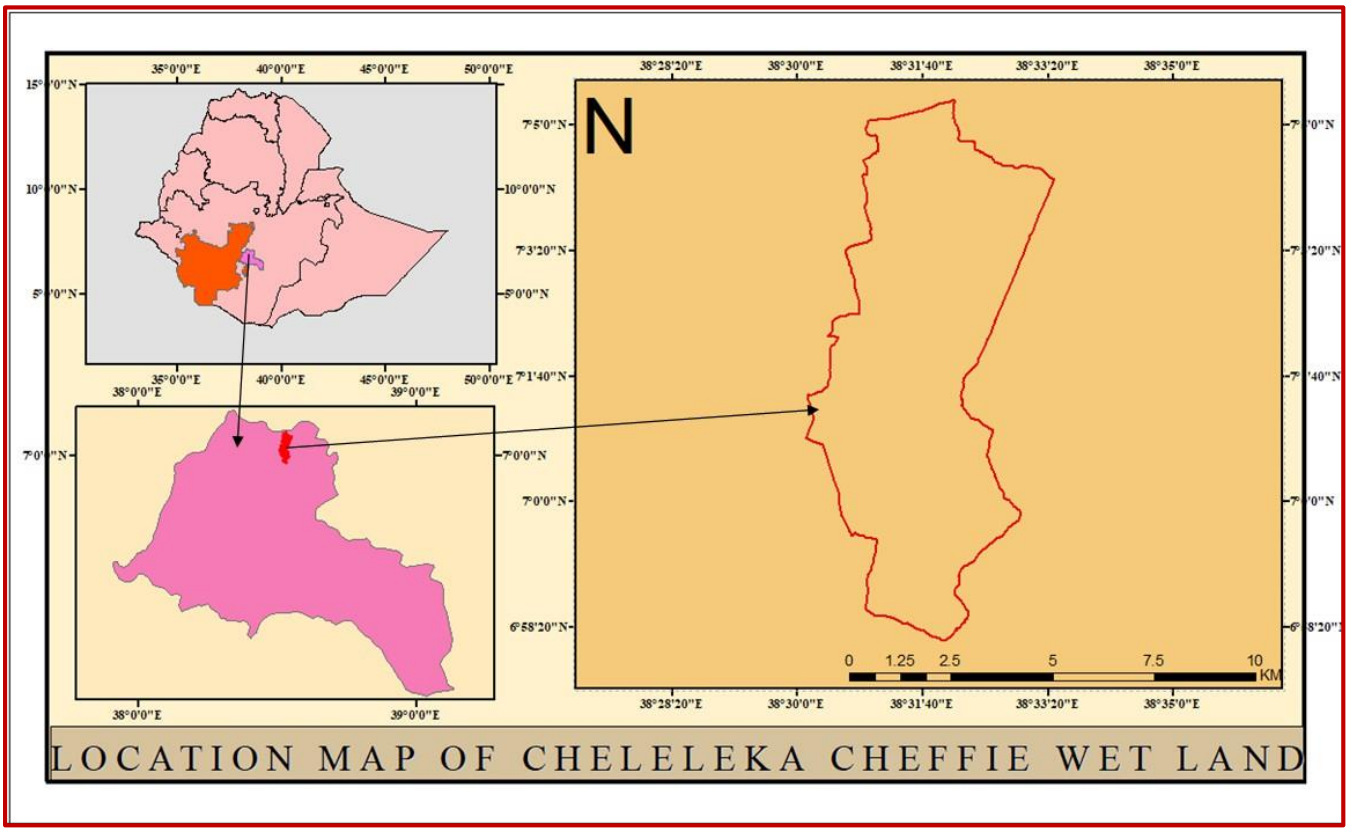


Figure 7: Location map of Cheleleka Wetland Ecosystem

The Cheleleka wetland is found in Tula Woreda, Sidama region of Ethiopia, which covers an area of 4453.4ha. It is far from about 5.5 km from the center of Hawassa town. It is located between (38° 30´ 7´´-38° 33´ 25´´ E longitude and 6° 58´ 9´´-7° 54´ 30´´ N latitude**.**

Land-use changes arising from a high rate of urbanization (settlements), agriculture; pasturing and deforestation are some of the contributing factors to land cover changes in the study area. These changes in LULC reflect the population growth, land consumption rate, and climate. The expansion of Hawassa town has resulted not only in depletion of natural resources but the deterioration of the environment. Agriculturally productive and non-productive land and forest land have been converted into residential and other land use classes. The land use and land cover pattern of a town is an outcome of natural and socio-economic factors and their utilization by a man in time and space. The uncontrolled growth of urban development has adversely affected

Hawassa towns' ecosystem which influences to indirectly reflect on weather parameters and eventually leads to local climate modification (Balogun et al., 2009).

The past and current uses of the Cheleleka wet ecosystem

Ethiopia has more than 58 different types of wetlands which provide significant socio-economic and environmental values. Despite their small area coverage, wetlands in Ethiopia are among the most productive ecosystems, and have significant economic, social, and environmental benefits. The importance of Ethiopian wetlands goes beyond their status as habitat of many endangered flora and fauna species but they are a vital element of national and global ecosystems and economies (Mengesha 2017).

The values (goods) and services that wetlands provide can be broadly categorized as:

- ✓ **Functions:** flood alleviation, erosion control, stream flow regulation, water storage, ground water recharge, retention of pollutants, water purification, nutrient cycling, exchange of water between the surface and the groundwater and the surface and the atmosphere.
- ✓ **Products:** fish, fuel wood, timber, fodder for domestic animals, habitat for wetland- dependent species, rich sediments used for agriculture in the floodplains, fiber for thatching roofs and handicrafts.
- ✓ **Attributes**: diversity of species, aesthetic beauty, cultural heritage, tourist attractions, and recreation such as bird watching, sailing, education and archaeology.



Figure 8: Host springs generating from the wetland

As you see from the figure above, the Cheleleka wetland provides several benefits to the community. Because the wetland ecosystem services provide several benefits to the community, the community used the water for irrigation, used water for household consumption, served as a home for different grass and fish species, and medicinal value from the spring water to treat their foot ulcers, (የእግር ቁርጥማት) self-portraits, (የራስ ምታት) stomach-ache (የሆድ ቁርጠት) and stomach disease(የጨንጉራ በሽታ). But now the community does not obtain good access to water due to many reasons overpopulation and urban expansion, city Administration provides drinking water to Hwassa people from this wetland.

Wetlands are unique, productive ecosystems where terrestrial and aquatic habitats meet. Wetlands play a critical role in maintaining many natural cycles and supporting a wide range of biodiversity. They purify and replenish our water, and provide the fish and rice that feed billions. They serve as a natural sponge against flooding and drought, protect our coastlines and help fight climate change. Bursting with biodiversity, wetlands are a vital means of storing carbon.

Wetlands are particularly important providers of all water-related ecosystem services. They regulate water quantity, groundwater recharge, and can contribute to regulating floods and the impacts of storms.

Wetlands also help in erosion control and sediment transport, thereby contributing to land formation and increasing resilience to storms. All these ecosystem services improve water security, including security from natural hazards and climate change adaptation. the role of ecosystems in the supply of water and its quality.

Wetlands are productive areas for plant life, animals and wetland agriculture. Compared to many other ecosystems,

Wetlands are the major habitat for most of the world's water birds and key habitat for migratory species. Almost all of the world's water birds use wetlands as feeding and breeding grounds. Migratory water birds use wetlands throughout their range which can sometimes literally be from pole to pole. The feeding, breeding and stop-over areas across and between continents that migratory birds depend on requires coordinated wetlands conservation efforts among many nations.

Wetlands are an important source of food. Well-managed rice paddy systems, for example, produce not only rice but also co-benefits from rice-associated biodiversity, such as highly nutritious food in the form of fish.

Wetlands also support the multitude of biota that helps sustain rice productivity through supporting nutrient cycling and pest and disease regulation.

Wetland ecosystems can have some of the highest ecosystem service values compared to other ecosystems. This is due to the importance of clean water provision, natural hazards mitigation, for example mangrove forests and floodplains, and carbon storage.

Wetlands have high recreational, historical, scientific, and cultural values. Wetlands have played an important part in human development and are of significant religious, historical or archeological value to many cultures around the world. They are also often inviting places for popular recreational activities including fishing, bird watching, photography and hunting.

The means of livelihood of the community who live around the Cheleleka wetland is both mixed agriculture type (ie animals rearing and crop cultivation) therefore, the major crop production in the area are Enset, maize, chat, coffee sweet, round potatoes and fruits like avocado and mango bananas and main pets animal those reared by the living community are oxen, sheep cows, donkey respectively. The production potential of the district in different crops is Maize 1758ha, Enset 1572ha, Coffee 1079.2ha, Haricot bean 950ha, and Vegetables 403.8ha. Land productivity also declines due to the unsustainable use of natural resources like the Cheleleka wetland. Now and then there has been a change in land use lands cover, for instance, grazing land to farmland and settlement.



Figure 9: Focus Group Discussions at the local level

As FDGs told us, there is a constant border dispute between the two regions. Both regions Sidam and Oromia are loggerheads over the use of wetland resources but local elders traditionally solve the problem. The major cause for the degradation of the wetland are; population, industry expansion (by waste disposal problem) high demand to use the wetland for farming by Oromia farmers, and expansion of eucalyptus tree plantation

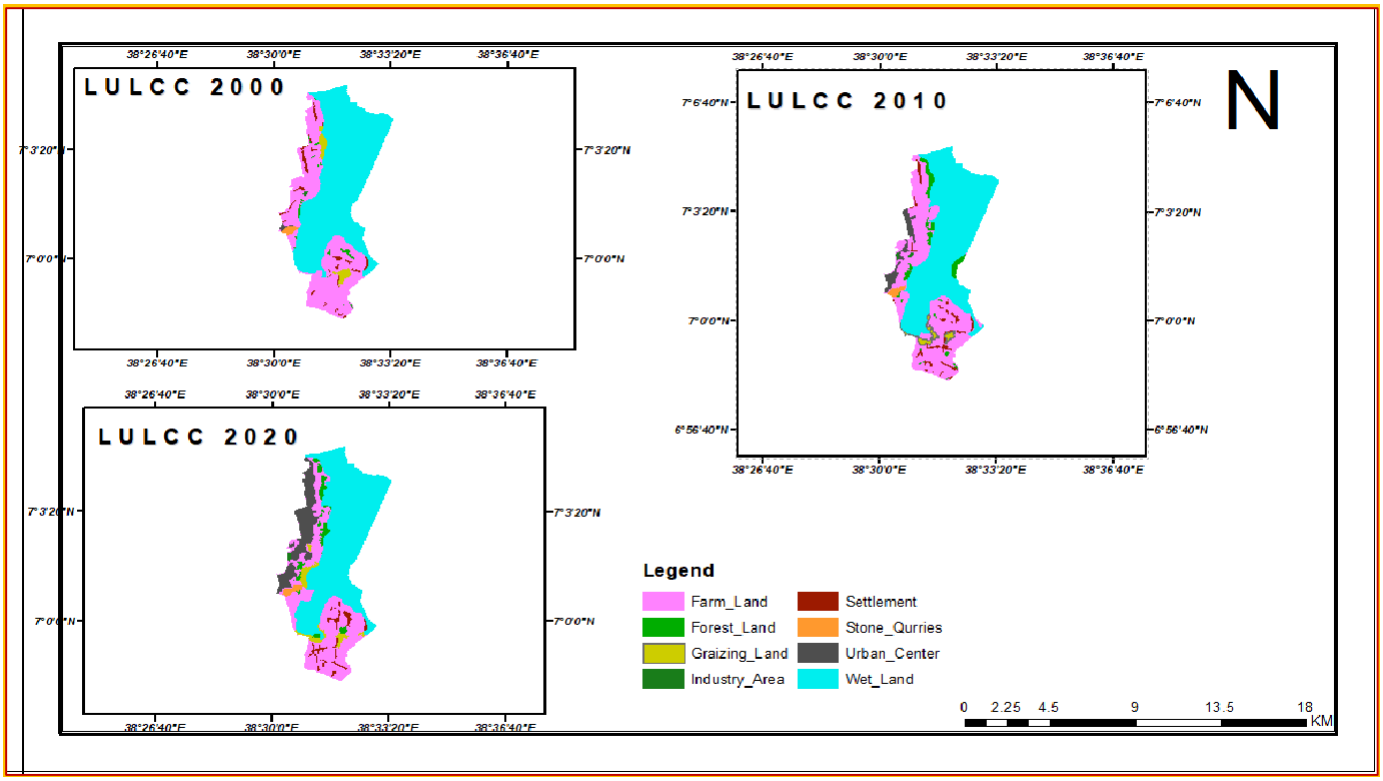


Figure 10: Land use land cover classification in the year: 2000, 2010 and 2020

Table 7 :Land use land covers distribution for (2000, 2010, and 2020) in Cheleleka wetland ecosystem.

Land use land cover classes	The year 2000		The year 2010		The year 2020	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Urban Centre	54.81	1.23	117.06	2.63	187.82	4.22
Farm Land	1360.26	30.54	1560.02	35.03	1625.28	36.50
Forest Land	113.32	2.54	144.87	3.25	157.28	3.53
Grazing Land	69.25	1.55	87.5	1.96	108.46	2.44
Industry Area	4.7	0.11	5.95	0.13	10.15	0.23
Settlement	94.79	2.13	99.17	2.23	110.53	2.48
Stone Quarries	28.63	0.64	31.62	0.71	36	0.81
Wet Land	2727.64	61.25	2407.21	54.05	2217.88	49.80
Total	**4453.4**	**100**	**4453.4**	**100**	**4453.4**	**100**

Source: Land classification of land sat images of **2000**, 20**10** and 20**20**

Land Use/Land Cover change

As indicated in the classification scheme Settlement, Urban center, Agricultural/farm/ land, Forest land, Grazing land, Industrial area, Stone Quarries, and wetland, and are the major LULC classes for the study periods. As it has been observed from the above table, from the year 2000 to 2010G.c, urban center was increased from 54.81ha (1.23%) to 117.06 ha (2.63%), farmland 1360.26 ha (30.5) to1560.02 ha (35.03%), Forest land 113.32 ha (2.54%) to 144.87 ha (3.25%),
Grazing land 69.25 ha (1.55%) to 87.5 ha (1.96%), Industry area 4.7 ha (0.11%) to 5.95 ha (0.13%), Settlement 94.79 ha (2.13%) to 99.17 ha (2.23%), Stone quarries 28.63 ha (0.66%) to 31.62 ha (0.71%). However, the wetland was decreased from 2727.64 ha (61.25%) to 2407.21 ha (54.05%) for the last ten years.

This result indicates that the high rate of urbanization coupled with population growth has caused changes in land use and land cover in Hawassa city, Ethiopia. Therefore, understanding and quantifying the spatial-temporal dynamics of urban land use and land cover changes and its driving factors is essential to put forward the right policies and monitoring mechanisms on urban growth for decision making.

Associated with the rapid expansion of urbanization, a lot of lands have been converted from rural to urban. From the land use and land cover change point of view, expansion of urban areas is of greater importance because of its strong effect on other land cover classes, such as agricultural lands, non-built areas, forests, and others. Ethiopia, having the second largest population in Africa has a total of over 80 million populations. It has a 2.3% of annual growth rate and having 4.6% average annual urban growth rate (Haregeweyn *et al*, 2012).

According to Hwassa city Administration annual report, 2019, Hwassa is one of the most important consumer centers of the country and the core of its industrial and commercial activity. Nowadays the cities serve as the center for public corporations and privately owned industrial companies. Among Hwassa's main industries are food processing and those producing consumer goods. For instance, beer, textiles, and footwear, industry are used for domestic markets. Numbers of investment projects who acquire investment certificates and projects that start operation are Service 8, industry 13, Agriculture 1, and construction 24. Especially factory-like

BJI beer and **Etabe soap** are major contributors particularly the beer industry releases its liquid waste to the wetland and this highly affected the land ecosystem.



Figure 11: Beji Beer factories

Hawssa is Ethiopian most important city for both business and investment. The city contains a high concentration of trade and other services and manufacturing commercial activities include wholesale, retail, small business, and different types of services.

As the FDGs confirm that, there is a continuous conflict on resource use among the living community and between Oromia and Sidama regions on the benefits of Cheleleka wetland but they resolve by traditional conflict resolution methods in the area. The major cause for the degradation of the wetland are; overpopulation, industry expansion (by waste disposal problem) high demand to use the wetland for farming by Oromias farmers, and expansion of eucalyptus tree plantation

Table 8: land use description

No	Land-use type	Descriptions
1	Cropland	This class describes land which is mainly used for growing crops. Crops in this land are either grown by irrigation (commercial farmland) or are rain-fed (small-scale farmland).
2	Grassland	This class of land cover defines grassland or tropical savannah as the main vegetation cover.
3	Forest land	This class describes the areas with evergreen trees, mainly growing naturally.
4	Shrubs land	Refers to those areas covered with trees, shrubs, bushes, and some grasses that dominate the foot-slopes and rivering landscapes. There exists variation in vegetation between dense shrub with an estimated cover of >50% and open shrublands with less than 50% cover.
5	Bare land	Refers to those land surface features devoid of any type of vegetation cover.
7	Settlement	This class describes the land covered with buildings in the study area. It includes commercial, residential, industrial, and transportation infrastructure.
8	Wetland	Those areas where the water table is at, near, or above the land surface for a significant part of most years .e.g. marshes, mudflats, and swamps
9	Built-up area	Consists of urban fabric industrial

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

Table 9: Land use lands cover mapping and change detection.

No	Land use land cover classes	Change detection between (2000-2010)		Change detection between (2010-2020)		Change detection between (2000-2020)	
		Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
1	Urban Center	62.25	1.40	70.76	1.59	133.01	2.99
2	Farm Land	199.76	4.49	65.26	1.47	265.02	5.95
3	Forest Land	31.55	0.71	12.41	0.28	43.96	0.99
4	Graizing Land	18.25	0.41	20.96	0.47	39.21	0.88
5	Industry Area	1.25	0.03	4.2	0.09	5.45	0.12
6	Settlement	4.38	0.10	11.36	0.26	15.74	0.35
7	Stone Qurries	2.99	0.07	4.38	0.10	7.37	0.17
8	Wet Land	-320.43	-7.20	-189.33	-4.25	-509.76	-11.45

Change detection can be defined as the process of identifying differences in the state of objects or phenomena by observing them at different times by using GIS remote sensing techniques. Change detection has a wide range of applications in different disciplines such as land-use change analysis, forest management, vegetation phenology, seasonal changes in pasture production, risk assessment, and other environmental changes (Singh, 1989).

The mapping and classification of the images taken for this study produced eight major land use land cover types. This result shows that there is a substantial variation in land use land cover for the study area since 2000-2020 G.C.

In the period between 2000 and 2020 for the last 20 years, except wetland, all land-use types show a positive trend. This is due to the expansion of agricultural activities by the community and eucalyptus tree plantation around the wetland farmland increased by 5.95% grazing land 0.88%, urbanization by 2.99%, industry area 0.12%, stone quarries 0.17% and forest land by 0.99% respectively declined while the wetland has been decreasing by 11.45%.

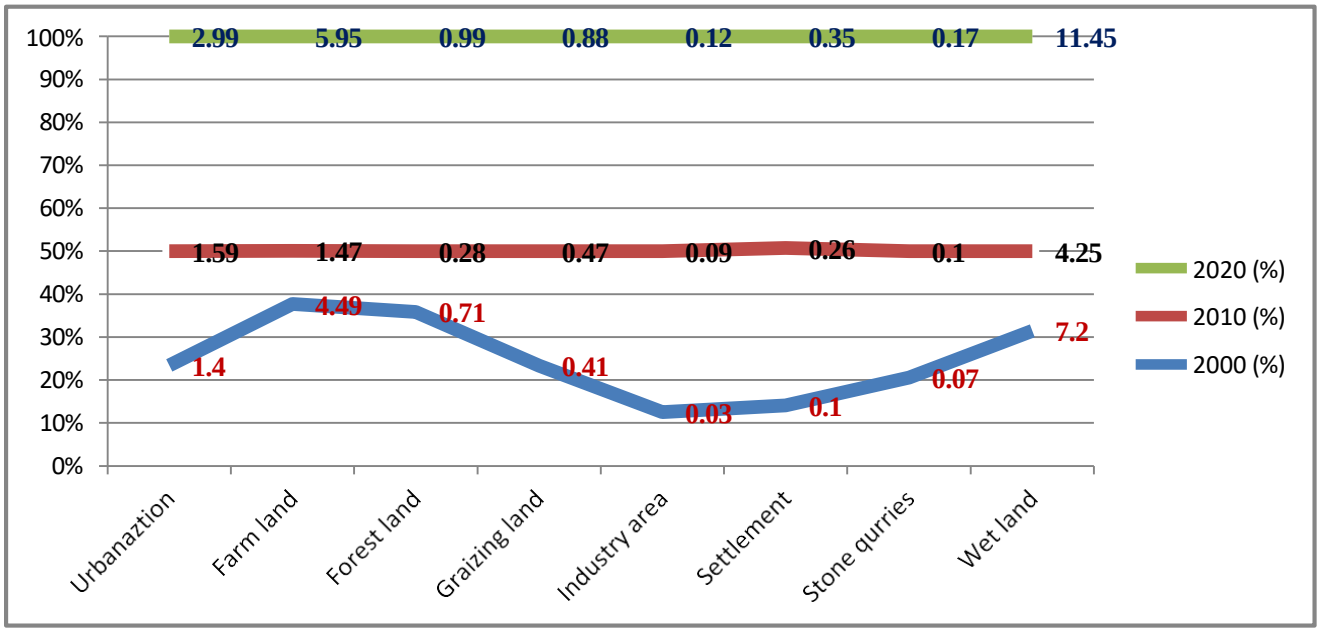


Figure 12: Graphic percentage representation of LULCC of 2000, 2010 &2020 respectively.

In particular, the expansion of the industrial area, urbanization, and eucalyptus tree plantations are accelerating over time to meet the requirements of an increasing population in the area.

Therefore, as you observed from figure 12, urbanization, grazing land, settlement, stone quarries, and industrial area clearly show increasing trend though time in all years interval and farm land, and forest land is decreasing in 2010 and highly increasing in 2020, however, the wetland has a decreasing trend at all times.

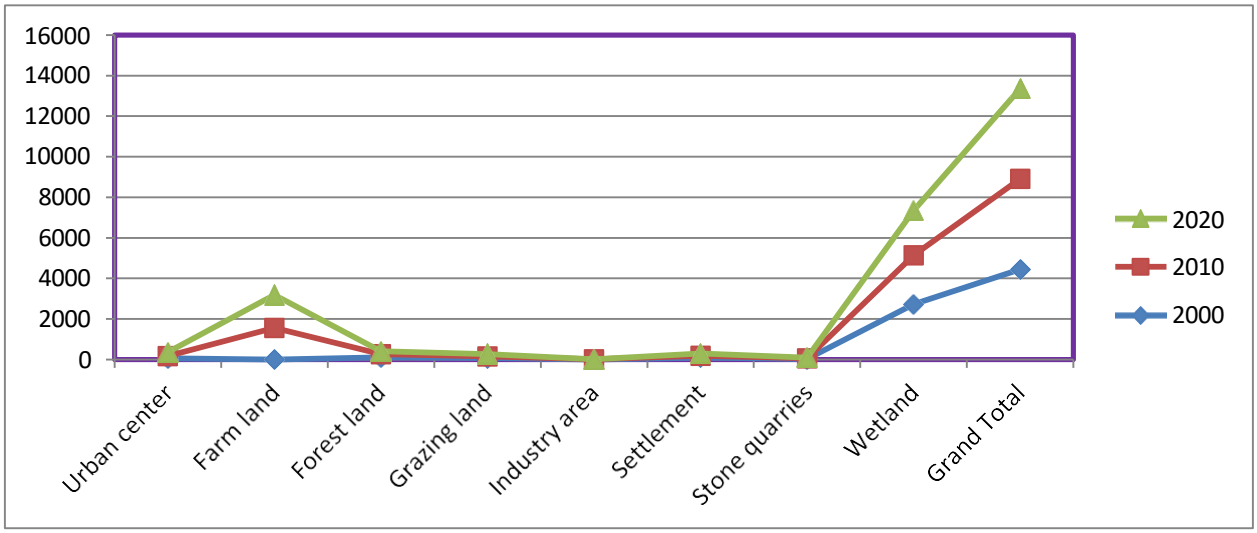


Figure 13: Summary of land use land cover extent by percentage (from 2000-2020).



Figure 14: overgrazing, stone quarries, and eucalyptus tree plantations (field survey, 2020)

As we have tried to prove in the field, the problem of eucalyptus tree plantation, stone quarries, and overgrazing are seriously affecting the Cheleleka wetland. Throughout human history,

anthropogenic manipulations of the hydrologic cycle have artificially altered the balance of salt and water on the landscape leading to increased salinity in some wetlands, inland aquatic systems, and upland soils. This accumulation of soluble salts, which causes ionic concentrations to increase above natural levels, is known as salinization. Grazing animals can ingest excessive amount of salt from feed, drinking water and soil which can lead to reduction in growth rate. Water is one of major source of salt from grazing animals and salt level in water could have more significant impact on their growth (Wilson 1978).

Animal population is another factor to the destruction of Cheleleka wetland because of large numbers of animals are deployment in the specific area of wetland to grazing. This effect is continuing to create serious problems to the wetland resources now and in the future.

2.2 Drivers and pressure for land Use Land Cover Change of Cheleleka wet land Ecosystem

Land use and land cover change is a major aspect of the pressure on the limited land resources that is driven by different biophysical and anthropogenic factors particularly population growth. Therefore, analyzing urban land-use changes provide greater importance to the research community, urban planners, stakeholders as well as decision-making groups in terms of understanding the impacts of land use land cover changes in the study area.

From most of these studies, it is evident that population pressure is one of the major drivers of land use and land cover changes through destruction of forest and vegetation cover for agricultural and urban expansion as discussed by (Amsalu *et al,* 2007). Population growth coupled with migration from rural to cities leads to further expansion of urban areas at the expense of vegetation cover which is commonly practiced in western highlands of Ethiopia according to Zeleke and Hurni (2001). As population pressure increases, there is further limited access to farmland. These farmers therefore encroach into wetlands and forest areas for conversion into agricultural land.

Ethiopia is one of the second largest populated countries in Africa with a total population of over 80 million and having an annual growth rate of 3.02%. The country is experiencing an average annual urban growth rate of 4.6%, which is a high rate by world standard (Cohen, 2004).

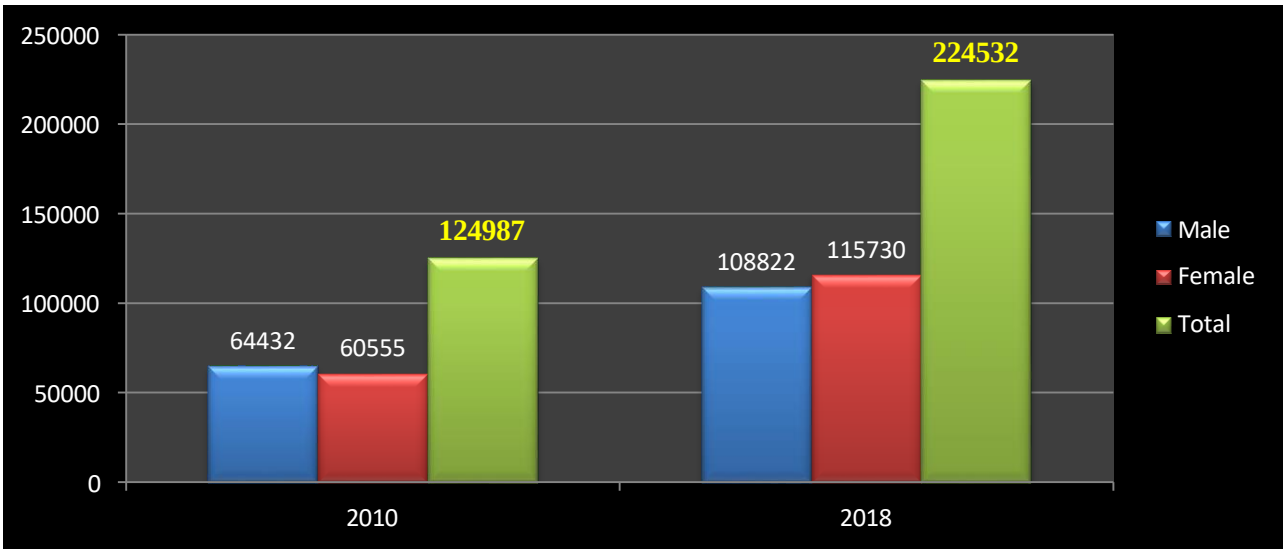


Figure 15 :Population growth rate

As we have seen from figure 15, in the last eight years, the population reached at 2010 is 124987 people and at 2018 is 224532 people and the difference (b/n 2010 -2018) is 99545 people. This indicated that, the population growth of Cheleleka wetland is growing rapidly.

Drivers of wetland loss

Often viewed as wastelands to be drained, filled and converted to other purposes, the main causes of wetlands loss and degradation include major changes in land use, especially an increase in agriculture and grazing and urban infrastructure development, air and water pollution and excess nutrients, and water diversion (dams, dikes and canalization).

However, major driving activities resulting in the transformation of wetland habitat in Cheleka wetland include unregulated conversion for agricultural production (including draining and diversion of water), overgrazing, population growth, urbanization and high concentration of salinization whereas, the pressure of Cheleleka wetland are: exploitation of ground water resources for Hawassa city (urban population), expansion of eucalyptus tree plantation.

2.3 Impacts of land use the land cover change of Cheleleka Wetland Ecosystem

Thus, at community level since the significance of wetlands in poverty reduction and ensuring food security is immense, their losses cause starvation. Since wetlands are sources of water and forage for livestock at dry season, it is major asset next to land in agricultural areas and may be

asset number one in pastoral communities (Wood, 1996) which will be absent due to the degradation and complete loss of wetlands.

The proportion of land affected by erosion is, rill erosion 30%, sheet erosion 47%, gully erosion 5%, stream bank erosion 10%, and flooding 8%

Changes in land use and land cover are caused by direct and indirect consequences of human activities on the environment to have a better life. One of the direct impacts of humans is population growth where its increase and decrease have effects on land use, especially in the developing world at longer time scales.

As a result, an influx of people is moving from rural areas. This would have a significant impact on the surrounding ecosystem: loss of agricultural land, destruction of forest cover, water depletion, and the benefits generated from the land. Because of this rapid growth on the urban-rural fringe, planners and policymakers lack accurate, timely, and cost-effective urban land use data which is most essential to decide on land resource management.

The groundwater of the catchment/wetland/ is significantly reduced from time to time. Increase evaporation decrease in rainfall and change of land use the land cover can be the reason for reduction (Lemelem et al, 2012).

Agrochemical usage (S) industrial wastewater released to farmland, grazing land that affects livestock, crops, livelihood women, effects on abortion vs human and animals, effects on crops. Especially liquid waste released from the factory is seriously affecting the wetland and the health of local community animals. The surrounding community planted eucalyptus trees near the wetland and eroding the land.



Figure 16: The impact of unwise use of water on humans.

As we have seen from the figure above, how solid waste affects wetland quality in the study area. Solid waste is a potential problem to human health and the environment from improper handling. Population growth is a major contributor to increasing solid waste in Hawassa. Under Cheleleka wetland, the local community brought a bath of soap and threw it into the water for bathing. This shows that the community has a cognitive impairment about the impact of solid waste on the environment and humans.

Table 10: The cumulative effect of the Tulla Woreda crops productivity rate from 2006-2012

No	Year	Area coverage in (ha)	Productivity in (quintal)	production in (quintal)
1	2006	225	51	11475
2	2007	2015	33.42	90473.5
3	2008	2153	31.79	78304.61
4	2009	2074	36.37	75565.02
5	2010	1958	32.74	64104.92
6	2011	1852.5	44.99	58057.35
7	2012	1817.5	31.64	55506.45

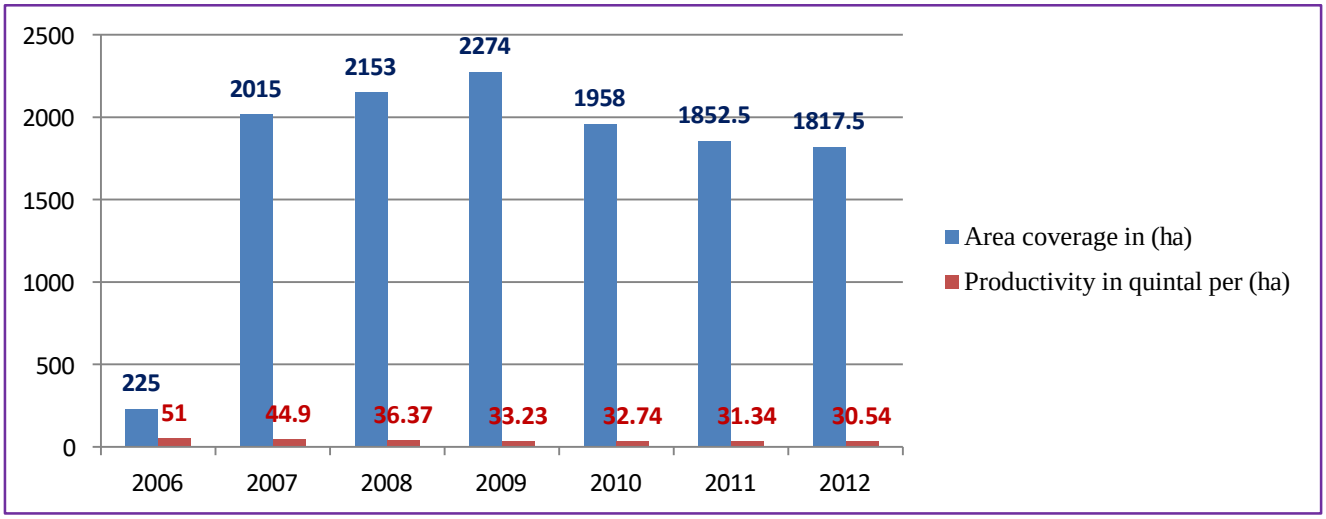


Figure 17 : Graphic representation of productivity and production change

As can be seen from the graph 17, productivity has decreased from (51, 44,33,32,31 and 30) quintals per annum respectively. In other ways In general, from this result (table) we can see that, there is highly declining in crop production and productivity from time to time.



Figure 18: Cheleleka wetlands, which is covering by salinization.

The effect of salt on the environment and human

Water resources like Cheleleka wetland have been significantly impacted by decades of sodium chloride application (Godin, *et al*, 2002). The high concentration of NaCl in the environment can cause disaster on the ecosystem by altering the soil and water composition and therefore impacting the biota and vegetation it sustains.

2.4 Response measures in improving the status of land use land cover change over Cheleleka Wetland Ecosystem

No practical action has been taken so far by the community and the government regarding the Cheleleka wetland. However, the regional government has submitted a request to the federal forest and climate change commission to study the wetland. In general the preventive measures are not enough to tackle the existing problem so it should be given further attention in the future

2.5. Outlooks

According to **(Land detection classification, (2000-2020 E.C), under Cheleleka wet land** the If business, as usual, means the rate of change will be continued in the same manner, in the coming three decades forest land by **7.06**% urban center by **8.44**%, grazing land **4.88**% and farm

land by **73%** while, Cheleleka wetland will declined by **99.6**% for the next 30 years. Therefore, we can state that, after 30 years no wetland will exist at Sidama regional state.

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

2.6. RECOMMENDATIONS

Wetlands are source of water, biodiversity and related resources; they attract a number of stakeholders that deal directly or indirectly.

- There is a need for a coordinator that harmonizes the relationship among the stakeholders and sets better management of wetlands.
- There should be a dialogue or conflict resolution mechanisms are needed in order to reconcile the needs of upstream and downstream users (Oromia and Sidama region). To this end, any initiatives and development plans should take the linkages between upstream and downstream users of water resources.
- Successful implementation of wetland conservation Policy and suitable legislative frameworks as a result of insufficient political conviction to formalize wetland conservation.
- Undertaking a prioritization process through full involvement of all concerned stakeholders to identify wetlands that need immediate conservation actions is important. There is a need to prepare management plans for Cheleleka wetlands.
- In order to reverse such emerging problems and conserve these fragile but crucial wetlands, integrated problem solving approach through realizing the collaboration of relevant stakeholders from policy level down to grassroots community is indispensible opportunity to Cheleka wetland. Government, Communities, private sector and all others who have stake in wetlands should cooperate and contribute their part.

3. Fresh water deterioration around Cheleleka wetland ecosystem

3.1 Introduction

Water is a precious natural resource, vital for life, development and the environment. It can be a matter of life and death, depending on how it occurs and when it occurs and how it is managed. Irrespective of how it occurs, if properly managed, water can be an instrument for survival and

development. It can be an instrument for poverty reduction. Access to safe water and sanitation to meet human and livestock needs is a prerequisite for sustainable development. However, when inadequate in quantity and quality, it can rather serve as a limiting factor in poverty reduction and overall national development, resulting in poor health and low productivity, food insecurity and constrained economic development. It is therefore imperative that the linkages between water development initiatives in the agriculture, food, energy, health, education and decentralized governance sectors be clearly understood and carefully managed to benefit from the inherent synergies and to minimize or avoid negative cross-sectorial impacts (WHO, 2010).

It is on this basis that water is one of the most essential substances for the sustenance of life. It is generally recognized that fresh water is the most important natural resource in all socio- economic development endeavors and indispensable input for environmental management. It is an important component of every type of environment where life is found. Successful management of the environment, therefore, can never be achieved in isolation from appropriate management of water resources. Water is a product of the environment, and vice versa, as it comes as rain from the environment and goes through land, which is the major component of the human environment and ends up in the sea or in the land. Managing water is thus intimately linked with managing the environment—all terrestrial, aquatic and atmospheric resources including human welfare. Based on the bond between water resources and the environment, integrated water resources management is gaining paramount importance worldwide. In pursuit of integrated solutions, it is observed that decision-makers and planners tend to be oriented towards the management of water while preserving the environment through appropriate legal tools and sustainable actions of development. Integrated management of water resources entails co-ordinated development of water, land and related resources to maximize socio-economic benefits and preserve the sustainability of the ecosystems.

Cheleleka wetland is found at the eastern part of the lake Hawassa. It is the major water sources that drain into the lake through Tikur Wuha River. The community of Hawassa and its environment has been utilizing the resources of this wetland as a livelihood source since long. The Wetland serves as a source of food, controls flood and improves water quality. It is an important to biodiversity and wildlife conservation. The wetland yields grasses and other vegetation on which cattle may be grazed, local boats constructed, mattresses, mats and

agricultural implements created and houses built, among others some to mention. Thus, the system plays a vital role in controlling flooding, particularly that originating from the Wondo Genet highland areas; diverse species of water fowl, weed bed fauna, zooplankton, phytoplankton, fungi, bacteria, amphibians, reptiles and macrophytes inhabit the wetland. This makes it an important regional biodiversity domain; the wetland's grasses is used by the local people to graze their cattle on and exploit its vegetation for other domestic needs; there was fish species in the wetland (this is not existing nowadays) and it was serving as a good source of protein for the local people; stabilizing the microclimate and serving as a buffer against harmful additions from natural processes and human activities in the catchment.

3.2. State and Trends of fresh Water in Cheleleka Wetland

Ethiopia has 12 major river basins/valleys, 11 lakes, 9 saline lakes, 4 crater lakes and over 12 major swamps. The total mean annual flow from all the 12 river basins is estimated to be 123.25 billion m3. Based on this information, it is always stated and often quoted that 'Ethiopia is the water tower of East Africa'. The major rivers carry water and valuable soil and drain mainly to the arid regions of neighboring countries. The total loss of top soil in Ethiopia has been estimated at 3 billion tons per year. The Wabi Shebelle and Genale drain to the desert areas of Somalia and flow into the Indian Ocean. Abay (Blue Nile), Tekeze-Angereb (Atbara) and Baro drain to the Sudan (and Egypt) and join the Mediterranean Sea through the Nile. The ground water and the gross Hydro-Electric potential in the country are estimated at 2.6 billion cubic metres and 139,250 Gigawatt hours (GWh) per year respectively. Based on available information the potential irrigable land in the country is about 3.7 million ha. There are also eleven major lakes with a total area of 750,000 ha. The biggest is Lake Tana found in the Northwestern part of the country while the rest of the lakes are found in the Rift Valley. Although Ethiopia's water resource is large, very little of it has been developed for agriculture, hydropower, industry, water supply and other purposes. To date only about 160, 000 ha (about 4%) of the potential irrigable land has been developed. National coverage of potable water supply stood at 26% by 1992 while coverage of sanitation services is only 7%, which is low by even the Sub-Sahran standards (MoWR, 2001).

The country can only be a water tower in terms of receiving ample water and donating it to neighboring countries but not in terms of ample water resources that is readily available for use.

This is because, most of the major rivers have created deep gorge in the country and the water they contain passes to neighboring countries, thus constraining development and utilization of the water resources in the country. In addition, uneven spatial and temporal distribution of the available water resources either demand huge investment to develop and extend to the water scarce areas or constrained the utility at required time and place.

Wetlands have been described as a living machine (MacDonald, 1994) and the kidneys of the planet (Wallance, 1998). They can also be thought of as "biological supermarkets" and the third most important ecological system on this planet (WCU, 1987). Cheleleka wetland, found at the eastern part of the lake, is the major water sources that drain into the lake through tikur wuha river. Nowadays, this wetland and the Lake at large have faced with serious ecological problems due to deleterious anthropogenic activities in the catchment. Clearing of forest, new human settlement and eucalyptus tree expansion, building of factories that emit toxic materials and use of fertilizers, herbicides and pesticides all contribute towards the damage of these indispensable but fragile systems.

In the nineteenth century, Lake Hawassa and Cheleleka had been a single lake (Grove et al. 1975) and Lake Cheleleka was serving as a natural regulator of flow, sedimentation, and biogeochemistry for Lake Hawassa. The progressive silting up of Lake Cheleleka over the last 35 years (1972-2007) (figures 37) is an example that indicates the severity of the sedimentation problem in the sub-basin (Belete, 2017). This 12 km2 loss in 45 years (≈0.27 km2 /yr or ≈2.25% per annum) is comparable with the nationally recognized tragedy of the disappearance Lake Haromaya, in Eastern Ethiopia, which experienced a loss of 8.3 km2 in 30 yrs (≈0.28 km2 /yr or ≈3.37% per annum) (Alemayehu et al., 2007). The trends tend to confirm the report by Ramsar (2018) that noticed the rate of wetland disappearance to be three times faster than forests (globally).

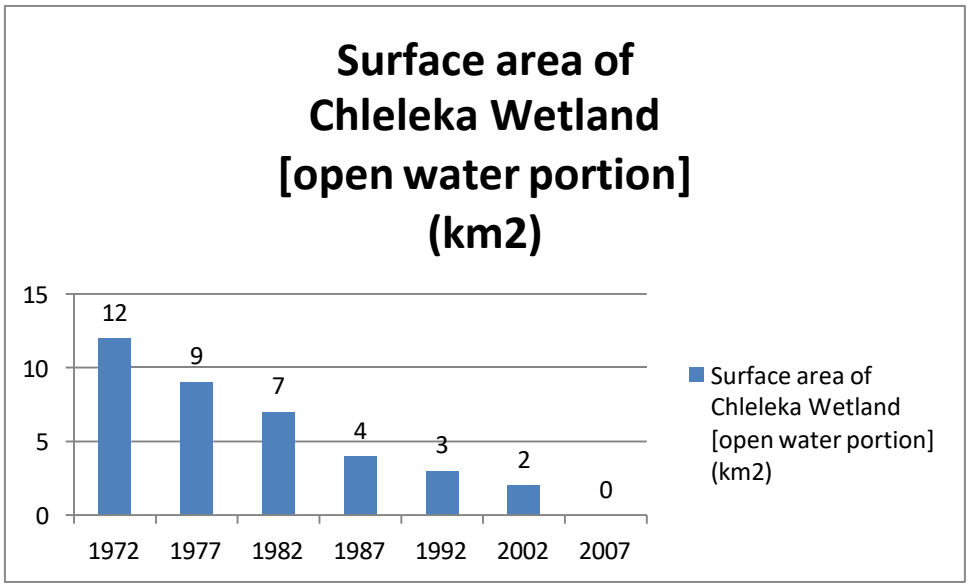


Figure 19: Time series of changes in the surface area of Lake Cheleleka

Source: Mulugeta Dadi, 2019

Table 11: Cover Change of water in Cheleleka Wetland in (2000, 2010 and 2020)

Total land	Year	Coverage of water in the Wetland		Percentage change of wetland from the year 2000 to 2020	
		Area (ha)	%	Area(ha)	%
4453.4	2000	2727.64	61.25	-509.76	-11.45
	2010	2407.21	54.05		
	2020	2217.88	49.80		

Source: from Efccc GIS land use land covers detection, 2021

As indicated in the above table the area coverage as well as the percentage of water body/wetland was declined from 2727.64 ha (61.25%) to 2217.88 ha(49.80%) from the year 2000 to 2020 G.c.This indicates that the coverage of the wetland was converted to other land uses like agricultural land, irrigated land, irregular settlements and others. The FGD participants

also approved that the wetland was declined through massive eucalyptus plantation for the targeted purpose of drying the wetland and to convert other land uses.

Water availability around and in Cheleleka wetland

According to the study conducted by Dagne Shibru(2019), people in Wendo Genet Woreda (particularly in such areas like Edo, Basha, Busa, and Elala) engaged in intensive irrigated agriculture for growing Chat, sugar cane and vegetables which seriously affected the amount of inflow of water into the wetland. Similarly, in the northern part of the wetland where Tulu spring is located, farmers are growing vegetables. They grow potato, onion, tomato and cabbage. These crops are important sources of income for the new settlers of the area. Unlike the vegetable production in the northern part of the wetland, the south western part has been irrigated with polluted water coming from factories. Indeed, polluted water could damage plants as well as aquatic life like fishes. The participants and key informants also explained that there were huge amount of fishes in the wetland before but know the fishes were endangered whereas the remaining fishes were not available for feed due to the let of polluted water from different factories.

Animals have been contaminated and drink when they cross the industrial effluent to grazing field. The waste cause's fetal abortion, reduces milk production, discolors milk and emaciates animals. Occasionally, it leads to the death of animals (Interview, Jan., 2021).

The participants confirmed that the industrial waste has been used for different purposes. Domestic animals have been drinking it when they cross the waste drainage. Moreover, people use the waste for domestic and vegetable productions.



Figure 20 :Polluted water around the wetland

Water supply system and coverage around Cheleleka wetland

Safe domestic water supply is an essential component of primary health care and plays a vital role in poverty alleviation. Inadequate water supply and sanitation services impact upon the lives of billions of poor people in the developing world (World Bank, 2004). Two in every ten persons lack access to safe water supply, five have inadequate sanitation, and nine do not have their wastewater treated. Yet, these estimates are believed to underestimate the extent of the drinking water supply problem. In many countries where water supply systems have been installed, the quality of the services provided is poor. Many consumers who are connected face unreliable water supply and when available, it is often not safe to drink (World Bank, 2004).

Water supply services in Ethiopia are among the lowest in Africa, with an average consumption of only 15 liter per day in urban areas, which is far below the World Health Organization (WHO) standard of 45 liters per person per day. Safe domestic water supply is estimated to be available to 36 percent of the population in rural areas and 80 percent in urban areas (EWSRFA, 2004).

According to the WHO, Ethiopia had the lowest level of water supply coverage in Sub-Saharan Africa in 2000 (39% compared to an average of 56% in Sub-Saharan Africa) and the second-lowest level of sanitation coverage (EPER, 2004). Unprotected water supply sources are one of the most important problems related to water supply quality. Consequently, a majority of the Ethiopians use unsafe and polluted water and are, as a result, exposed to a large variety of water-borne diseases. This is especially the case for the rapidly growing urban population. Besides limited protection of water supply sources, financial constraints also play an important role in the current state of water supply in Ethiopia. Investment and operation costs of domestic water supply facilities are only partly covered by the consumers (15%). The central government contributes more or less the same as the consumers, but the majority of the costs (70%) are funded by financial sources from outside Ethiopia, primarily through international aid (Teshome, 2007). There exists a huge gap between the finance required to maintain and operate the existing water supply system. The study area (Tula sub city) water supply is inadequate due to rise of population (consumers) and inefficiency of water supply system. Water consumption in the area is directly linked to socio economic factors such as economic level, population density and the cost of water. The quality of water in the area is a big issue that needs to be investigated while, the sources of water also influences its safety.

Table 12:Drinking water supply

No	Types of water Sources	Quantity	Functional	Non-functional
1	Tap water	124	112	12
2	Spring water	7	7	--
3	Deep water burrow	10	7	3
4	River abduct	1	1	--
5	Shallow wells	8	5	3

Source; Hawela Tula sub-city water, mineral, and energy office, 2013

According to the Assessment report of Hawela Tula sub-city water, mineral, and energy office (2012/2013) the main water sources for the sub-city was Tap water, spring water, Deep water wells, river abduct and shallow wells.Recentlly the coverage of water in the sub-city reaches up

to 90%.eventhough, in contrast to the last year the coverage of water was increased by 5% ,most of hand dugs were not functional and also females' were travel long distance to fetch water otherwise they bought one Gerika of water for high cost.

The FGD and key informant interview also explained that the decline in the coverage of water in Cheleleka wetland prawn to water shortage and also females' travel long distance to fetch water.



Figure 21: Females Travel long Distance to fetch water (Source: Field photo, 2021)

Water quality of in and around Cheleleka wetland

About 71 percent of the Earth's surface is covered with water, and the oceans hold about 96.5 percent of all Earth's water that is categorized under undrinkable water due to the high amount of salt concentration (Oba, 2017).

Water quality is affected by a wide range of natural and human influences. The most important of the natural influences are geological, hydrological and climatic, since these affect the quantity and the quality of water available. Their influence is generally greatest when available water quantities are low and maximum use must be made of the limited resource (Oba, 2017).

Industrialization is considered the cornerstone of development strategies due to significant contribution to the economic growth and human welfare, but it carries inevitable costs and problems in terms of pollution of the air and water resource. Specially, water bodies near to industrial area have been extremely affected from disposal of waste which can alter the physical chemical and biological nature of the receiving water body. So industrial waste is the most common source of water pollution the present day and it increase yearly due to the fact that industries are increasing because most countries gate industrialized

The rate of industrialization and wastewater management is not proportional, because of which the degree of fresh water degradation increases. Urban settlement and poor wastewater management affect the lakes found close to towns. Appropriately, most world cities are found near to water bodies for easy of life, yet the waste generated from industries and residential areas significantly affecting the water bodies (Akpro, 2011).

According to the study conducted by Fiseha (2017), quality of drinking water in Hawela Tula sub city were mentioned as follows. The turbidity determines light emitted by water and it indicates the waste discharge in respect to colloidal matter. The WHO recommended figure of turbidity for quality water is 5.00 NTU, however the turbidity of water in Hawela Tula sub town averaged 1.16 that is far lower than the WHO recommendation (WHO, 2011). The pH compliance (pH range of 6.5–8.5) was included in the analysis to evaluate whether the drinking water at different sources have acceptable acidity and salinity balance. The measured pH values varied across different sources. The most saline value was obtained in the ground source ((pH = 9.3) and the most acidic was obtained river (pH value of 5.4). However, the average of pH values in each source was

still in compliance with WHO range (WHO, 2004) and most of the samples ranged in neutral level. The WHO guideline (WHO, 2011) suggests that, drinking water to be safe should possess maximum temperature of 30 °C. The measured average temperature of water samples across different sources ranged between 26–29 °C. Conductivity was measured for all water samples from four water sources (tap water, ground water, and spring and river water) and in general compliance with the WHO suggested value of 400 µS/cm. The mean conductivity for all water supplies was 220.32 µS/cm, but conductivity was lower for tape source water supplies (average of 193.45 µS/cm) and higher for ground source averages of 276.44with an average value of 0.97 colony/100 ml and found to be within low risk level of WHO standards (1-10 count/100ml) Fiseha bekele (2017).

The Cheleleka wetland, an important source of water for surrounding rural community for various uses like domestic, irrigation, livestock watering, fishing and recreation. Quality of water in the wetland is vital for the surrounding rural and urban communities for proper and safe use of the wetland. Water quality of the wetland can deteriorate due to climate, geographical position, and land use land cover of the area.

During the field visit there was a great disposal of plastic material around the wetland especially around hot spring because most of the people shower their bodies to make cure from different diseases at that time they dispose soap plastics around the wetland. Due to the no degradable of the plastic material it accumulates on the wetland, generate toxic substance and decline the quality of water due to sunlight and plastic material reaction.

As shown in the figure below the color of the water was blue-black this is out of the characteristics of normal water because the water quality was deteriorated due to point source pollutants emanates from human beings.



Figure 22: Plastic concentration around the remaining part of water in Cheleleka wetland

In the field observation there was high accumulation of salt in the wetland, these have its own health impact on plant and animal. Due to these reason animals move in that area and feed the salt excessively, these cause abortion.



Figure 23: **High amount of salt concentration in the wetland**

3.3. Driver and Pressures of deterioration of water bodies in Cheleleka wetland

The main drivers for the deterioration of Cheleleka wetland are listed below

Population growth

According to the data obtained from key informant and FGD the number of population live around Cheleleka wetland was increased from year to year. Based on the 2007 Census conducted by the CSA, this Region has a total population of 2,954,136, of whom 1,491,248 are men and 1,462,888 women; with an area of 6,538.17 square kilometers, In the 1994 Census Sidama had a population of 2,044,836 in 439,057 households, of whom 1,039,587 were men and 1,005,249 women, whereas the total population of sidama region in 2017 was 3,200,000. This indicates that the number of population in the region was increased in each year, which directly and indirectly the affect water resources exist around the wetland and also damage the wetland itself.

Industrial Effluent

The south western part of the wetland has been a direct contact with discharges from factories operating in the area. These industries have been releasing effluent since their establishment in 1980s. During our field observations there were several industries such as beverage, soap, textile, plastic, meat processing and many others are operating in the area, it was evident that the brewery factory, has prominently discharged its waste. The nature, amount of waste discharged and its impact on aquatic and marine life are not adequately studied.

Irrigation activities

The participant in the FGD explained that there was 12 tributary rives drain in Cheleleka wetland, from this Galchach, Abosu and Wedasa were the major contributor for Cheleleka wetland.Eventhough the weteland has many tributary rivers, those rivers were minimized for purpose irrigation especially in winter season.

Irregular settlement and land encroachments

According to the study conducted by Fiseca B (2017), there were about 400 persons who have involved in irregular house construction and farming activities in and around the wetland. It was also evident during our field visits that the wetland has been under encroachment from the periphery as well as in the middle for housing construction and farming activities.



Figure 24: Irregular settlement in the wetland

Eucalyptus plantation

Eucalyptus trees can be used for drying marshy areas and other plots of land with a high water table. Species that grow rapidly and use a lot of water are particularly suitable. The trees dry the land by allowing water to evaporate through their leaves (Tilashwork C. 2009).

The participant in FGD and key informant explained that most of the local community plant eucalyptus tree individually and in association to dry the wetland purposively to convert the wetland in to other land use especially for agriculture and house construction.



Figure 25: Eucalyptus tree around the wetland

Emergence of social institutions

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

addition, the lowest government structures (Kebeles) of the Oromia and SSNPR States are in place. They administer the people and the land in and around the wetland.

3.4. Impact of fresh water degradation on the lively hood of local people

According to WHO (2005), the scarcity of water is one of the most significant issue that policy makers face in developing countries. Water related diseases caused by an unsafe drinking water and the absence of proper sanitation facilities are among the main causes of death in developing world (salmon et al, 2004). About one tenth of the disease throughout the world could be prevented with improved access to safe water, sanitation and hygiene, and improved water management as a whole (WHO, 2010). Continuity of water supply is a guarantee in most developed countries but it is severe problem in developing nations including Ethiopia.

Ethiopia, the second mostly populated nation with over 90 million people have one of Africa's lowest rate of access to improved water supply, sanitation and hygiene. Although water is considered as the soul of existence, this basic necessity is still a luxury for many of the world's poor. Increasing the number of people with access to safe water supply, sanitation and hygiene has become a burning challenge throughout the developing world including Ethiopia (UNICEF, 2009). Access to safe and adequate water is a key to health and healthiness in turn is a prerequisite for progress, social equity and human dignity (William P. and Cunningham M., 2013). According to (MOH, 2011) Access to safe drinking water supplies and sanitation services in Ethiopia are among the lowest in sub Saharan Africa. Over 60 % of the communicable diseases are caused due to unsafe and inadequate water supply and poor hygienic and sanitation practices that result in poor environmental health (Abera et. al, 2011).

The participants in the desiccation explained the impact of poor quality and quantity of fresh water around Cheleleka wetland as follows:

- The industrial effluents coming from Brewery and Hawassa Textile Factory have caused several health and economic problems on humans and animals
- The local community suffering from skin irritation and respiratory diseases due to direct contact and pungent smell.

- Children are affected by the waste, which smells alcohol, while they often use it for swimming during the rainy season and also children who fetch the waste water (for the construction of mud houses) are direct victims.
- Animals have been contaminated and drink when they cross the industrial effluent to grazing field. The waste cause's fetal abortion, reduces milk production, discolors milk and emaciates animals. Occasionally, it leads to the death of animals (Interview, Jan., 2021). During field visits we have confirmed that the industrial waste has been used for different purposes. Domestic animals have been drinking it when they cross the waste drainage. Moreover, people use the waste for domestic and vegetable productions.
- **Devastation of water sources**: On the FGD and key informant participants were clarified that the amount of different water source like springs and rivers deteriorate, Yield production decreased due to shortage of rainfall and increasing of climate variability. FGD participant in Gerariketa Kebele explained 12 tributary rivers of Cheleleka wetland was dried through irrigation purpose. The drying of 12 rivers was one of the cause for destruction for Cheleleka wetland.
- **Destruction of hot spring water;** According to the discussion on FGD and key informant there were various hot springs used as a medicinal purpose like cure for chill diseases, Sinus, for common cold and the like. So, the destruction of the wetland was one of the causes for the loss of medicinal valued hot springs.
- **Drought was occurred;** The participants explained that drought was occurred in the year 1977 and 1996, due to this 734 peoples loss their asset and also supported by the government.

3.5. Response

Even though the federal government was not take any response, the region environment was committed to work in collaboration with other sectors to reduce the impact on wetland by removing plastic deposit from hot spring and also they put dust bin to minimize water pollution of the wetland

3.6. Outlook

As indicated in land use land cover detection the coverage of water/wetland was declined from 2727 ha to 2407 ha between the years 2000 to 2020 by 509 ha (11.45%).The deterioration of wetland contentious as the existing rate the coverage of the wetland will be declined by 763.5 ha (17%). The community in Hawela Tula sub city as well as Hawassa Town residents will prawn to sever fresh water scarcity because Cheleleka wetland was one of the water tower of the surrounding community as well as Hawassa town.

Unless the federal government as well as the regional take quick and hard response on the driving force of wetland deterioration the remaining medicinal value hot springs will totally dried and also the wetland will totally change in to other land uses.

3.7. Recommendation

Cheleleka wetland is an important natural resource sharing a boundary between Oromia and SNNP regional States. The efforts for conserving and restoring the wetland require the commitment and dedication of the leadership of two regions.

- Delineations of boundaries around the wetland, and create buffer-zone to prevent land encroachments resulting the decline of the size and function of the wetland and thereby the Hawassa lake

- Producing synergy by creating working environment between local institutions and local government administrations to mitigate land encroachments; initiate social corporate responsibilities among industrialists and other stakeholders to treat industrial solid and liquid wastes;

 enact a policy over the use and management of natural resources shared by two or more regional states.

4. Deforestation and Forest Degradation around Cheleleka wetland

Definition of terms

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

According to MEFCC (2015) the technical definition of Ethiopian forest is 'Land spanning at least 0.5 ha covered by trees and bamboo), attaining a height of at least 2m and a canopy cover of at least 20% or trees with the potential to reach these thresholds in situ in due course“ ,

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

Deforestation is the complete removal of forest and conversion of its land use for other land uses other than forest.

A wetland is"…areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"

3.1 Introduction

The world’s forest ecosystems provide critical and diverse services and values to human society. As primary habitat for a wide range of species, forests support biodiversity maintenance and conservation. Forest growth sequesters and stores carbon from the atmosphere, contributing to regulation of the global carbon cycle and climate change mitigation. Healthy forest ecosystems produce and conserve soil and stabilize stream flows and water runoff—preventing land

degradation and desertification, and reducing the risks of natural disasters such as droughts, floods, and landslides. Forests also serve as sites of aesthetic, recreational, and spiritual value in many cultural and societal contexts, and contribute to poverty eradication and economic development by providing food, fiber, timber, and other forest products for subsistence and income generation (Michael and Brian, 2018).

Forest has its own Ecosystem Services. The concept of ecosystem services was developed as part of the Millennium Ecosystem Assessment project in the early 2000s to analyze and quantify the true and total value of an ecosystem. There are four types of ecosystem services all of which contribute to a range of human outcomes. **Provisioning services,** these are the familiar, tangible and direct products extracted from the forests to be used or sold. They are the wood, fiber and fuel. They also include crops such as ginseng or truffles, which may be planted or developed in the forest, and koura (freshwater crayfish) grown in fire ponds. Participants in the FGD explained that the local community used the forest for fuelwood, fence and furniture.

Regulating services, these include the ability of the forest to store carbon, reduce erosion, improve water quality, and reduce the effects of floods. Steep land planted in trees will also have less erosion than if it were in pasture. Key informants and participants in the FGD explained that forests around Cheleleka wetland used to improve the quality of water. On the other hand factories around the wetland plant trees to check the quality of water before removing the liquid dust water to the wetland.

Cultural services, Non-material social and cultural benefits are also provided by planted forests. These include recreational opportunities, aesthetic enjoyment and spiritual enrichment, as well as a biodiversity and conservation appreciation. Participants in FGD and key informants explained that the wetland and their surrounding forests are used for aesthetic enjoyment and also used the forest to conduct spiritual conference because the hot springs in the wetland used to cure for different diseases.

Supporting services, the biological and physical processes in a forest drive the other three services. Examples of these include soil formation, nutrient cycling, water regulation, and oxygen production.

The forest resources of Ethiopia play critical roles in providing valuable ecological and economic resources for the country's overall development, and in particular rural population in forest regions which are heavily dependent on these resources for their livelihoods (MEFCC, 2018). Managing forests sustainably and equitably will be essential for maintaining the ecological integrity, maintaining or enhancing freshwater supplies, protecting biodiversity and improving rural livelihoods. Nevertheless, Ethiopia's remaining forest resources are under threat, internally, from agricultural expansion and unsustainable fuel wood collection, inadequacy of legal and regulatory frameworks coupled with their poor implementation, institutional instability of the forest sector and poor capacity, all these compounded with economic, cultural and demographic factors. Ethiopia has been losing about 92,000 ha (0.54%) of forest annually between 2000 and 2013 (Ethiopia's FRL, 2016). It has historically lost most of its forest cover in the north and central areas from various forces, and these areas now require large scale restoration. Recent deforestation occurs mainly in the remaining Moist Afromontane Forest in the southwest and southeast, and the Dry Forest areas in western lowlands (Combretum- Terminalia woodlands) and must be priority areas for intervention. On the other hand, Ethiopia has been active in implementing Participatory Forest Management (PFM) for conservation of its natural forests, and forest restoration through watershed development activities (tree planting and area closure on degraded lands) over the past decades. Since the 1970s, Ethiopia has also implementing large scale plantation programs aimed at meeting the ever increasing demand for industrial wood and other forest products. The current area estimate for plantations is at 972,000 ha including commercial plantations, small holder eucalypt woodlots and community forests (MEFCC, 2015).

Ethiopia has close to 17.35 million ha (15.7% of the country area) of forest resources, including bamboo, dense woodland, natural forests, and planted forests. Plantation forest also comprises public industrial plantations and private woodlots. Most of the natural forests exist in the south-western and south-eastern parts of the country (MEFCC, 2015). Oromia, Gambella, SNNPR, Amhara and Benishangul are regional states that have most of the natural forest resources, while Oromia, SNNPR and Amhara and Tigray have most of the industrial plantations and woodlots. Oromia, Amhara and SNNPR have the largest commercial plantations.The forest area of SNNPR was 2,438,042 ha with its coverage of 22.54%.The study was conducted Sidama region in

Cheleleka wetland ecosystem. This study was conducted in Cheleleka wetland ecosystem found in Sidama Region.During this study the data was collected from both primary and secondary source. With regard to this the primary data was collected from FGD, key informants from Kebele administrator, development agents and Landsat image. To conduct the study we used FGD of 4 surrounding Kebeles which are beneficiary and□victim from Cheleleka wetland ecosystem. During the study there was one expert for each FGD from the region and sub city, who guided the participants through sets of prepared questions, related to their opinion on forest cover change, drivers of deforestation, their impact, existing remedies and possible solutions. Filed observation was also another primary source of data that support the analysis of the study. On the other hand, secondary data was used to conduct the study. This data was collected from published documents, region and Woreda reports.

4.2. State and Trends of forest around Cheleleka wetland ecosystem

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

According to MEFCC (2017) there are four vegetation types in Ethiopia. These are Acacia Commiphora, Combretum Terminalia, Dry Afromonotrne and Moist Afromontra.

Though, Ethiopia is the centre for diverse flora and fauna, these resources are under immense pressure from deforestation and forest degradation, overexploitation, overgrazing, habitat loss, invasive species and pollution. The depletion of forests has many ecological, social and economic consequences, including the extinction of biotic communities leading to reduction in biodiversity, soil erosion, global warming and loss of income to forest dwellers (Friis et al. 2011).Continued degradation of the forests can destroy the entire forest cover and biodiversity, and it mainly occurs because of anthropogenic changes (Abraham, 2016). A growing influence of forest based livelihoods, illegal harvesting of forest products, expansion of farms(smallholder and commercial farms) ,overgrazing and other activities were identified as major causes of forest degradation (Fekadu, 2010 and Ministry of Environment and Forest, 2015). Due to similar reason, the remaining natural high forest species and woodlands (e.g. Aningeria adolfi-friederci,

Yushania alpina, Albiza schimperiana, Prunus africana, Podocarpus flactus) of the southern and south-western parts of the country were found to be highly vulnerable (Kumlachew, 2003).

Ethiopia: Trends in Total (Net) Forest Cover, 1990-2010

Table 13: Trend of forest in Ethiopia

TOTAL FOREST COVER (1000 ha)

year	1990	2000	2005	2010
Area in 1000 ha	15114	13705	13000	12296

ANNUAL CHANGE RATE (1000 ha)

Year	1990-2000	2000-2005	2005-2010
In %	-0.97	-1.05	-1.11

Source: The FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS's Global Forest Resources Assessment (2005 & 2010)

During the discussion with FGD Cheleleka wetland ecosystem was one of the densely bio- diverse (plant and animal) populated ecosystem in the previous years. But know the coverage of water and their aquatic life was declined continuously, due to various reasons, such as smallholder agricultural land expansion, expansion of investment around the wetland, due to increment of animal population that the local community used the forest for free grazing for their animals and for fuel wood consumption. Population growth was also contributed to this change by increasing demand for agricultural land and for other subsistence use. According to the report obtained from Hawela Tula sub-city the total area of forest around chaleleka wetland was approximately 1889.81 ha, from this 15% was covered by bushes and shrubs. The sub-city was covered by 850.41ha natural forest and 1039.4ha plantation forest. The Hawela Tula sub-city report indicated that the rate of deforestation on existing species was increased from year to year, On the other hand expansion of eucalyptus plantation around the wetland become increased as a result the size of the wetland become shrink and destructed. Generally high population pressure, expansion of different industries, urbanization and increasing demand for fuel wood

consumption are the main driving forces for the degradation of the wetland ecosystem as well as the forest resources around the wetland.

Table 14 :Forest covers change in (2000, 2010 and 2020)

Total land	Year	Forest land		Wetland		Percentage change of forest land from the year 2000 to 2020		Percentage change of wetland from the year 2000 to 2020	
		Area (ha)	%	Area (ha)	%	Area(ha)	%	Area(ha)	%
4453.4	2000	113.32	2.54	2727.64	61.25	43.96	0.99	-509.76	-11.45
	2010	144.87	3.25	2407.21	54.05				
	2020	157.28	3.53	2217.88	49.80				

Source: from Efccc GIS land use land covers detection, 2021

As indicated in the table above, the forest coverage around chelelka wetland ecosystem was increased from 2.54 ha to 3.53 ha by 0.99% from the year 2000 to 2020.but the coverage of wetland declined from 61.25 to 49.8 by -11.45% in the same year. This indicates that the community plant eucalyptus trees so as to drain and change the wetland to other purposes. Participants both in the FGD and also the key informants explained that youths around the wetland make an association to get land and also plant eucalyptus trees around the wetland. Due to this reason the area was dominated by eucalyptus tree, whereas the other trees specious were degraded for different purposes. Most eucalyptus species have a root depth of 1.5-2.0 meter and its root system is more specifically adapted to using rain-fed soil moisture from the upper soil profile, rather than from the groundwater table at considerable depth. Eucalyptus trees can be used for drying marshy areas and other plots of land with a high water table. Wetlands are suitable particularly for those species that grow rapidly and use a lot of water. The trees dry the land by allowing water to evaporate through their leaves (Tilashwork C. 2009).



Figure 26: Eucalyptus tree dominate the wetland

On the other hand other trees like cordia africana was declined due to illegal deforestation. Due to this reason the coverage of eucalyptus tree was raised whereas the other tree specious was declined. Generally, the land use land cover detection Efccc, 2021 indicates that the eucalyptus forest coverage in the study area raised, wetland coverage and other forest type was declined. This trend indicates that there was degradation of forest resource that are naturally growing around the wetland.



Figure 27: Illegally deforestation

4.3 Driver and pressures of forest degradation in Cheleleka wetland ecosystem

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

The major drivers of forest degradation in Cheleleka wetland

Human population: According to the data obtained from key informant and FGD the number of population live around Cheleleka wetland was increased from year to year. Based on the 2007 Census conducted by the CSA, this Region has a total population of 2,954,136, of whom 1,491,248 are men and 1,462,888 women; with an area of 6,538.17 square kilometers, In the 1994 Census Sidama had a population of 2,044,836 in 439,057 households, of whom 1,039,587 were men and 1,005,249 women, whereas the total population of Sidama region in 2017 was 3,200,000. This indicates that the number of population in the region was increased in each year,

which directly and indirectly depend on the forest resources existed around the wetland and also the wetland itself.

Industrial expansion: As we get the data from key informant and FGD there were four industry sites directly pollute Cheleleka wetland and other forest specious, these were Itab soap industry, Brewery factory, Pepsi factory and ceramic factory. These industry sites release their liquid dust particles to Cheleleka wetland.

Urbanization: The wetland is near to the Hawassa city most of the people need to build their house and other industry parks near to the wetland and they degrade forests for their own purpose.

The major pressure on the degradation of forest around Cheleleka wetland ecosystem

Deforestation: The FGD participants explained that due to the presence of furniture industry, other forest specious like **Cordia Africana** was highly degraded illegally, on the other hand the local community plant eucalyptus tree to dry the wetland.

Increasing demand for agricultural land expansion: this is one of the pressures exerted by local community. Increase in population in the area created increased demand for agricultural land. Increasing demand for fuel wood, House construction and Furniture products also another pressure exerted in the forest.

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

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

Devastation of water sources: Participants on the FGD and key informant discussion explained that the amount of different water source like springs and rivers became deteriorated due to degradation of the wetland, Crop productivity and yield become decreased due to shortage of rainfall and increasing of climate variability. FGD participant in Gerariketa Kebele explained 12 tributary rivers which contribute ample source of water for Cheleleka wetland was dried through irrigation purpose. As a result degradation and destruction of Cheleleka wetland become increased from year to year.

Flora resources were declined. Key informant and FGD participant explained that the destruction of Cheleleka wetland cause the devastation of forest biodiversity. The floral resources around Cheleleka Wetland ecosystem are indigenous plant species like Sekena, Qetama, Hangena, Shasho/Celtis africana, Mecincho/Croton macrostachyus/, Wadicho/Cordia Africana/ and Girar/Acacia albida. Plant species like Hanbena, Lungena, Haqalena, Honcho/Juniperus procera/, Gerbicho/Prunus africanus/, Mure, Qa'esa, Qulema and Koso/Hagenia abyssinica are totally threatened from the ecosystem.

Destruction of hot spring water; According to the discussion on FGD and key informant there were various hot springs used as a medicinal purpose like cure for chill diseases, saynouse, for common cold and the like. This implies that wetlands are rich in resources and the destruction of these wetlands become the main causes of for the loss of those valued hot springs that the local community depends on for different purposes.

The number of poor peoples was increased: Participants during FGD in Gerariketa Kebele explained that the number of poor family in 1998 was 6, but know the number of poor family was increased in to 27.

Drought was occurred; The participants in the FGD explained that drought was occurred in the year 1977 and 1996, due to this 734 peoples loss their asset and they are depend on by the government support.

4.5. Response of deforestation and forest degradation

Even if there were no responses taken from federal and regional level to solve those problems, there are some responses taken for the protection of deforestation and forest degradation from the Hawela Tula sub city .Some of the responses were given below. The sub-city control illegal deforestation through strong follow up.

4.6. Outlook

If Federal as well as Regional government tries to reverse forest coverage change of the area, the community will lose the important forest and other biodiversity resources including the buffer zone which was covered by shrub and trees, On the other hand the expansion of eucalyptus plantation on the buffer zone of the wetland become increase for the next 30 years.

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

Deforestation due to agricultural land expansion this will also contribute to livelihood food insecurity of the community living in the forest-farm interface.

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

On the some hand if the degradation of forest continues in the existing rate, endemic plant and Animal population will totally devastate.

4.7. Option for future action

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

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

The federal and regional government should aware and enforce those industries that destruct the forest and other biodiversity's.

Re-enforcing and expanding protected forest areas; and adopting agroforestry, afforestation and reforestation and sustainable management of existing plantation forests to meet demand for wood, thereby reducing pressure on natural forests.

Establishment of forest nursery site in the command area and produce sufficient amount of seedlings for plantation purposes.

Putting penalties for illegal persons, who clear the forest illegally, infract laws and regulations to protect forest, and zoning for production and protection.

They concerned body should give awareness about the impact of deforestation and forest degradation on the local community as well as on the environment.

5. Biodiversity

5.1. State and Trend of Biodiversity on Cheleleka wetland ecosystem

Biodiversity is 'the variability among living organisms from all sources including; terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystem' (CBD, 1992; Article 2). Ethiopia is one of the world countries, which is rich in faunal, floral and microbial diversity. Ethiopia is considered as the fifth largest floral country in tropical Africa. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, of which about 15 percent or more are probably endemic. Ethiopia is also rich in faunal diversity with mammals (277 spp.), birds (861 spp.), reptiles (78 spp.), amphibians (54 spp.), and fishes (101 spp.) (Mishra et al,2012).

This study was conducted in Cheleleka Wetland, Central Rift Valley of Ethiopia, Sidama region, Hawela Tula sub-city.

Wetlands habitats are considered one of the most fruitful environments in the globe. They are homes for wide range of biodiversity including the assemblages of birds, reptiles, amphibians, mammals, fish and invertebrate species. These habitats are also vital stores of plant genetic material. This is an indication for the recognition by Ramsar International in 1971 as a haven for waterfowl habitats. In line for to their immense biodiversity and ecological features, wetlands are also destinations for recreational and ecotourism opportunities. Where wetlands habitats are developed as ecotourism sites, they provide enormous benefits for ecotourism activities (Amare G. and Zelalem T., 2020).

Wetlands deliver a wide range of **ecosystem services** that contribute to human wellbeing. These include **provisioning services** such as food, fresh water, fibre and fuel; **regulating services** such as water purification and waste treatment, climate regulation, retention of soils and sediments, protection from storms and floods; **supporting services** such as soil formation and

nutrient cycling (nitrogen, phosphorus and carbon); and **cultural services** such as aesthetic and spiritual values, education and recreation.

Wetlands serve as valuable natural infrastructure for agriculture, providing reliable water and fertile soils, but they are at risk from agriculture's growing demands for land and water. They are increasingly threatened by population growth, large-scale development initiatives intended to alleviate poverty, and the possible impacts of climate change. The functions and economic values of wetlands must be considered in planning for the production of food and other agricultural products

In the Cheleleka wetland watershed, large expansions of new land uses were made mostly through the displacement of the original forests and pasture land. For example, using remote sensing and Geographic Information System (GIS) methods, Gessesse (2007), estimated an alarming 82% forest decline in the area when comparing 1972 forest cover to 2000. In many cases, this conversion occurred without evaluating the land use capacity, thus exposing the new cultivated fields to a high level of degradation. Moreover, the erosion and sedimentation processes disrupt the hydrological balance in the study watershed. In contrast to other lakes in the Rift Valley of Ethiopia, the level of Lake Hawassa has been increasing while the Cheleleka wetland is unfortunately drying up. Thus the increasing discharge from the wetland through the 'TikurWuha' River is partially related to the activities of erosion and the sedimentation processes in the Cheleleka watershed (Gessesse 2007; Tenalem et al. (2007); Kebede et al. (2014)). Increased flood and erosion risks were investigated as part of the field work for this study (Figure 1). Medo, Burara, and Gotu-Onoma aKebeles were found to be victims of erosion and flooding which damaged large areas of cropland, forming new rills and gullies, and damaged ditches along concrete and asphalt roads. Recently, the watershed stream discharge has increased, causing flooding (Kebede et al. 2014). Therefore, the extent and spatial pattern of the watershed's soil erosion needs to be assessed. This will assist the identification of erosion susceptible areas for planning and implementation of a watershed-based soil and water conservation plan. No soil erosion susceptibility analysis and map were available for this watershed. This highly populated, socioeconomically, and hydrological relevant rural watershed, supplying significant water resources to watershed residents and other towns outside the watershed, is in need of assessment and management.

Long regarded as wastelands, wetlands are now recognized as important features in the landscape that provide numerous beneficial services for people and for fish and wildlife. Some of these services, or functions, include protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods. These beneficial services, considered valuable to societies worldwide, are the result of the inherent and unique natural characteristics of wetlands.

5.1.1. Flora Biodiversity of Cheleleka Wetland

The floral resources of Cheleleka Wetland ecosystem are indigenous plant species like **Sekena, Qetama, Hangena, Shasho/*Celtis africana*, Mecincho/*Croton macrostachyus*, Wadicho/*Cordia Africana*** and **Girar/*Acacia albida*.** Plant species like **Hanbena, Lungena, Haqalena, Honcho/*Juniperus procera*, Gerbicho/*Prunus africanus*, Mure, Qa'esa**, **Qulema** and **Koso/*Hagenia abyssinica*** are totally extinct from the ecosystem.

There are fruit plants like **Avocado, Mango** and **Banana**, which are the dominant fruit trees. Besides these there are plant species like **Coffee, Chat, Sugarcane,** and **Enset**, which uses for income generation and consumption purpose.

5.1.2. Faunal Biodiversity of Cheleleka Wetland

Cheleleka Wetland encompasses desirable habitat contributing for the occurrence of high faunal diversity. However, the information for this state of environment report is limited to mammals, and birds.

Mammal species: - The identified mammal species in the Cheleleka Wetland ecosystem are listed in table 15 by their Local name, common name, and scientific name.

Table 15 :Identified mammal species in Cheleleka Wetland ecosystem.

Local name	Common name	Scientific name
Jib	Hyena	*Hyaenidaecarnivora*
Nebir	Tiger	*Panthera tigris*
Midaqo	Duiker	*Cephalophus harveyi*
Ro,e/ Gumare	Hippotamus	*Hippopotamus amphibious*
Marabawi		

Source:- FGD 2013

In the past the Wetland ecosystem was essential habitat for different mammal species. However, nowadays many species like **Lion, Boar,** and **Crocodile** are totally leaving the ecosystem. On the other hand, the other mammal species like, Tiger, Baboon and Rabbit are highly threatened.

Bird species: - Wetland ecosystem is essential habitat for bird species, due to this reason there are different bird species in the Cheleleka Wetland ecosystem. These are listed in table 16 by their common name, scientific name, Family/sub-family and order.

A total of 3500 individual birds belonging to 49 species, 21 families and 10 orders were recorded from the study area. Among the 10 orders Ciconiifores dominates with 14 species followed by Passeriformes and Anseriformes (9) species each. The least species was recorded in the order Accipitriformes, Charadriiformes, Columbiformes and Piciformes one species each (Table 16). Out of the species recorded in the study area, Wattled Ibis (Bostrychia carunculata) was endemic to both Ethiopia and Eritrea (Amare G. and Zelalem T., 2020).

Table 16: Systematic list of bird species at Cheleleka wetland (Aug. 2018 to February 2019)

Common name	Scientific name	Family/sub family	Order	MS	2018IUCN Red List category
Abdim's Stork	*Ciconia abdimii Polyboroides typus*	Ciconiinae Accipitridae	Ciconiformes	*AM R*	LC
African pygmy Goose	*Nettapus auritus*	Anatinae	Anseriformes	*PM*	LC

Black Crake	*Amauromis flavirostris*	Rallinae	Gruiformes	*R*	LC
Black Crow	*Corvus capensis*	Corvidae	Passeriformes	*R*	LC
Black Heron	*Egretta ardesiaca*	Ardeidae	Pelecaniformes	*PM*	LC
Black-crowned Night Heron	*Nycticorax nycticorax*	Ardeinae	Ciconiformes	*R*	LC
Black-headed Heron	*Ardea melanoceephala*	Ardeinae	Ciconiformes	*R*	LC
Black-tailed Godwit	*Limosa limosa*	Scolopacinae	Charadriiformes	*PM*	NT
Blue-headed Coucal	*entropus cupreicaudus*	Cuculidae	Cuculiformes	*R*	LC
Comb (Knobbilled) Duck	*Sarkidiomis melanotos*	Anatinae	Anseriformes	*R*	NR
Common Bulbul	*Pycnonotus barbatus*	Pycnonotidae	Passeriformes	*R*	LC
Egyptian Goose	*Alopochen aegyptiacus*	Anatinae	Anseriformes	*R*	LC
Glossy Ibis	*Plegadis falcinellus*	Threskiorbithinae	Ciconiformes	*PM*	LC
Goliath Heron	*Ardea goliath*	Ardeinae	Ciconiformes	*R*	LC
Great Egret	*Egretta alba*	Ardeidae	Pelecaniformes	*R*	NR
Great Reed Warbler	*Acrocephalu sarundinaceus*	Sylviidae	Passeriformes	*PM*	LC
Grey Heron	*Ardea cinerea*	Ardeidae	Pelecaniformes	*PM*	LC
Gull-billed Tern	*Gelochelidon nilotica*	Laridae	Charadriiformes	*PM*	LC
Hadada ibis	*Bostrychia hagedash*	Threskiorbithinae	Ciconiformes	*R*	LC
Hammer kop	*Scopus umbretta*	Scopidae	Ciconiformes	*R*	LC
Hooded Vulture	*Necrosyrtes monachus*	Accipitridae	Accipitriformes	*R*	LC
Hottentot Teal	*Spatula hottentota*	Anatidae	Anseriformes	*PM*	LC
Intermediate Egret	*Egretta intermediary*	Ardeinae	Ciconiformes	*R*	LC
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	Sylviidae	Passeriformes	*R*	LC
Little Egret	*Egretta garzetta*	Ardeinae	Ciconiformes	*R*	LC
Little Ringed Plover	*Charadrius dubius*	Charadriidae	Charadriiformes	*PM*	LC
Little Weaver	*Ploceus luteolus*	Ploceinae	Passeriformes	*R*	LC
Marsh Warbler	*Acrocephalus alustris*	Sylviidae	Passeriformes	*PM*	LC

Northern Carmine Bee-eater	*Merops nubicus*	Meropidae	Coraciiformes	*R*	LC
Northern Pintail	*Anas acuta*	Anatidae	Anseriformes	*PM*	LC
Northern Shoveler	*Anas clypeata*	Anatinae	Anseriformes	*PM*	LC
Pied Avocet	*Recurvirostra avosetta*	Recurvirostridae	Charadriiformes	*PM*	LC
Pied Crow	*Corvus albus*	Corvidae	Passeriformes	*R*	LC
Purple Heron	*Ardea Purpurea*	Ardeidae	Ciconiifores	*R*	LC
Red-eyed Dove	*Streptopelia semitorquata*	Columbinae	Columbiformes	*R*	LC
Ruff	*Philomachus pugnax*	Caliditrinae	Charadriiformes	*PM*	LC
Sacred Ibis	*Threskiomis aethiopicus*	Threskiorbithinae	Ciconiformes	*R*	LC
Silver-cheeked Hornbill	*Bycanistes brevis*	Bucerotinae	Coraciiformes	*R*	LC
Slender-billed Starling	*Onychognathus tenuirostris*	Sturnidae	Passeriformes	*R*	LC
Southern Pochard	*Netta erythrophthaima*	Anatinae	Anseriformes	*PM*	LC
Spur-winged Goose	*Plectropterus gambensis*	Anatinae	Anseriformes	*R*	LC
Squacco heron	*Ardeola ralloides*	Ardeinae	Ciconiformes	*PM*	LC
Village Weaver	*Ploceus cucullatus*	Ploceinae	Passeriformes	*R*	LC
Wattled Ibis	*Bostrychia Carunculata*	Threskiorbithinae	Ciconiformes	*R*	LC
White Stork	*Ciconia ciconia*	Ciconiinae	Ciconiformes	*PM*	LC
Whitebacked Duck	*Thalassomis leuconotus*	Anatinae	Anseriformes	*R*	LC
Yellow-billed Egret	*Egretta intermedia*	Ardeidae	Pelecaniformes	*R*	LC
Yellow -billed storck	*Mycteria ibis*	Mycteriinae	Ciconiformes	*R*	LC

Source:- (Amare G. And Zelalem T., 2020).

Description: (1) Movement: MS=migratory status, PM=Palaearctic Migrant, AM= Intra-African Migrant, R=resident (2) Endemism: NE=near endemic NE (3) IUCN Conservation Status: NT=Near Threatened, LC=Least Concern, CR =Critically Endangered, NR= Not Recognized (4) Family names end with …dae and subfamily …nae. The analysis of data on migratory status revealed that out of 49 species, 17 Palaearctic Migrants (34.69%) and 1 Intra-African Migrants (2.04 %) were recorded during the study period. The remaining (31) bird species (63.26%) were

residents. As per IUCN status (2018), 46 species were least concern, and one species Black- tailed Godwit (Limosa limosa) was near threatened. Two non-recognized species were also recorded during the study period (Amare G. and Zelalem T., 2020).

Fish species: - according to FGD in the past period there were different fish species in the Wetland, but nowadays there is no any fish species, due to the dehydration of wetland and its contamination from the factories wastes.

5.2 Drivers & Pressures of Biodiversity Degradation on Cheleleka Wetland ecosystem

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

The drivers of biodiversity degradation in Cheleleka Wetland ecosystems are population growth, urbanization, industrial expansion, and agricultural land expansion, water harvesting scheme and settlement expansion.

Based on the land use land cover detection the agricultural land/Farmland, grazing land, settlement, Urban Centre and industrial area in Cheleleka Wetland ecosystem were increased from 1360.26 to 1625.28 ha, 69.25 to 108.46 ha, 94.79 to 110.53 ha, 54.81 to 187.82 and 4.7 to 10.15 ha, respectively from year 2000-2020. But, the wetland area is decreased from 2727.64 to 2217.88 ha within these periods.

Biodiversity is degraded rapidly due to pressures such as over utilization of water resource, generation of industrial waste, deforestation, and illegal encroachments to the wetland buffer zone.

Over Utilization of water resource: - there are eight (8) water harvesting schemes which have around 170 meters depth. These water harvesting schemes are uses as drinking water source for Hawassa town and also source of water for factories. The other is drying of tributary rivers due to over utilization for irrigation and the others.

Generation of industrial waste: - there are different factories around the Cheleleka wetland ecosystem which generate waste water and other wastes to the wetland. This activity has a high contribution to the degradation of the wetland biodiversity.

Deforestation: - according to FGD before twenty year there were natural forests in Cheleleka forest ecosystem, but nowadays there is no forest without eucalyptus and gravilia trees due to high degree of deforestation.

Illegal Encroachments to the wetland buffer Zone: - the wetland is between the Sidama region and Oromia region, therefore there is a competition between the communities to use the wetland area for their high demand of land resource. Due to this reason both communities are enter into the Wetland boundary to cut grass for their cattle's and introducing their cattle's for grazing and also to expand the agricultural land. Besides these the local community also plants the eucalyptus tree to dehydrate the Wetland.

5.3 Impact of Biodiversity Degradation on Lively Hood System of the Local People of Cheleleka Wetland ecosystem

Cheleleka Wetland is one of a Wetland, which is under great impact of land-use changes, mainly due to agricultural land expansion, industrial expansion, settlement expansion, generation of industrial wastes, over utilization of water resources, and illegal encroachment to the Wetland area. Losses of biodiversity affect human well-being. These effects include an increased risk of sudden environmental changes such as diseases outbreak, flood and drought affects the livelihood of the community.

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

Impact on local community: - The local community affected by scarcity of different Wetland products such as fish, which uses for consumption and income generation purposes. Livestock's are affected by water borne diseases, this causes abortion on cows; due to this reason the livestock production is decreased. The women which use the bi-product and meat of livestock are become infertile. Beside this the local community also affected by the scarcity of hot spring which uses it as traditional medicine. The Wetland loses its recreational value, due to this reason the local community exposed to the scarcity of recreational places and also the tourism value is decreased. The other is the traditional houses are decreased because of the shortage of grasses which uses for the construction of traditional houses.

Impact on aquatic life: - due to the hydration and contamination of wetland the aquatic lives are highly affected. Because of these the fishes and crocodiles species are totally extinct from the wetland.

Impact on wild life: - due to their habitat degradation different bird species are migrated to the other area and also different mammal species are migrated near to different rivers.

Impact on the flora species: - due to high degree of deforestation in the past many indigenous tree species are extinct from the Wetland ecosystem. Tree species like Hanbena, Lungena, Haqalena, Honcha, Gerbicho, Koso, Mure, Qa'esa, and Qulema are totally extinct from the ecosystem.

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

5.4 Responses to Biodiversity Degradation on Cheleleka Wetland ecosystem

The local communities try to manage the wastes from hot spring users by providing wastes/garbage's baskets and by providing uncovered soups. But, there are no extra responses taken by local community and the government bodies above these responses to reduce and control the problem of Cheleleka wetland ecosystem biodiversity degradation.

5.5 Outlook

Unless the Federal government and Sidama regional state government, concerned bodies and stakeholders deal and work together to protect and safe the Cheleleka wetland ecosystem in common understanding, the Cheleleka wetland forest ecosystem is at great risk and it's difficult to control the future risk.

If the practices degrading and dehydrating the Wetland for agricultural land expansion, industrial expansion, settlement expansion, generation of industrial wastes, over utilization of water resources, and illegal encroachment to the Wetland area are continues as it is practiced as the present, the biological diversity resource of the Cheleleka wetland ecosystem will destruct within the coming one decade.

5.6 Recommendation

- Promote public training, education and community-based monitoring, where appropriate, as integral elements in conservation and management.
- Control illegal encroachment to wetland boundary and work in line with investment/industrial/ sectors of the region to conserve the Wetland and its biodiversity in common sense.
- Ensure legislations and guidelines to introduce a system of direct and indirect incentives to promote the conservation and sustainable use of biodiversity.
- Promote participatory wetland management programs.
- Implementing the National biodiversity policies like; the policy provides for guidance towards effective conservation, rational development and sustainable utilization of the country's biodiversity, and contains comprehensive policy provisions for the conservation and sustainable utilization of biodiversity.
- Conducts ecological principles of conservation methods, such as
  - ✓ Biodiversity is supported by the protection of any species and varieties
  - ✓ Habitat maintenance is fundamental to species conservation
  - ✓ We can start planting trees at an individual community level to restore our degraded environments.

6. Climate Variability and/or Change of HTSC

Introduction

The Weather and climate of Ethiopia depended on altitude and geographic location. The landscapes of Ethiopia are wildly varied from the Afar Depression (~125 m below sea level) in the east to the spectacular world heritage Mountains of Ras Dashen (4533 m above sea level) in the north (IBC, 2005). Elevation is the most important determinant of the average annual temperature of the country with a reduction of 0.5–0.7 °C per 100 m increase in altitude (Liljequist, 1986), and given its geographic location close to the equator and the Indian Ocean. The Weather and climate of Ethiopia arise from the influence of tropical weather systems, like the Inter-Tropical Convergence Zone (ITCZ), the South Indian Ocean anticyclone (Mascarin High), the low-level jet (LLJ), the South Atlantic anticyclone (St. Helena), etc. (Bekele F. 1997).

It is mainly controlled by ITCZ and associated atmospheric circulations as well as by the complex topography of the country.

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

Climate change is inevitably resulting in changes in climate variability and the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events (IPCC, 2012). A different source indicates that Ethiopia has less contribution to climate change but highly exposed to its impact. Climate change increased the number of 'hot' days in Ethiopia by 20% from 1960 to 2003, and a 37.5% increase in the number of 'hot' nights over the same period (Alex Evans, 2012).

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

Drought

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

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

Flash flood: A flood caused by heavy or excessive rainfall in a short period, generally less than 6 hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through river beds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain

has fallen, for instance after a levee or dam has failed, or after a sudden release of water by a debris or ice jam (NWSWFS, 2021).

Our study focuses mainly on the HTSC of Cheleleka wetland in Sidama region; it's located at - 38^0 30' 07'' to $38^0$30'25''to $09^0$49'00'' E longitude, and, N latitude and $06^0$58'09'' to $07^0$54'30'' – $07^0$54' 30'' N latitude with an altitude of Hawassa 1,708 m.a.s.l.

The field data collection process took place in January 2021 with trained data collectors supervised by the Director. More data were gathered through focus group discussions (FGD) which were carried out across four Kebeles around the Cheleleka wetland Ecosystem in the city administration. Structured questionnaires and field observation employ together the necessary data. The study also used Meteorological data collected from the National Meteorological Agency of Ethiopia for the period 1991–2020 other relevant data and official unpublished documents from governmental organization were employed.

Hawila Tula sub-city is one of the Woredas near Hawassa city administration of Sidama Region which is including the study area; it's located around 5.5k.m far from Hawassa city.

6.1 State and Trend of Climate Variability and Change of HTSC Administration

Rainfall

The climate of the region characterized by **Bimodal /rain gets twice a year/** rainfall distribution which occurs in the summer and spring seasons. As it is indicate in figure 28 high rain fall recorded in the Automn "Belg" season, it includes March to May, peeks in May with a mean of **3819.9mm**, by the influence of south western winds, coming from the Congo basin, that can bring relatively abundant R.F (M. Fazzini et al.2015). Whereas the other seasons were getting a heavy amount of rainfall in the summer "Kiremt" season, these include **July, August,** and **September** with Maximum of 3775.6mm. Due to the influence of Guinean monsoon, equatorial warm and humid winds, which are also substantially influenced by the orographic diversity (M. Fazzini et al.2015). The study area has a high RF variability due to the seasonal progression of the inter-tropical convergence zone (ITCZ), an atmospheric circulation feature often modified by

the El Niño–Southern Oscillation (ENSO) (Tafesse M. 2019).

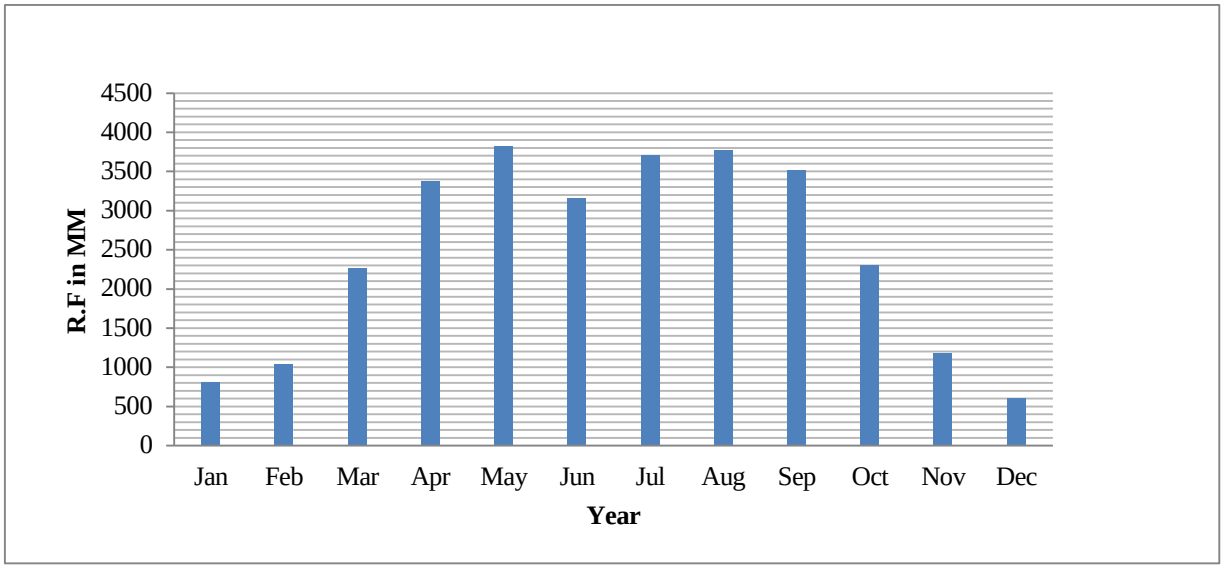


Figure 28: Monthly Average rainfall of HTSC from the year2091 to 2020 in mm.

The amount of rainfall differ from year to year because of climate change and/or variability, as figure 29 indicated total average annual rainfall of Hawela Tulla Sub-City was 985.04.8mm with the highest of 1277.5mm in the year 2019 while, the lowest of **670.9mm** in the year 2015.

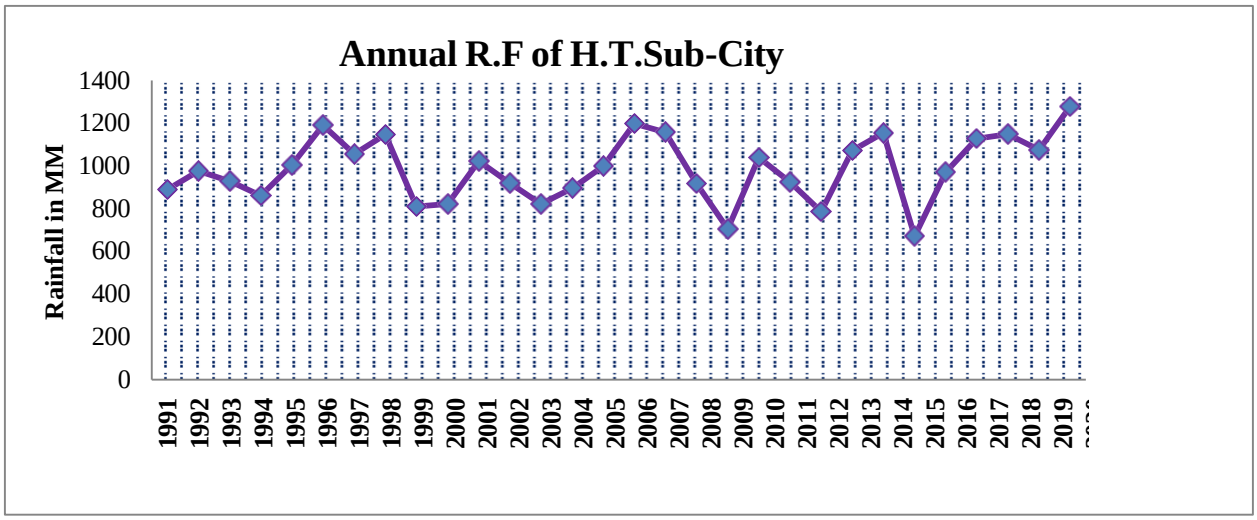


Figure 29: HTSC Annual Average Rainfall in mm from the year 2091-2020.

Rainfall Anomaly (Drought) Index

The agricultural, metrological and hydrological drought standard precipitation value is shown as below table.

Table 17 :Standard Precipitation Value (SPV)

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

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

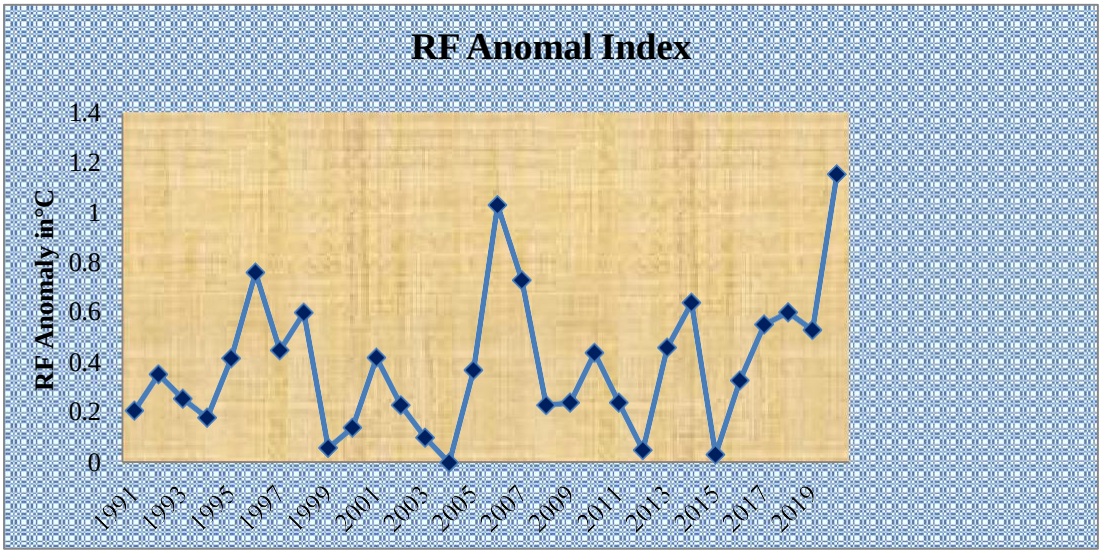


Figure 30 :Rainfall Anomaly Index of HTSC (1991-2020)

Depends on **standard precipitation value**s (SPV) rainfall anomaly index of HTSC was shows that **moderately wet** precipitation and also it shows variability and trend line were increased as a result the frequency of flood increased than drought.

State and Trend of Temperature for HTSC

The atmospheric concentration of CO2 increased from year to year (F. Joos et al., 2013). The temperature has risen by about 0.3-0.6oC since the late 19th century. The fourth assessment report (AR4) by the (IPCC, 2007) stated that the best estimates of likely increases in the mean global surface air temperature by the end of the 21st century are between 1.1°C and 2.9°C for the "low scenario" and 2.4°C and 6.4°C for the "high scenario,". Our study area is similarly exposed to climate change and/ or variability.

The metrological data analyses of Hawella Tulla Sub-City in figure 30 indicated that average annual temperature **variability and trend** was highly increasing from the year 1991 to 2020. The variation of average temperature between lowest was 19.73^{O}C in the year 1996 and highest was 21.44^{O}C in 2015 whereas; average temperature and range were 20.42^{O}C and **1.7^{O}C** respectively. The rate of change or slope is 0.044^{O}C.

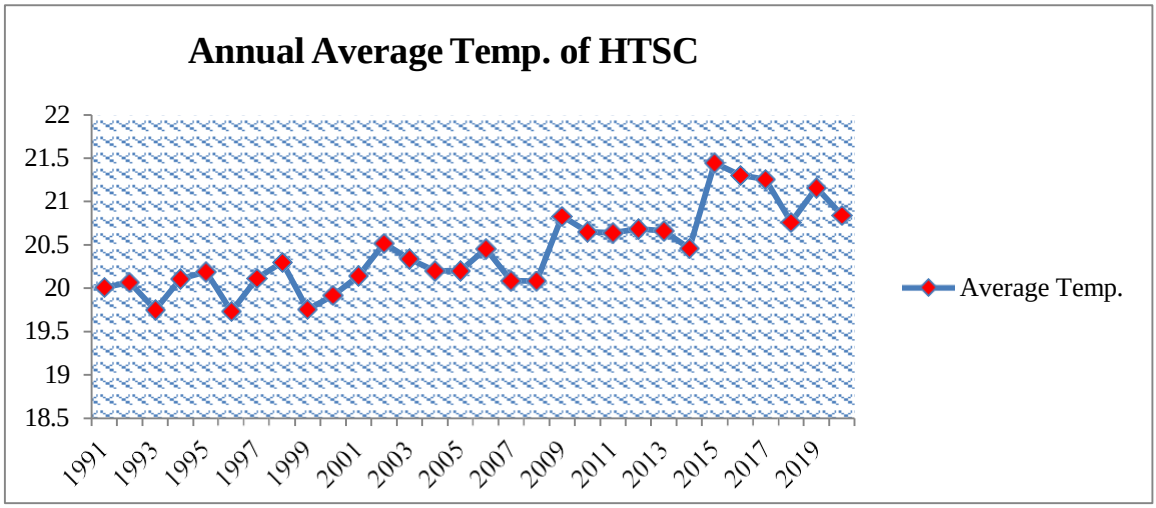


Figure 31: Average Annual Temperature of HTSC from the year 2091-2020.

The blow figure illustrates that **the Monthly average** temperature of the study area was **27.5°c** whereas; **the highest and lowest in February (31.18) and July (24.7)** respectively. Additionally the figure shows that the short dry season extending from January to March this is resulted in the difference between the thermal anticyclone of western Asia and Egypt and the equatorial low pressures determines the presence of trade winds blowing from northeast to southwest. These winds relatively cool but rather dry, control the dry period (Bega) (M. Fazzini et al.2015).

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

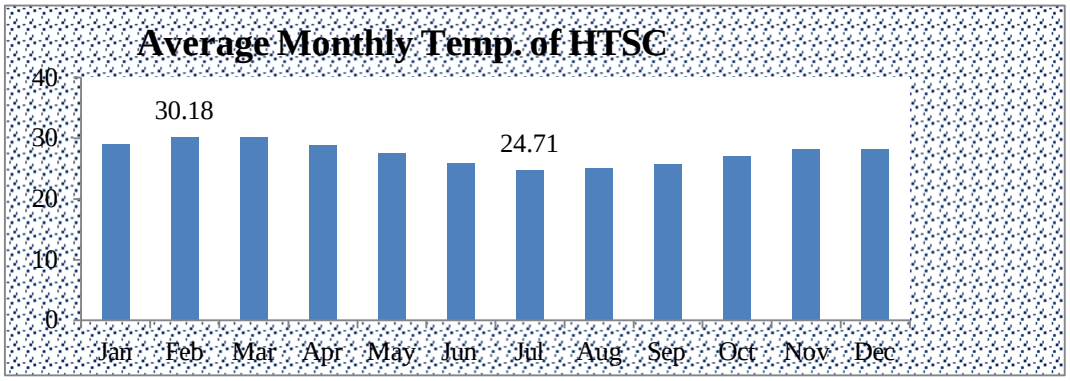


Figure 32*: Average Monthly Temperature of HTSC from the Year of 2091-2020.*

Temperature Anomaly

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

Depends on the blow figure 53.4% of the year was recorded negative temperature anomaly from 1991-2008 except 2002 and 2006 with lowest cool temperature of -0.69°C and the remaining 46.6% was positive anomaly from 2009 to 2020 with peak of 1.02°C was recorded in 2015.

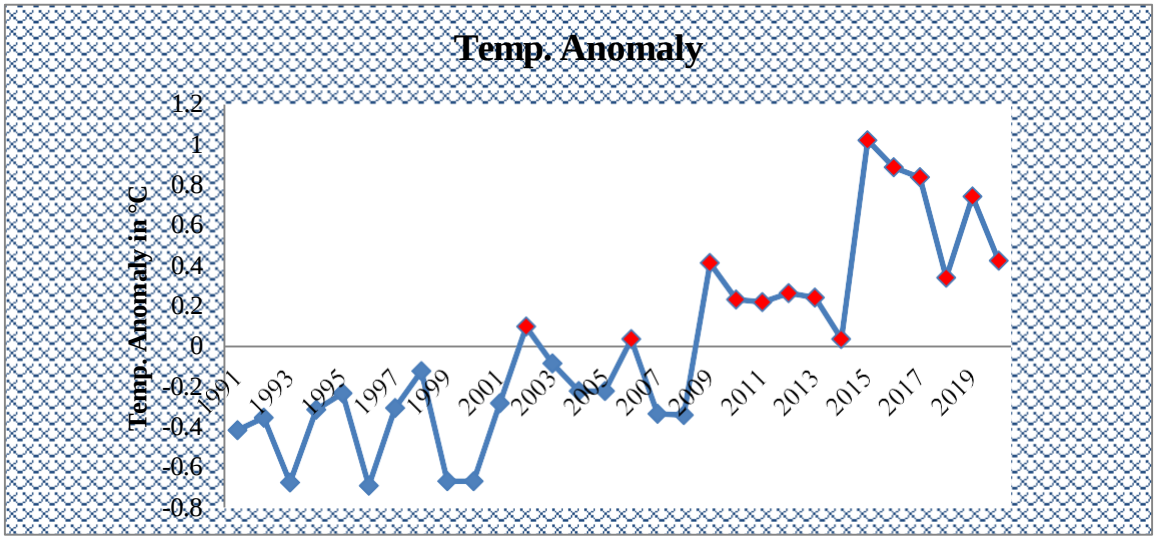


Figure 33: Average Annual Temp. (Calculating with WMO, 2017)

6.2. The driver and pressure of Climate Variability and/or Change to HTSC

Expansion of Industry:

It was a factor for increased frequency and magnitude of environmental degradation in the ecosystem as a great Deriver. After 1999 the city administration of Hawassa was more urbanized from time to time due to this several factories planted in the area like Etab soap factory, Brewery (Saint George Brewery), Pepsi Factory, Hawassa Industrial Park, Hawassa textile factory, Tabor Ceramic factory, etc. Rapid industrialization case for different types of waste like solid, liquid and gasses (outputs from factory chimneys to the environment) were release to the environment, due to this macro-climate change and variability was occurred in the wetland area, it has nationally contributed 1% for GHG emission (online).

Urbanization

Ethiopia is among the least urbanized, but most rapidly urbanizing, nations in the world (UNDESA/PD, 2018). After 1999 the city administration of Hawassa was more urbanized from time to time or rapid urbanization, its land policy and the undergoing urban development endeavors are shaping new settlements at the HTSC. Therefore, 10.4% former rural settlements and private farm lands have been transformed into urban districts (HTSCANRO, 2021) and also 2.99% of the wetland area was changed in to urban area (LULCC, 2021). The society in the study are tray to avoid the solid waste by burning, and also used to manure preparation (FGD, 2021) which is contribute to the emission of methane, carbon dioxide, and stabilized organic material (Francesco N. et al. 2014), additionally waste disposal of Hawassa city is located at Alammura Mountain in the rainy seasons it drain into the wetland and polluted the environment

.Generally, raped urbanization has created major impacts on the environment with deforestation, burning of waste material, waste disposal and manure preparation from the waste in HTSC (FGD, 2020). A waste material has nationally covers (3%) for GHG emission (online).

Due to this the Solid and liquid wastes increase and polluted the environment.

GHG increasing in the atmosphere

It is responsible for regional micro and macro climate change and global warming. In the year 2015 Global level of CO2 crossed the symbolic and significant 400 parts per million bench mark (WMA 2019).

And also the Hawassa city location along the East African rift valley, due to this the toxic gases may become surrounded in the valley under conditions of atmospheric stagnation, compounding existing poor environmental conditions (DDEPA, 2013). According to FGD indicated that in the dry season the wetland is naturally burning for 20 days for every year and then cool down by itself which is responsible for GHG emission.



Figure 34: Naturally burning land in the dry season (field survey).

LULCC

Rapid population growth:-According to FGD discussion different purposes like economic improvement and other cause the number of peoples displaced from rural area and other regions were moved to the HTSC which leads wetland area changed in to **settlement and agricultural** area by **raised by 0.35% and 5.95% respectively, by** using different mechanisms for the purpose of drying the wetland.





Figure 35: Settlements and Graves in the interior of the wetland.

Agriculture

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

The economic activities of the people around Cheleleka wetland ecosystem in HTSC are mainly dependent on Agriculture; therefore the farmer mostly crop cultivated in the wetland area and also they could be planting Eucalyptus tree around the wetland then the result under and above groundwater was reduced and shrink the wetland . Therefore to make a favorable condition for animal grazing and other activates, it is responsible for microclimate change and /or Variability around the area.



Figure 36: Exculpates tree plantation on the wetland

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

1. Land use change (CH4 from deforestation)
2. Crop production (N2O emission from organic and mineral N imputes. Burning of crop residues, N2O and CH4 from manure handling (storage, etc.) and
3. Cattle farming (CH4 from enteric fermentation), being the major source. (Frank Brentup Year GambH and Co.KG May 2008).

Deforestation (CO2 from Land-use change);

In the study area 265 ha (5.95%) of forest land (LULCC 2020) or Acacia-Commiphora woodland vegetation (Friis et al., 2010) changed in to agricultural land due to this 32,330 tone/ha of CO_2 (calculate with MRV directorate rule) emit to the atmosphere, which is **affected net mitigation potential (4.7 MtCO2e/year) of Ethiopia** through afforestation or enhancement of forest carbon stocks (UNFCCC 2017).This study is related to the estimation of Bellarby et al.

(2008) about 12% (range of 6% - 17%) of the global GHG emissions are due to land conversion to agriculture.

Crop production (N2O emissions from organic and mineral N inputs, burning of crop residues, N2O and CH4 from manure handling (storage etc.)

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

The application of mineral fertilizer is a significant material for agricultural products and productivity improvement. In the climate change context, the fertilizer industry is a consumer of energy and an emitter of CO2 and other greenhouse gases (GHG). Crop cultivation in Ethiopia emitted nitrous oxide total of 12 Mt CO2e, which cover 9% of the total emission. (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ethiopia%20First/INDC-Ethiopia-100615.pdf

And the production of N fertilizer (in IPCC assigned to "Industry") releases another 410 Mt CO2-equivalents (CO2eq) per year, which is equivalent to 0.8% of the global GHG emissions. Our study area use fertilizer as followed and contributed to GHG emission.

Table 18 :Use of mineral fertilizers in the HTSC

Dap and urea in Kg					
Years	**Dap in Kg**	**Emission factors**		**Urea in Kg**	**Emission factors of**
		N2O in ton	**CO2** in ton		**CO2 in ton**
2017	195,800	35.244	90.068	264,000	52.8
2018	185,250	32.715	85.215	277, 870	55.574
2019	181750	32.715	83.605	272,625	54.525
Total	562, 800	101.304	258.888	814,495	162.899
Average annual emission	**187,600**	**33.768**	**86.29**	**271, 498.3**	**54.29**

Source; HTSCANRO data with calculated by MRV given value (202)

Methane (CH4) emissions from enteric fermentation (cattle farming);

Animal population: According to FGD and HTSCFEO, (2021) indicated that the wetland was highly dominated by **well grass cover** and **bar of salt** (field observation) which is better option to the raise of cattle population.



Figure 37: Cattle grazing in the Cheleleka wetland.

Source; field observation, (2021)

Livestock is a significant source of global methane (CH4) emission, among Ethiopian livestock species, the major contributor to CH4 emission is cattle which account for 83%. The amount of methane emitted is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed IPCC (2006).

Table 19: Methane (CH4) emission from Cattle population of Hawela Tula Sub-City

S.N	Year	Cattle population	Emissions Factor kg/head/yr.	Total Emission of HTSC in k.g	CH4 emission from livestock enteric fermentation (Gg CH4 yr-1)	In tCO_2
1	**2017**	**55,980**	**31**	**1,735,380**	**1.73538**	**43.3845**
2	**2018**	**77,140**	**31**	**2,391,340**	**2.39134**	**59.7835**
yearly Ave.	**yearly**	**66, 560**	**31**	**2, 063, 360**	**2.06336**	**51.584**
Increment	**2017& 2018**	**21,140**	**31**	**655340**	**0.65534**	**16.3835**

Source: IPCC (2006 with author calculation)

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

The **methane production** potential of manure depends on the manure's specific composition, which in turn depends on the **composition and digestibility** of the **animal diet** (Francesco N. et al. 2014).

In Ethiopia livestock emitted **methane** and **nitrous oxide** total of **65 Mt CO2e**, which cover 42% of the total. In the context of the study area, the livestock population was increased by 21,140 from the year 2009 – 2010, which contributed to the rising of methane (CH4) and nitrous oxide (N2O) emissions.

6.3 Impact of climate change and/or variability to HTSC Administration

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

The wetland is located in the heart of the East African Rift Valley and they were chosen based on their higher potential risk of exposure to adverse climate change and variability (Tafesse, 2019). it was accelerated degradation and soil erosion, increase vulnerability to droughts and floods. It is also responsible for the loss of agricultural productivity and the expansion of insects, pests, and human diseases were known problems in the study area (FGD 2021).

Drought

Drought exists when seasonal rainfall drops below normal by almost 30 to 50 % (Getachew Alem, 2018). It was occurred in the year 1984 and 2003, and. In 1984 and 2003 drought was occurred and affected 734 of the people. The major effect of climate variability and/or change was changed crop cultivation period which is rain comes after the beginning of the normal cropping season, and occasionally heavy amount of rain and high temperature occurred, for the fact that negatively affected at early or late vegetative stages of crop and also unexpected rain devastated the crop product at harvesting time. Seasonal change before 2006 permanent cropping seasons was started in March but currently shifted to half of April to May which is responsible for the occurrences of disease and pest. Both the kiremt and belg rains are irregular and unpredictable, resulting in frequent decline agricultural products from 50% to 31.64% within the (2014 until 2020).

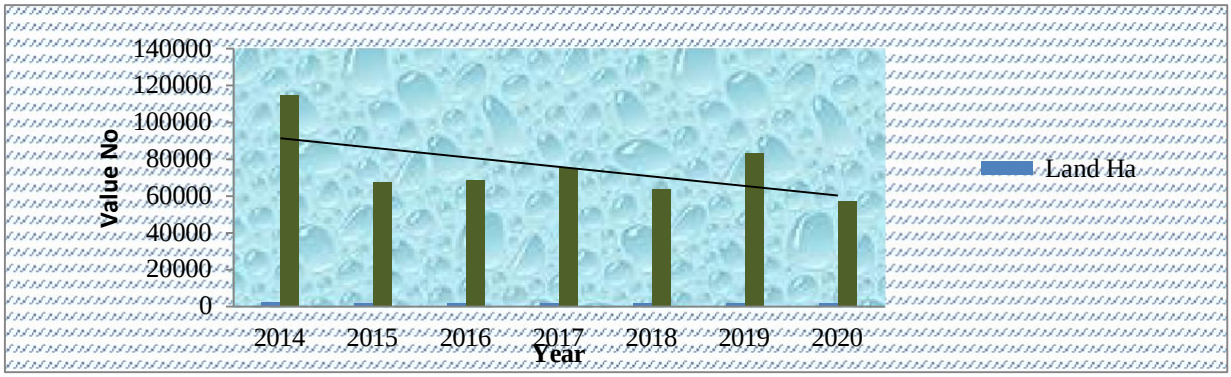


Figure 38: Rate of change in Agricultural product and Productivity from 2014-2020

Source; HTSCRDAO, (2021)

Due to climate variability and/or change and other socio-economic factors the food insecurity problem was raised from 7.86% to 25% of total population which is male 20,511, female 25,067 total 45,578 people in the next 6 month (Jan –July 2021) will be failed under chronically food insecure (ARHTSCAO, 2020). This data showed that **female**s are more **vulnerable** than **male** by **22.2%, whereas** at global level with 700 million people now living in extreme poverty and hunger (Oasis Earth, 2021).

Flood

From the year 2000 to 2020 forest cover and other LULCC similarly increased by 0.28 and 3.87 respectively (LSILLCC, 2021), which means limited improvement of forest land and high expansion of urbanization, farmland, grazing land, settlement area and industry. Due to this increased loss of infiltration capacity of the soil and the development of land through different construction activities like stone quarry site was responsible for the occurrences of flood in the study area.

On the other hand, since the area is located in lower elevations, there are run-offs from the surrounding highlands that damaged crop and house, and displace all peoples live in the surrounding of Chelalaka wetland mostly starting from July to September from 2006 to 2020 due to Flooding, not only that partially displaced peoples did not return to back until January (FGD and field visit 2020).

Table 20:Flood event and its impacts

Year	Flood affected Kebeles and Woreda	Loss of crop type	Flood affected area	Flood affected people	Internally migrated from their resident	Damaged House
2020	1. Dato Chefe, 2.Chefakotejabessa 3. Garaikta, Gemeto 4. Gale and 5. Harametama.	Maize, Zoom Out (Enset), Chat, Colcannon (Dinichi), Haricot been and Vegetables	11,377 ha	M=8759 F=8084 T=16,843	1340	268

Source: HTSCAO and FDREMARDDRMFSEWRD.



Figure 39: Due to flood people loss stable settlement in the wetland area

Health Impact

As the climate is changing, the existing diseases will aggravate and new diseases will emerge. Diseases such as cardiovascular mortality, respiratory illnesses, water-related contagious diseases, and malnutrition are directly or indirectly associated with climate change (Tafesse, 2019). The Health-related impact in Cheleleka wetland is human diseases like malaria, typhoid, typhus, TB, influenza, and malnutrition (ARHCAAO, 2020).

According to FGD and field observation (2021) implies that the society was used wetland for medicinal purpose like spring water and Pond for the medicine of human bone, skin, and gastric illness, etc.

The wetland is surrounded by different industries. These industries have been releasing toxic waste to the wet land. As a result of this those cattle grazing on the wetland exposed to abortion and death. Even human females through food chain can get sterility when they consume cattle product (FGD 2021).



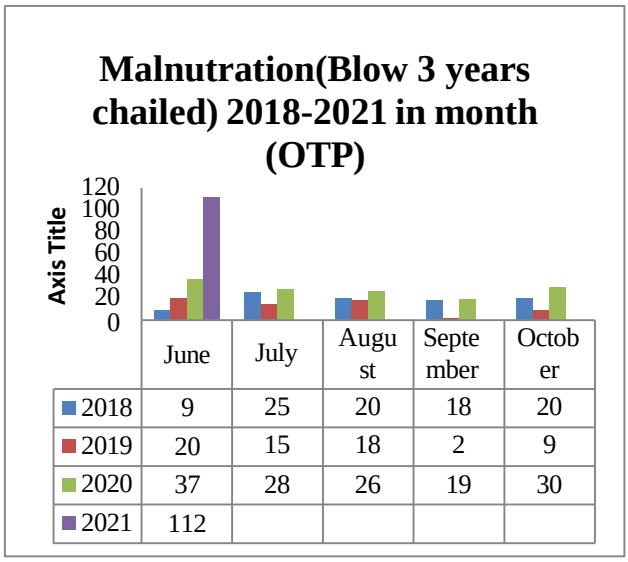
Figure 40: Medicinal purpose of Hot Spring in the wetland (Source: Field Survey 2021)

The expansion of industry and urbanization in the surrounding of the Cheleleka wetland is a case to the declining of outdoor air quality which is lead to the emission of toxic gases such as SO_2, NO_2, and CO in addition to increasing concentrations of CO_2 and VOCs (Volatile organic compounds). The result especially NO_2 levels, may decrease lung function and increase the risk

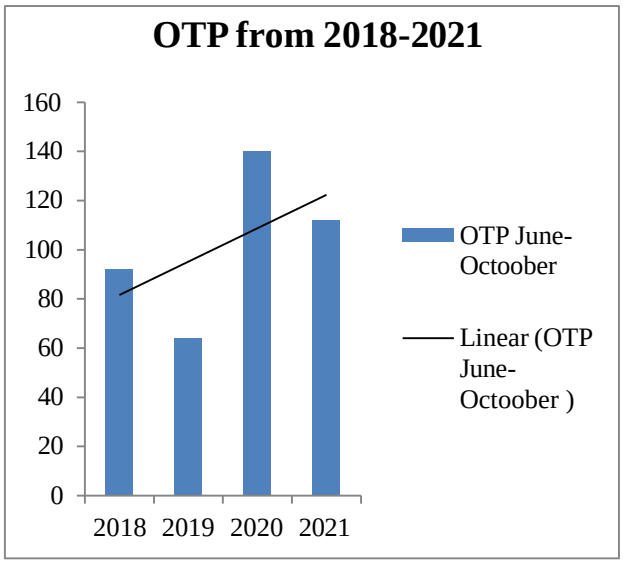
of respiratory symptoms, such as acute bronchitis and cough and phlegm, particularly in children, and. Also S_2O affects the human lung (Oluwasinaayomi et al., 2018). Top ten human diseases in the wetland were malaria, typhoid, respiratory illnesses, and malnutrition (ARHCAAO, 2020) are directly or indirectly associated with climate change (Tafesse, 2019). Globally 19,000 people dying every day from breathing polluted air (Oasis Earth, April 2021).

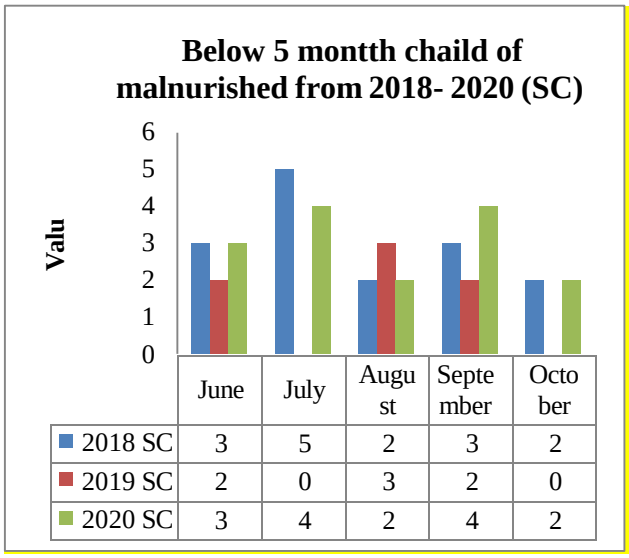
OTP and SC (Health-related)

According to NMASHB trend analyses was indicated that frequent losses of agricultural product was resulted outpatient therapeutic program (OTP) hunger gap case tend to increase during January – May from the year 2018 - 2020.



	June	July	August	September	October
2018	9	25	20	18	20
2019	20	15	18	2	9
2020	37	28	26	19	30
2021	112				





	June	July	August	September	October
2018 SC	3	5	2	3	2
2019 SC	2	0	3	2	0
2020 SC	3	4	2	4	2

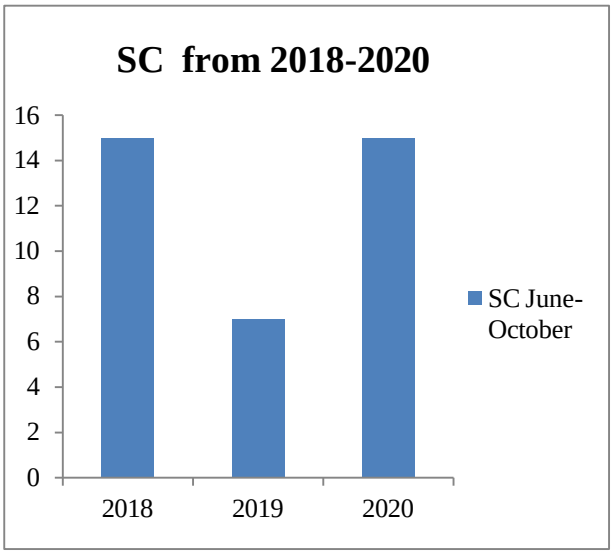


Figure 41: Malnutrition in the children of blow 3years and 5 month

Source: HTSC Health office (2020).

Based on the FGD data, the area experiences severe water shortages when the declines of underground water during the December–February. Because of shrinking sources of freshwater, droughts, and changes observed in the water cycle due to this 22, 9% of water source was not served (HTSC water, mineral, and energy office). Therefore during the dry season, the people in the study area travel long distances every other day to drinking water. Such long-distance trekking undoubtedly hinders household heads or other family members from devoting enough time to other livelihoods and, therefore, incurring further economic losses and made sanitation problem and also responsible for water-borne diseases like typhoid. Globally billions living in water-stressed regions (Oasis, 2021).

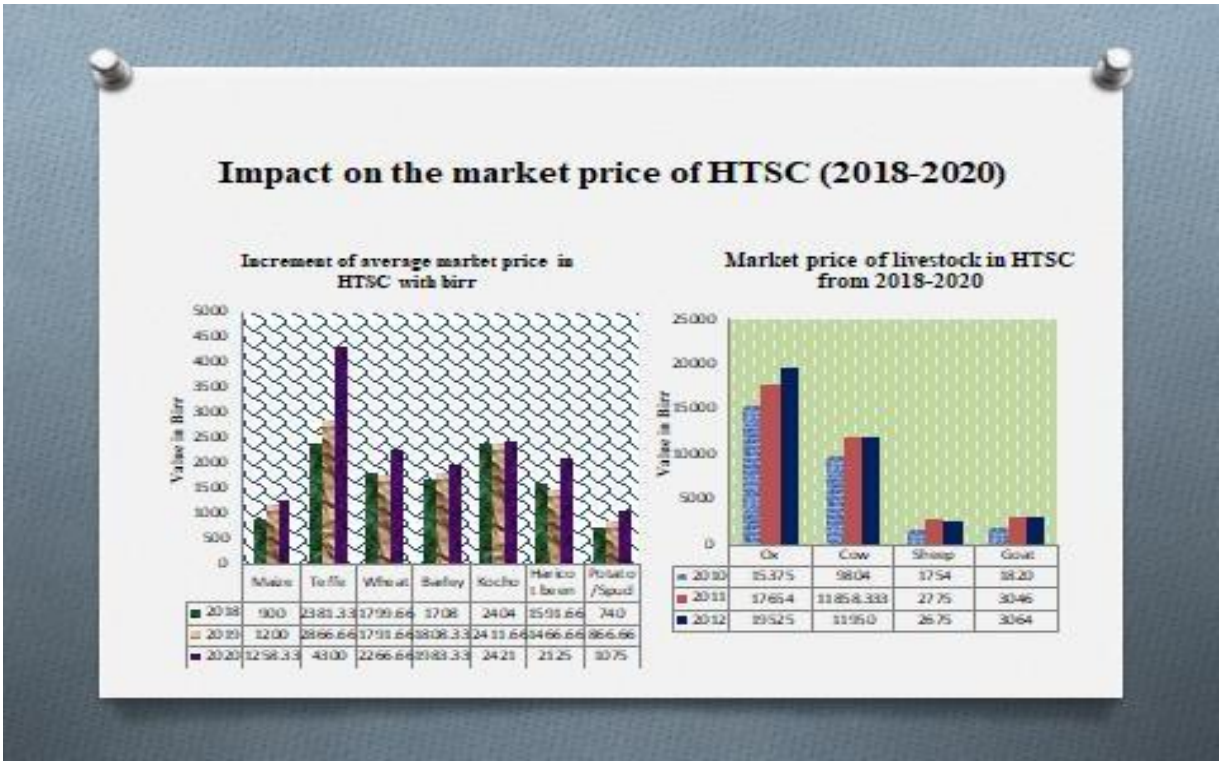


Figure 42: Impact of market price of HTSC (2018 – 2020)

In the study area climate change mainly affect the value of food crop and domestic animals. The above figure shows that the increment of the market price in cereal and root crop were continuously raised from the year 2018 to 2020, due to decline of productivity and less supplied.

And also the price of livestock in HTSC was increased from the year 2018 to 2020, due to shortage of grazing and contaminated water in the wetland exposed to health problem like abortion.

Ecosystem Impact

According to FGD and field observation (2021) implies that the society was used wetland for different purpose like traditional house cover, and a recreational service (different Spp. of birds), grass for grazing animal, etc. But currently the service was highly declined, due to this the society loss social and economic value.

6.4 Response to Climate Change and/or Variability in HTSCCWL

Community Level

In the earlier time the wetland was conserved by traditional low/agreement/ of the society but now omit it

Almost all people in the surrounding wetland area perceived the occurrence of climate change and/or variability especially in every summer seasons move to other neighboring Woreda and kebele until September to save their life from the flood and similarly, nearly all farmers were predominantly cultivating drought resistance root crop like Enset, (FGD, 2021).

Government Response at the HTSC level

The construction of Adiss Abeba - Hawassa express railway was started and near to accomplished. According to FDEMADRMFSSEWRD, 2011 indicated that effort to mitigate the impact of the anticipated floods and facilitate a timely response, a Flood Contingency Plan is being prepared to outline expected sectorial requirements, as well as preparedness and response activities.

To minimize the likely adverse impacts of flooding, appropriate mitigation and preparedness measures should be undertaken. These activities should include dissemination of early warning information to populations at risk, enhancing communication linkages between Woreda officials in highland areas that receive heavy rainfall and those downstream that are at risk of flooding, dam management, strengthening flood protection structures, reactivation of regional flood taskforces in areas that are likely to be affected, and preparation of evacuation plans. Moreover,

priority should be given to the pre-positioning of food and non-food items, particularly in areas that may become inaccessible.

Government and humanitarian partners are urged to take measures for an appropriate and timely response. The Flood Task force will continue to closely monitor the situation and regularly update the Flood Alert report and facilitate the revision of the Flood Contingency Plan, as the need arises. The PSNP is a social protection program that government instruments in drought-prone and food-insecure areas of Ethiopia. Because of the widespread food insecurity, the government has been carrying out the PSNP in the study area (HTSCARDO, 2021).

Table 21: Government responded to flood affected people and PSNP beneficiary (ARHTSC).

Cause to support	Year	Client			Types of response			
					Support in quintal			yearly payments
		M	F	T	Wheat	Oil	Nutrient	
Response to flood affected people	2020	8,759	8,084	16,843	1473	14.53	31	
Response to Under poverty people /PSNP/ beneficiary	2014	6,313	6,581	12,894				16,788,290
	2019	10,236	11,089	21,325				20,954,457
	2020	10,236	11,089	21,325	10, 534	292.5	378	
Total					12,007	307.03	409	37,742,747

Regional forest and climate change commission has tray to protect the sop cover and other solid waste collected from the surrounding area of the spring water and pond, then inter in to the garbage and put near it by user or workers (RFCCC stake holder, 2021).



Figure 43: REFCCC create contractual agreement with jobless youth to protect soiled waste collected from the surrounding of the spring and Pond water (Source: Field Survey, 2021)

Government Response at National Level

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

- ✓ **The Ethiopian Constitution (1995)** provides the rights to a clean and healthy environment as fundamental rights of citizens (articles 43 and 44).
- ✓ **Environmental Policy of Ethiopia (1997)** is the overarching policy for managing the environment and natural resources.
- ✓ **National Action Program** for the equitable sharing of the costs and benefits, arising from them and contribute to the well-being and security of the nation.
- ✓ **Climate change subject will integrate as a curriculum for the coming few years**

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

International Response

- ✓ Ethiopia intends to limit its net greenhouse gas (GHG) emissions in 2030 to 145 Mt CO2e or lower. This would constitute a 255 MtCO2e reduction from the projected 'business-as-usual' (BAU) emissions in 2030 or a 64% reduction from the BAU scenario in 2030. Ethiopia also intends to undertake adaptation initiatives to reduce the vulnerability of its population, environment, and economy to the **Combat Desertification (NAP, 1998)** the GoE ratified the UN Convention to Combat Desertification (UNCCD) in 1997 and subsequently undertook the formulation of a NAP.
- ✓ **National Biodiversity Strategy and Action Plan (NBSAP, 2005)** the GoE developed the NBSAP to ensure the conservation and sustainable use of biodiversity, and to provide adverse effects of climate change, based on its Climate Resilient Green Economy Strategy (CRGE). The CRGE is Ethiopia's strategy for addressing both climate change adaptation and mitigation objectives. The implementation of the CRGE would ensure a resilient economic development pathway while decreasing per capita emissions by 64% or more. The CRGE is also integrated into the Second Growth and Transformation Plan (the national development plan). In the long term, Ethiopia intends to achieve its vision of becoming carbon-neutral, with the mid-term goal of attaining middle-income status.

The full implementation of Ethiopia's INDC is contingent upon an ambitious multilateral agreement being reached among Parties that enables Ethiopia to get international support and that stimulates investments. The INDC will be updated periodically, as appropriate.

Overall, the EINDC marks an important next step on the path towards sustainable development, consistent with the Principle of Common but Differentiated Responsibilities and Respective Capabilities. In this context, Ethiopia reaffirms its continued commitment to building a climate-resilient green economy. This EINDC contributes to the global effort to mitigate climate change while ensuring the realization of an equitable and resilient green economic growth nationally.

6.5 Outlook for Climate Change and/or Variability of HTSC

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

If the rate of climate change and /or variability increased just like as trend line and industrial liquid waste material release to wetland will continue without implemented the recommended points and other additional research over the next three-decade,

- The situation continue as baseness as usual (BAU) the wetland should be completely lose, not only that but also Lake Hawassa should be dry up because it was tributary to the lake due to this the city loss recreational service from the lack and the sustainability of human settlement should be fail under the question mark.
- According to baseline data of 2014 - 2020 kiremt and belg product was declined by 19.36%, similarly in the next 30 years it should be declined by 82.97%.
- Flood risk will increase significantly. Like due to flooding the number of internal migrants from 1,340 in the year 2012 will increase double time or above it.
- The frequency of drought will be increased significantly.
- Depends on the baseline data of 2014 to 2020 the number of **PSNP** beneficiary was raised by **17%, where as in the next 30 years** it will be increased by **73.45%.**
- In the same years, the vulnerability of female was **22.2%** it will be raised by **95.1%**
- CO_2 emission from livestock and fertilizer will be reached at 9,608 tones.
- N_2O emission from fertilizer (N_2O) will be reached at 1,688.4 tones.
- CO_2 emission from forest will be reached at 1,616,500 tones.
- Lose potential health benefits like increased malaria will rise to the epidemic level and also will increase the death due to malaria and water-borne disease (Typhoid, conjunctivitis, etc), malnutrition cause and other new diseases will be emerging.
- Scarcity of water will be increased significantly.

6.6. Recommendations according to the study area profile, Field visit, & NMASSNNPR

Data indicated that the rate of atmospheric temperature increasing from year to year.

Therefore the following problem reduction method should be needed.

- Retrieve traditional low about conservation of the wetland area.
- Industrial waste material should be **recycled** (beter e.g Etab sop factory) and **corporate social responsibility** will be financially supporting the community to soil and water conservation activities.
- EFCCC and Sidama Regional FCCB and other concerned body will measure the quality of pond water and then take action to protect it.
- Environmental compliance directorate should be taken toxic chemicals sample from the wetland area and it should be tasted in the laboratory.

- Health centers should be prepared for additional research on the impact of human and animal fertility of grazing cattle in the wetland area and human females through food chain can get sterility when they consume cattle product.
- The coping mechanism to climate variability and adaptation option for climate change should be implemented.
- Adaptation options should focus on reforestation, area closure, implement zero grazing and ensuring better management of soil and water, cultivate the short growing crop and drought resistance crop should be possible.
- Develop research on the new productivity technology on the crop and animal.
- Water mineral and energy office purify water source and improve water coverage.
- HTSC municipal, SRFCCB and Health office should be organized to improve waste management system.
- Farmer implements effective reduction of agricultural emission.
- Government should be effectively implementing international agreement to reduce CO2 emission.
- Identify wetland for protection in parks, sanctuaries, reserves,
- carbon-free electricity which is fully electrified transportation system **(exigently construction of Adiss Abeba - Hawassa express railway)**
- Health center should be cerise attention on family planning.
- Generally, the government and any concerned body should think of a possible solution to recover this study area.

7. Referenc

Abate (2010), about the factors of forest degradation.

Aberham. (2016). Vegetation Composition and Deforestation Impact in Gambella National Park. Ethiopia.

Albert, S.et al., 2017 heading for the hills: climate driving community relocations in the Solomon Islands and Alaska proved insightfora1.5cfuture. Regional environment changes 1-12, do: 10.1007/s10113_017-1256-8.

Alex Evans, August 2012, Resources, risk, and resilience: scarcity and climate change in Ethiopia.

Amare Gibru* Zelalem Temesgen (2020). Diversity and Threats of Avifauna in Cheleleka Wetland, Central Rift Valley of Ethiopia.

Amsalu, A., Stroosnijder, L and Graaff, J. de. (2007). Long-term dynamics in land resource use and the driving forces in the Beressa watershed, highlands of Ethiopia. Journal of Environmental Management, 83(4), 448–459.

Amsalu, A., Stroosnijder, L and Graaff, J. de. (2007). Long-term dynamics in land resource use and the driving forces in the Beressa watershed, highlands of Ethiopia. Journal of Environmental Management, 83(4), 448–459.

Bekele Fekadu (1997) Ethiopian use or ENSO Information in Its Seasonal Forecasts.

Belete, Mulugeta Dadi (2013). The impact of sedimentation and climate variability on the hydrological status of Lake Hawassa, South Ethiopia. Bonn, Germany: PhD Thesis, Rheinischen FriedrichWilhelms-Universität.

Bilsborrow, R.E. (1991).Population Pressure and agricultural development in developing countries: A conceptual frame work and recent evidence. World development, vol. 15(2):183- 203.

Boserup, E. (1981). Population and Technological change. Study of long term Trends, Chicago: University of Chicago press.

Census 2007 Tables: Gambela Region Archived 2010-11-14 at the Wayback Machine, Tables 2.1, 2.4, 2.5, and 3.4.

Climate Variability and Household Adaptation Strategies in Southern Ethiopia

Dagne Shibru. “Socio-Economic Aspects of Cheleleka Wetland: Current Status and Future Prospects." IOSR Journal of Humanities and Social Science (IOSR-JHSS). vol. 24 no. 08, 2019, pp. 79-89.

Daniel Alemayehu Demessie, March 2007, Assessment of Flood Risk in Dire Dawa town, Eastern Ethiopia, Using GIS

Di Gregorio, A and Jansen, L. J. (2000). Land cover classification system: LCCS: classification concepts and user manual. Food and Agriculture Organization of the United Nations Rome.

Di Gregorio, A and Jansen, L. J. (2000). Land cover classification system: LCCS: classification concepts and user manual. Food and Agriculture Organization of the United Nations Rome.

DPPA, 2005. The number of people affected by drought in Ethiopia during 1990 – 2005. Addis Ababa, Ethiopia.

EDRI2015R, (https://www.climate links.orh/).

Environmental Protection Authority and Ministry of Economic Development and Cooperation, CONSERVATION STRATEGY OF ETHIOPIA PHASE III PROJECT (1996-2001), FINAL
EVALUATION REPORT VOLUME ONE by Adrian Wood and Kifle Lemma with Alemayehu Konde October 2001.

Ethiopian FRL . (20162). Ethiopian first African country to submit forest reference level to UNFCCC. Posted By: Maddie West On .

Ethiopian Mapping Authority (EMA) (1988). The National Atlas of Ethiopia. EMA, Addis Ababa

European Union emergency trust fund for stability and addressing the root causes of irregular migration and displaced persons in Africa (EUTF) cross-border analysis and mapping, cluster 3: western Ethiopia-east Sudan, august 2016.

EWSRFA, 2004. Ethiopia Water Supply Sector Resource Flows Assessment. Sector Finance Working Papers, V. 2, No. 10.

Expectations and belonging in Dire Dawa Drivers, dynamics and challenges of rural to urban mobility, THE RESEARCH AND EVIDENCE FACILITY FEBRUARY 2018.

FAEDOAW, 2015, about different socio economic data.

FDRE: MOFED (2010), Growth and Transformation Plan (GTP) 2010/11-2014/15, Addis Ababa, Ethiopia.

Federal Democratic of Ethiopia Ministry of Agriculture Disaster Risk Management and Food Security Sector Early Warning and Response Director June 2011.

Fertilizer, Biomass and CO2 Emission: presented by Frank Brentup Year GambH and Co.KG, Germany May 2008.

Fourth Assessment Report (AR4) Climate Change 2007: Synthesis Report. September 2007. Working Group Report ... AR4 Climate Change 2007: Impacts, Adaptation, and Vulnerability.

Friis I., Sebsebe D., Breugel P. 2010. Atlas of the Potential Vegetation of Ethiopia Atlas of the Potential Vegetation of Ethiopia.

Getachew Alem Mera, 2018, Drought and its impacts in Ethiopia Water Resources Engineer and Hydrologist, Principal Consultant.

Global Environment Outlook (Geo-6) Healthy Planet, Healthy People (2019).

Godwin, K.S., et al. Long-term trends in sodium and chloride in Mohawk River, New York: the effect of fifty years of road-salt application. December 5, 2002.

Godwin, K.S., et al. Long-term trends in sodium and chloride in Mohawk River, New York: the effect of fifty years of road-salt application. December 5, 2002.

Ghosh and Suparna Sreenivasa Salla and Assessment of water quality parameters of lower lake, Bhopal [Journal] // Archives of Applied Science Research. - CMJ University, Sheelong, India : [s.n.], Oct 6, 2014. - pp. 8-11.

GRSEBESAA, 2017, about participation of females.

Guteirrez,AnnaP.A.,Engle,NathanL.,ErwinDeNys,Molejon,Carmen,Martins,EdwardoSavio,2014

Haregeweyn, N., Fikadu, G., Tsunekawa, A., Tsubo, M and Meshesha, D. T. (2012). The dynamics of urban expansion and its impacts on land use/land cover change and smallscale farmers living near the urban fringe: A case study of Bahir Dar, Ethiopia. Landscape and Urban Planning, 106(2), 149–157. doi:10.1016/j.landurbplan.2012.02.016.

Haregeweyn, N., Fikadu, G., Tsunekawa, A., Tsubo, M and Meshesha, D. T. (2012). The dynamics of urban expansion and its impacts on land use/land cover change and smallscale farmers living near the urban fringe: A case study of Bahir Dar, Ethiopia. Landscape and Urban Planning, 106(2), 149–157. doi:10.1016/j.landurbplan.2012.02.016.

http://www.definitions.net/definition/social environment.

https://www.epa.gov> ghg emissions>).

https://www.researchgate.net/publication/258049236_Biodiversity_Status_in_Ethiopia_and_Challenges [accessed Dec 11 2018]. © ResearchGate 2018.

Ib Friis,Finn N. Rassmusen and Kaji Vollesen . (n.d.). Studies in the flora and vegetation of SW Ethiopia.

IBC. vol. 115. 2005. Institute of Biodiversity Conservation, National Biodiversity Strategy and Action Plan, Government of the Fedral Democratic Republic of Ethiopia.

International Journal of Fauna and Biological Studies 2017; 4(5): 67-75, Isolation, identification and antimicrobial susceptibility of Pasteurella multocida from cattle with hemorrhagic septicemia in Assosa and Bambasi districts, Benishangul Gumuz Regional State, Ethiopia.

International Journal of Scientific and Research Publications, Volume 6, Issue 6, June 2016 390 ISSN 2250-3153 www.ijsrp.org

IPCC, (2007): Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (Eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Kumlachew Y and Tamrat B . (2003). The Woody Species Composition and Structure of Masha Anderacha Forest, Southwestern Ethiopia. Ethiopia. J. Biol. Sci., 2(1): 31– 48, Addis Ababa.

Lambin, E. F., Geist, H. J and Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. Annual Review of Environment and Resources, 28(1), 205–241.

Lambin, E. F., Geist, H. J and Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. Annual Review of Environment and Resources, 28(1), 205–241.

Land classification of land sat images of 1999, 2009 and 2018.

Liljequist some aspects of the climate of Ethiopia. Symb. Bot. Ups. 1986; 26(2):19–30.

MEFCC. (2017). vegetation types in Ethiopia.

Mekonnen M., Sewunet T., Gebeyehu M., Azene B., Melesse A.M. (2018). 2016) Federal Democratic Rebublic of Ethiopia Ministry of Environment, Forest And Climate Change National REDD+ Secretariat FINAL DRAFT Version 1.2).

Michael Jenkins and Brian Schaap, 2018. Forest Ecosystem Services, Background study prepared for the thirteenth session of the United Nations Forum on Forests.

Millennium Ecosystem Assessment Ecosystems and Human Well-being: Biodiversity Synthesis (2005) Ministry of Environment and Forest. 2014. Overview of REDD+ Process in Ethiopia. A Proceedings Paper, Addis Ababa. 2014.

Ministry of Environment and Forest. (2015). Overview of REDD+ Process in Ethiopia. A Proceedings Paper, Addis Ababa.

Mishra, Husen, A., V.K., Semwal, K. and Kumar, D. 2012. Biodiversity Status in Ethiopia and Challenges. Gonder, Ethiopia: s.n., 2012. (ISBN 978-93-5056-149-2)

Mr. Musba Kedir (2019), Greener Journal of Agricultural Sciences,Vol. 9(2), pp. 119-137, 2019,, ISSN: 2276-7770.

N.K.Nanda 2018.Climate classification: Research gate

NAPA. 2007. Climate Change National Adaptation Programs of Action (Napa) of Ethiopia. S.L.: National Meteorological Agency, 2007.

Oasis Earth, April 2021, Urgent Policy Actions 2020 - 2030.

Oba Belay Tefa Chamo, assessment of physicochemical properties of water from lake [Journal] // International Journal of Applied and Natural Sciences (IJANS). - Arba Minch: [s.n.], Dec 2017. - 1 : Vol. 6. - pp. 69-76.

Ola et al., G.H.leeks, G.J.I. pack man, J, C., Smith, B, P.G., Lewis.s, Hiwitt, E., J.2006 river flow and assisted transport of sediments and Solute through highly urbanized catchments, Bradford, west yorksimire, the science of the total environment 360:98-108.

Peter T. et al. 2015. What is the difference between weather and climate? s.l.: U.S. Department of Agriculture, 2015. MF3197.

Rapport and Friend, 1979 state about DPSIR approach.

Samson Wakuma Abaya1, 2*, Nicodemus Mandere3, 4, and Go¨ ran Ewald3-Floods and health in Gambella region, Ethiopia: a qualitative assessment of the strengths and weaknesses of coping mechanisms-Accepted: 4 October 2009; published: 28 October 2009

Singh, A. (1989). Digital Change Detection Techniques Using Remotely Sensed Data. International Journal of Remote Sensing, 1,

Singh, A. (1989). Digital Change Detection Techniques Using Remotely Sensed Data. International Journal of Remote Sensing, 1,

Teshome A., 2007. Prospects and Challenges of Water Supply and Sanitation in Ethiopia with respect to MDG. Proceedings of the Fifth International Conference on the Ethiopian Economy: Vol. III.

Tilashwork Chanie Alemie . 2009. The Effect of Eucalyptus on Crop Productivity, And Soil Properties in the Koga Watershed, Western Amhara Region, Ethiopia

UNFCCC. 2007. Climate Change: Impacts, Vulnerabilities, and Adaptation in Developing Countries. 2007, pp. 17, 28, 51, and 54.

United Nations Human Settlements Programme (UN-HABITAT), 2008. ETHIOPIA: DIRE DAWA URBAN PROFIL

Wassie Berhanu 1,* and Fekadu Beyene, 2015)

World Bank, 2004. World Bank Group's Program for Water Supply and Sanitation. Unpublished report, Water Supply and Sanitation Sector Board.

WMO, 2012 Standardized Precipitation Index User Guide.

Woldesemayat Alemu, 2018. Land use land cover changes environmental analyses and implication for sustainable agricultural development in Gambela Woreda. Gambela region southwestern Ethiopia: s.n., 2018.

World Health organization 2016, Building adaptation to climate change in health in the least developed countries through resilient Water, Sanitation, and Hygiene (WASH) Project, Climate Change and Health – Ethiopia.

Zeleke, G and Hurni, H. (2001). Implications of land use and land cover dynamics for mountain resource degradation in the Northwestern Ethiopian highlands. Mountain Research and Development, 21(2), 184–191.

Zeleke, G and Hurni, H. (2001). Implications of land use and land cover dynamics for mountain resource degradation in the Northwestern Ethiopian highlands. Mountain Research and Development, 21(2), 184–191.

WRITERS	POSITION
• **Mrs. Yewubdar Alemu**	**Environmental Information Exchange Expert**
• **Mrs. Banchaymolu Terefe**	**State of Environmental Reporter Expert**
• **Mr. Tewelde Alema**	**State of Environmental Reporter Higher Expert**
• **Mr. Endalkachew Yelikal**	**State of Environmental Reporter Expert**
• **Mr. Assaye Tessega**	**State of Environmental Reporter Higher Expert**

FACILITATOR

• **Mr. Antenhe Teshome**	**State of Environment Directorate General**
• **Mr. Tilahun Alemu**	**Environmental Information Management Director**