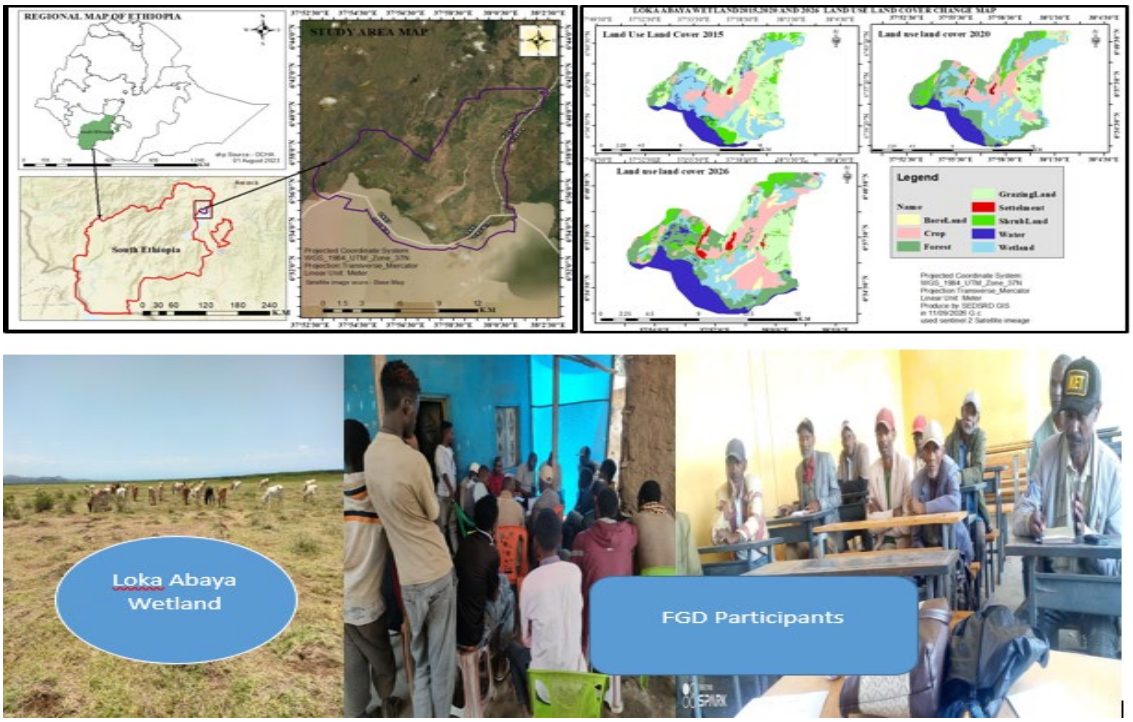
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

ENVIRONMENTAL PROTECTION AUTHORITY

FACT–SHEET OF LOKA ABAYAWETLAND ECOSYSTEM IN SIDAMA REGION



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Abbreviations

AGP—Agricultural Growth Program

Avr – Average

CBD – Convention on Biological Diversity

CDM- Clean Development Mechanism

CRGE – Climate Resilience Green Economy

CSA - Central Statistical Agency

DLUMDR: Department of Land use Management directorate report 2011

DPSIR: Driver, Pressure, State, Impact and Response

E.C. - Ethiopian Calendar

EPA – Environmental Protection Authority

FAO –Food and Agriculture Organization-

FGD: Focus Group Discussion

GDP: Gross Domestic Product

GHG: Green House Gas

GTP: Growth and Transformation Plan

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation Nature

IWRM - Integrated Water Resources Management

KI: Key informants

MAOD: Meteorology Agency office

Max – Maximum

MEA-Millennium Ecosystem Assessment

Min – Minimum

MoWIE - Ministry of Water, Irrigation, and Electricity

NGO - None Governmental Organizations

NMA – National Metrology Agency

NTFPs- Non-Timber Forest Products.

RF- Rain Fall

T – Temperature

UNEP - United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

UNICEF - United Nations Children's Fund

Uwao-Uba Woreda agriculture office

Uwfo-Uba Woreda finance office

WHO - World Health Organization

WMO: World Meteorological Organization.

WWAP - World Water Assessment Programme

1. General Back ground

1.1 Environment for Green Economy Development

Human being highly interacting with the environment so, they full their basic need from the environment like food, shelter, fuel energy, clean air , water etc. generally natural resource. Human being disrupt their interaction with the environment through over exploitation of natural resource and produce un wanted waste substance to the environment so, this condition alter the environment on the contrary environment also affect human lives. Human impact on the environment increased through expansion of industrialization (http://www.open.edu/).

According to (Human Development Report 2016) Progress in human development has been impressive over the past 25 years. The Millennium Declaration and the Millennium Development Goals Global commitments at the turn of the century to end basic human deprivations within 15 years added to the momentum. Yet human development has been uneven, and human deprivations persist. Some groups, communities, societies and people have achieved only the basics of human development, and some not even that. In addition, new development challenges have emerged, ranging from inequalities to climate change, from epidemics to desperate migration, from conflicts to violent extremism (2016). To solve the challenges of development needs use environmental friendly means improve sustainable use of environment resource especially development of green economy is very necessary to improving human wellbeing and social equity by reducing environmental risks and ecological scarcities.

Nevertheless, the record of development at the global level is unsatisfactory and criticized for two reasons. First, the benefits of development distributed unevenly, i.e. income inequalities remain persistent and sometimes increasing over time; and the global numbers of extremely poor and malnourished people either have remained high or in some areas have increased. Secondly, development-related endeavors have resulted in major negative impacts on the environment (such as depletion of biological resources and pollution) and on the existing social structures. Growing awareness on the failure of the traditional development thinking to satisfy the needs of the expanding global population, in turn, led to emergence of the idea of sustainable development.

Sustainable development is development, which meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The concept of sustainable Development takes into account the interlinking of the environment, economic and social issues.

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

According to Clouth (2012), categorized key words definitions according to the three dimensions of sustainable development as follow.

Social green economy Human well-being; social equity; socially inclusive; reduced inequalities;

Better quality of life; social development; equitable access; addressing needs of women and youth.

Social green growth Well-being, socially inclusive, access to basic commodities for the impoverished; meeting demands for food production, transport, construction, housing and energy,

Economic green economy Growth in income and employment; public and private investments; resilient economy; economic growth; new economic activity.

Economic green growth Economic growth and development; technology and innovation; environmentally sustainable economic progress; more resilient; sustained economic growth; driver for economic growth; new growth engines; green technology; new job opportunities; qualitative growth rather than simply increasing GDP; job creation or GDP growth.

Environmental green economy Reducing environmental risks and ecological scarcities; low carbon; resource efficient; reduce carbon emissions and pollution; enhance energy and resource efficiency; prevent loss of biodiversity and ecosystem services; within ecological limits of the planet; environmental responsibility; finite carrying capacity.

Environmental green growth Protection and maintenance of natural assets and environmental services; provision of resources and services; low carbon; using fewer resources and generating fewer emissions; resource efficient; cleaner; climatic and environmental sustainability; energy and resource efficient; minimizes pollution and environmental impacts; resilient to hazards; harmony between the economy and the environment; environmental protection; reduce GHG.

Most of Africa countries their economy activity and their livelihood based on natural capital assets in order to raised their economy growth rates they over exploits the natural resource and degraded the environment, change the climate, increases desertification, and increase environmental risks and resource scarcities due to these most of African countries are face to persistent poverty(UNECA 2012).

The Government of the Federal Democratic Republic of Ethiopia and the Regional State governments are striving to fulfill their responsibilities to their citizens. They strive to provide social services and security, ensure adequate functioning of infrastructure, provide a climate conductive employment and pay their debts. In addition, promoting development and achieve their national aspirations using the resources available at their disposal. 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 5 years Growth and Transformation Plan (GTP) that aims at improving the livelihoods of its people implemented. The GTP, which aims at sustaining the rapid and broad-based growth of the country, hinges on seven pillars and four of these (i.e. sustaining faster and equitable economic growth, maintaining agriculture as a major source of economic growth, creating favorable conditions for the industry to play key role in the economy, and enhancing expansion and quality of infrastructure development). Furthermore, the environmental sector plan is one of the GTP of the country.

The green economy, growth mostly based on the reduction of carbon emissions and pollution and enhances energy and resource efficiency prevents the loss of biodiversity and ecosystem services. Ethiopia aims to be a middle-income country by 2025 through developing a climate-resilient green economy. The country has developed Climate Resilient Green Economy (CRGE) strategy and mainstreamed it into the second Growth and Transformation Plan (GTPII) NAP-ETH (2017).

Why are Wetlands Important?

Wetlands are 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 valuable functions are the result of the unique natural characteristics of wetlands.

Wetlands and Nature

Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs. An immense variety of species of microbes, plants, insects, amphibians, reptiles, birds, fish and mammals can be part of a wetland ecosystem. Climate, landscape shape (topology), geology and the movement and abundance of water help to determine the plants and animals that inhabit each wetland. The complex, dynamic relationships among the organisms inhabiting the wetland environment are called food webs. This is why wetlands in Texas, North Carolina and Alaska differ from one another.

Wetlands can be thought of as "biological supermarkets." They provide great volumes of food that attract many animal species. These animals use wetlands for part of or all of their life-cycle. Dead plant leaves and stems break down in the water to form small particles of organic material called "detritus." This enriched material feeds many small aquatic insects, shellfish and small fish that are food for larger predatory fish, reptiles, amphibians, birds and mammals.

The functions of a wetland and the values of these functions to humans depend on a complex set of relationships between the wetland and the other ecosystems in the watershed. A watershed is a geographic area in which water, sediments and dissolved materials drain from higher elevations to a common low-lying outlet or basin a point on a larger stream, lake, underlying aquifer or estuary.

Wetlands play an integral role in the ecology of the watershed. The combination of shallow water, high levels of nutrients and primary productivity is ideal for the development of organisms that form the base of the food web and feed many species of fish, amphibians, shellfish and insects. Many species of birds and mammals rely on wetlands for food, water and shelter, especially during migration and breeding.

Wetlands' microbes, plants and wildlife are part of global cycles for water, nitrogen and sulfur. Scientists now know that atmospheric maintenance may be an additional wetlands function.

Wetlands store carbon within their plant communities and soil instead of releasing it to the atmosphere as carbon dioxide. Thus, wetlands help to moderate global climate conditions.

Wetlands and People

Far from being useless, disease-ridden places, wetlands provide values that no other ecosystem can. These include natural water quality improvement, flood protection, shoreline erosion control, opportunities for recreation and aesthetic appreciation and natural products for our use at no cost. **Protecting wetlands can protect our safety and welfare.**

Natural Products for Our Economy

We use a wealth of natural products from wetlands, including fish and shellfish, blueberries, cranberries, timber and wild rice. Some medicines derived from wetland soils and plants. Many of the nation's fishing and shell fishing industries harvest wetland-dependent species. In the Southeast, for example, nearly all the commercial catch and over half of the recreational harvest are fish and shellfish that depend on the estuary-coastal wetland system. Louisiana's coastal marshes are tremendously valuable for their commercial fish and shellfish harvest. Wetlands are habitats for fur-bearers like muskrat, beaver and mink as well as reptiles such as alligators.

Fish and Wildlife Habitat

More than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half use wetlands at some point in their lives. Many other animals and plants depend on wetlands for survival. Estuarine and marine fish and shellfish, various birds and certain mammals must have coastal wetlands to survive. Most commercial and game fish breed and raise their young in coastal marshes and estuaries. Menhaden, flounder, sea trout, spot, croaker and striped bass are among the more familiar fish that depend on coastal wetlands. Shrimp, oysters, clams, and blue and Dungeness crabs likewise need these wetlands for food, shelter and breeding grounds.

For many animals and plants such as wood ducks, muskrat, cattails and swamp rose, inland wetlands are the only places they can live. Beaver may actually create their own wetlands. For

others, such as striped bass, peregrine falcon, otter, black bear, raccoon and deer, wetlands provide important food, water or shelter.

Many of the U.S. breeding bird populations-- including ducks, geese, woodpeckers, hawks, wading birds and many song-birds-- feed, nest and raise their young in wetlands. Migratory waterfowl use coastal and inland wetlands as resting, feeding, breeding or nesting grounds for at least part of the year. Indeed, an international agreement to protect wetlands of international importance was developed because some species of migratory birds are completely dependent on certain wetlands and would become extinct if those wetlands were destroyed.

Flood Protection

Wetlands function as natural sponges that traps and slowly releases surface water, rain, snowmelt, groundwater and flood waters. Trees, root mats and other wetland vegetation also slow the speed of flood waters and distribute them more slowly over the floodplain. This combined water storage acts as a braking action lowering flood heights (peaks) and reducing erosion (speed).

Wetlands within and downstream of urban areas are particularly valuable, counteracting the greatly increased rate and volume of surface- water runoff from pavement and buildings. The holding capacity of wetlands helps control floods and prevents water logging of crops. Preserving and restoring wetlands together with other water retention can often provide the level of flood control otherwise provided by expensive dredge operations and levees. The bottomland hardwood-riparian wetlands along the Mississippi River once stored at least 60 days of floodwater. Now they store only 12 days because most have been filled or drained.

1.2. Frame works/Approaches

1.2.1. The Driver-pressure-state impact response framework

The current study tried to use DPSIR approaches. The “DPSIR” framework is multi-scalable and indicates generic cause and effect relations withinand among the following:

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

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

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

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

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

1.3. Social and Economic Environment

1.3.1. Social Environment

The social environment refers to the combination of individuals and groups that interact and display various activities and characteristics. It includes the family environment, school environment, and community.

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

The physical and social environment is a determining factor in active and healthy aging in place, being a central factor in the study of environmental gerontology.

Moreover, the social environment is the setting where people live and interact. It includes the buildings and roads around them, the jobs available, and how money flows; relationships between people, like who has power and how different groups get along; and culture, like art, religion, and traditions. It includes the physical world and the way people relate to each other and their communities.

The physical environment is the ever-changing natural world, including weather, land, and natural resources. Floods or earthquakes can alter the landscape, affecting how plants and animals live. Human interaction with nature can also have an impact. For example, logging can change the weather in that area, pollution can make water dirty, and habitat fragmentation caused by human activity makes it so animals cannot move around as easily, which can cause problems for their families.

In order to enrich their lives, people have used natural resources, and in the process have brought about many changes in the natural environment; human settlements, roads, farmlands, dams, and many other elements have all developed through the process. All these man-made components are included in human cultural environment

Social environments encompass the immediate physical. Surroundings, social relationships, and cultural milieus. Within which defined groups of people function and. interact.Jul 11, 2017

The social environment *subsumes many aspects of the physical environment*, given that contemporary landscapes, water resources, and other natural resources have.

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

The **Sidama Region** (Sidama: *Sidaamu Qoqqowo*; Amharic: ሲዳማ ክልል) is a regional state in southern Ethiopia. It was formed on 18 June 2020 from the Southern Nations, Nationalities, and Peoples' Region (SNNPR) and transformation of the **Sidama Zone** after a 98.52% vote in favour of increased autonomy in the 2019 Sidama referendum. It is the second smallest regional state in the country, after Harari. Sidama is the name of both the Sidama people, the language, and the territory. Sidama is bordered to the south by the Oromia Region (except for a short stretch in the middle where it shares a border with Gedeo zone, in South Ethiopia Regional State, on the west by the Bilate River, which separates it from Wolayita Zone, and on the north and east by the Oromia Region. Towns in Sidama include Hawassa, the capital of Sidama and of SNNPR when it existed, Yirgalem, Wondogenet, Chuko, Hula, Bona, Bursa, Bensa, and Aleta Wendo. Sidama has a population of around 3.2 million in 2017 who speak the Cushitic language Sidama (also known as *Sidaamu Afoo*).

Loka Abayais one of the Woredas in the Sidama National Regional State of Ethiopia. Part of the Sidama Region located in the Great Rift Valley, Loko Abaya is bordered on the south by the Oromia Region, on the southwest by Lake Abaya, on the west by the Wolayita Zone, on the north by Boricha, on the northeast

by Dale, on the east by Shebedino, and on the southeast by Chuko. Loko Abaya was separated from Dale Woreda.

Based on the 2007 Census conducted by the CSA, this Woreda has a total population of 99,233, of whom 50,603 are men and 48,630 women; 1,059 or 1.07% of its population are urban dwellers. The majority of the inhabitants were Protestants, with 87.7% of the population reporting that belief, 3.88% were Catholic, 2.85% observed traditional religions, and 1.93% were Muslim.[1]

1.3.1.1. State and trend of social environment

Population

Population trends refer to the patterns and changes in population size and growth rates over time, characterized by historical data and statistical measurements, and are essential for understanding the influences of demographic change on various phenomena.

Timely and accurate information about changes in the size and characteristics of a country's population is need by national governments, the United Nations, international organizations and civil society to formulate, implement and evaluate policies and programmes in almost all spheres of life. Such information is critical as well as for monitoring progress toward achieving the Sustainable Development Goals. The Population Division produces estimates and projections of population size by age and sex, as well as indicators that describe various characteristics of a population, including levels and trends in fertility, mortality, migration, urbanization and so forth, at the global, regional and national levels. The Division produces the dataset World Population Prospects every other year.

Here, altitude and the attendant climatic differences determine the distributional pattern of the Ethiopian population more than any other single factor, but not in the manner, it affects global population distribution. Population distribution is a measure of how spread out a population is in any given area. The simplest way to measure population distribution is to calculate the percentage of a population over a specific geographic area.

Table 1. Population Trend of Loka AbayaWoreda (2006-2018)

Year.	Rural population			Urban. Population		population on
	Women	men	Total	women	Men	TOTAL
2006	48076	47062	95136	7596	6203	13798
2007	49031	47349	96380	7663	6312	13975
2008	49187	47616	96803	7702	6401	14103
2009	49396	47801	97199	7801	6517	14318
2010	49598	47906	96797	7912	6620	14532
2011	49685	48009	97694	8011	6700	14711
2012	49895	48065	97960	8073	6901	14974
2013	50081	48204	98285	8073	6901	14974
2014	50263	48204	98464	8332	7109	15441
2015	50408	48521	98929	8481	7198	15679
2016	50603	48630	99233	8592	7363	15955
2017	54083	50892	104975	8785	7475	16260
2018	61242	51108	112350	9202	9279	18481
						130,831

Source:- Loka AbayaWoreda (2018)

As the population increases, associated with poverty their economic interest, the demand on infrastructure, food security, energy source, health facilities and necessities as a whole is increased. The consequences, which we saw in the nearby Loka Abayawetland Ecosystem due to high population the demand for grazing land and agriculture courses the distraction of the ecosystem. Generally, in Loka AbayaWoreda the number of population is increasing time to time.

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 FDRE Ministry of Education is promoting primary education in every corner of the country, based on the motto "education for all". Accordingly, regions and City administrations are working in line with this objective.

Table 2. Students, teachers and number of schools in Loka Abaya *Woreda*

NO	**Level of School**	**Students in Loka AbayaWoreda**																			
		2009		**2010**		**2011**		**2012**		**2013**		**2014**		**2015**		**2016**		**2017**		**2018**	
		M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
1	Elementary schools 1-6	13166	14770	14140	13290	121011	13996	12083	12095	13553	11432	12060	11407	94 30	96 38	10525	1077 74	1048 2	998 7	1034 8	978 1
2	Elementary schools dropout	304	314	401	391	478	560	77	80	998	742	563	585	438	434	521	602	407	442	488	414

3	Primary School (7-8)	2460	2540	2150	2690	2333	2181	2601		292	1407	2049	2320	2360	1847	2012	2043	2222	1399	1351	1301
4	Primary School dropout	380	440	306	412	82	91	70	66	9	19	154	162	105	118	70	47	72	59	55	69
5	High school (9-12)	280	160	290	200	1575	1319	1474	1487	2166	1929	1906	2206	2545	2082	167	229	912	828	929	1012
6	High school dropout	50	67	80	91	52	25	58	78	161	103	58	68	47	27	38	41	25	33	39	38
7	Number of teachers	408	154	440	179	464	182	506	192	514	198	524	205	571	213	615	220	640	223	740	226

Source: Loka AbayaWoreda education office

Education is the most important factor that plays a leading role in Human development.

According to Loka AbayaEducation office report school dropout is high in both male and female.

Health

The Health service sector is one of the key sectors of the economy. Adequate health service is one aspect of social service that communities aspire to get from the government. To this end, the Government of Ethiopia is putting the maximum possible effort to set targets towards societal development such as GTP goals and targets, and other policies and strategies. This is exhibited by

increasing number of health institutions being established in different regions and city administrations including the rural clinics.

Health Institution & Health Coverage

Table 3 the health institutions in Loka AbayaWoreda gives various services to the area's population.

No	Types of health institutions	years											Number of health professions l
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
1	Governmental Health Center	6	6	6	6	6	6	5	5	5	5	5	166
1.1	Primary Hospital	0	0	1	1	1	1	1	1	1	1	1	65
	Private pharmacy	4	4	4	4	4	4	4	4	4	5	5	unknown
1.2	Health center												
1.3	Health post	26	26	26	26	26	26	22	22	17	17	17	72
2	Private Health Centers	0	0	0	0	0	0	0	0	0	0	0	
2.1	Primary Health clinics	1	1	1	1	2	2	2	3	4	5	5	
	Total	37	37	38	38	39	39	34	35	31	32	32	

Source: Lo k a A b a y a Woreda Health Report 2018

As indicated on the above tables, the numbers of Governmental Health Institutions in the *Woreda* is constant no increment. As we seen from the table, there is no health centers problem in the Woreda. However, Due to high temperature associated with cline water shortage in the Woreda the community are suffering with malaria and several water born disease like typhoid pneumonia typhus, because of this reason the number of health institutions and health professionals in the

Woreda are not sufficient to tackle this problem.

Road transport

The level of development of transport Facilities and services including the road are determining factor for other development activities. Thus transport sector play a key role in the socio- economic development of Loka AbayaWoreda. Old age rood and the development of such infrastructures is the great problem in the area. Road is an essential infrastructure for a given area for economic and social development. It eases mobilization of resources and communication and there by hasten the socio economic development of a given area. Thus road type, network connectivity, accessibility and its Organization with various facilities and services have major impacts on its key role of development (SAFEDO, 2018).but in Loka AbayaWoreda road transport is one of grate problem for the community .

Table 4: Types and length of Roads, in Loka AbayaWoreda

No	**Road type**	**Length in km**	% of population who has access to Road
1	Asphalt		
2	All weather rood	97	90.%
3	Dray weather rood	11.62	
	Total	108.6	

Source: Woreda transport office

Water Resource and Supply

Water is an inorganic compound with the chemical formula H_2O. It is a transparent, tasteless, odorless, and nearly colorless chemical substance. It is the main constituent of Earth's hydrosphere and the fluids of all known living organisms in which it acts as a solvent. Water, being a polar molecule, undergoes strong intermolecular hydrogen bonding which is a large contributor to its physical and chemical properties. It is vital for all known forms of life, despite not providing food energy or being an organic micronutrient. Due to its presence in all organisms, its chemical stability, its worldwide abundance and its strong polarity relative to its small molecular size, water is often refer to as the "universal solvent".

In the *Woreda*, there is no sufficient drinking water for human and animals, elder in the *Woreda* under lined that currently due to various environmental and social problems the wetland and springs were dried, while the volume of existing small streams and river as well as the discharge rate of springs has been decreasing from time to time. Because of this risen, the percentage of population who has access to cline water is 58%.

Communication Services

Even though communication services in urban area has an old age, its expansion yet is poor in terms of the stage of development and service per capital. The communication infrastructure that have been rendering service are telecommunication, telephone, fax, and postal services. Loka Abaya*Woreda*, has 24 hours telephone services, from total population 80% has access to communication services.

Housing

Housing is one of the three basic needs for human being; there is no problem of housing as mentioned during key informant, group discussion and the Woreda final report. In the Woreda the houses mostly where constructed by woods and mud. There is no big housing problem as comparing to population density.

Electricity *Electricity* is an essential infrastructure for a given area of economic and social development. In Loka Abaya Woreda most of the population has access to electric service

From both hydroelectric and solar energy.

1.3.1.2. Drivers and pressure of social environment

Loka Abayawetland Ecosystem is one of highly degraded ecosystem. The main drivers for the deterioration of the ecosystem are mainly population growth, the demand for grazing land and water use for agriculture, which results to degradation.

In the last two decades basically due to a number of drivers among them the following are the important ones,

- The rural communities, due to high labor demand and old age security, prefer large number of children. Thus, the need for more labor force in the agrarian economy (for plowing, weeding, harvesting, looking after cattle, and various household duties, etc.) are among others the major cause aggravating pressure on natural resources.
- Low educational background and less exposure to contraceptive technologies aggravate high birth rates among the rural population.

1.3.1.3. Impacts due to social environment change

Two hundred years ago, Malthus predicted that the power of population is indefinitely greater than the power of the earth to produce subsistence for man (Bilsborrow, 1991). In a latter period, Ester Boserup (1981) forwarded contrasting views to the Malthusian theory and emphasized innovation and land use intensification as a response to population growth or resource scarcity. They focus on "population density" as a driving factor for innovation and the expansion of Carrying capacity. With current high population growth rate of there is a very high demand over the available natural resources to satisfy the increasing demand for water use for different purpose. This is usually happen in Loka Abayawetland

- Large amount of water demand for agricultural use and increasing animal population around Loka Abaya wetland ecosystem is one problem for ecosystem degradation.

1.3.1.4. Responses to social Environment Change

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

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

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

(iii) Improving the social and economic status of vulnerable groups (women, children and elderly). In line with the policy document, Ethiopia set out a national population program in accordance with national priorities as stated below

(i) Expansion of population information, education and communication;

(ii) Provision of expanded family planning services;

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

The communities at a grass root level to reduce their vulnerability to risk situations and recover from the unhealthy events adopted a number of livelihood strategies. For instance, income diversification, engaged in off-farm activities, livestock fattening,

and changing the cropping pattern from subsistence crop to perennial cash crops. In addition, population policy, family planning policy, forest protection policy and others has practically implemented at grass root level. To alleviate the problem and attain the Millennium Development Goals both the government and society are working together to achieve sustainable natural resource conservation.

Finally Different response measure were taken to decrease the growth of population they were apply different family planning method. The society who live around Loka Abayawetland ecosystem they were done conservation work like afforestation to protect the ecosystem.

1.3.1.5. Outlook for Socio Environment

If the whole social and economic activities, over population and the land use /land cover change continue under present condition: soil erosion, land degradation, injured people and livestock by natural and human induced caused would aggravate, leading to increase loss of biodiversity in Loka Abayaecosystem.

1.3.2. Economic Environment

1.3.2.1. State and trend of the economic Environment

The livelihood of the people is dependent on agriculture and animal production however, agricultural system in the region is at subsistence level and food insecurity problem is increasing at alarming rate.

According to FGD Water shortage is one of the problem for expanding agriculture including animal production in Loka AbayaWoreda.

1.3.2.2. Drivers and pressures of the economy

The driving force behind economic policy-making lies in the macro-economic objectives. The macro-economic objectives should be environmentally and socially sustainable. Obviously, the macro-economic objectives are: economic growth measured

in terms of the percentage change inthe Gross Domestic Product (GDP), employment, price stability, and equity. The very concept ofstudying population dynamics and economic environment is that its interlinked nature natural resources.

1.3.2.3. Impacts due to the Economic Condition

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

Thus, the agricultural, industrial and service sectors are used. Agriculture have a higher direct impact on the environment than the other sector. Natural resources and bio diversity of Loka Abayawetland Ecosystem where degraded Avery year. As we discussed from different members of the community. Soil fertility is declining every production season. Forest coverage is very low and decreasing every year, due to intensive destruction of forests for agriculture and for construction and firewood production. Livestock's per capita production is very low and decreasing due to limited modern technique application and yield enhancing inputs. Therefore, the current livelihood strategy and pattern is a challenging task to promote sustainable development by protecting the environment.

1.3.2.4. Response Measure

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

i. Closing the gap between high population growth and low economic productivity through Planned reduction of population growth;
ii. improving thecarrying capacity of the environment by taking appropriate environmental

protection measures; and

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

iv. Maintain at least an average real GDP growth rate of 11% and meet the Millennium development goals,

Expand and ensure the qualities of education and health services there by achieving the MDGs in the social sectors,

- Establish favorable conditions for sustainable state building through the creation of stable democratic and developmental state.
- Ensure growth sustainability by realizing all the above objectives within stable macro-economic framework.

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

- Sustaining faster and equitable economic growth
- Maintaining agriculture as a major source of economic growth
- Creating favorable conditions for the industry to play key role in the economy
- Enhancing expansion and quality of infrastructure development
- Enhancing expansion and quality of social development

- Building capacity and deepen good governance
- Promote women and youth empowerment and equitable benefit
- Biodiversity conservation including wetland management should be done

1.3.2.5 Outlook for Economy

Because of high biodiversity lose and inappropriate utilization of the ecosystem If everything continues business as usual, Loka Abayawetland Ecosystem could not be able to provide the required environmental service.

Options for future Action

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

- Biodiversity conservation
- To improve Livestock production management of all farmers
- Awareness creation should be give about climate change
- Facilitating Cline water access to the community

2. Biophysical Environment

2.1. Land

In environmental science and environmental management, *land* is understand as more than simply the physical surface of the Earth or soil. It is a terrestrial, bio-productive system consisting of soil, vegetation, other living organisms (biota), and the ecological and hydrological processes that operate with in it.

The United Nations Convention to Combat Desertification (UNCCD) defines land as:

"The terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system." — UNCCD, 1994, Article 1(e)

Therefore, from an environmental perspective, land includes:

1) Soil – provides the physical and nutrient foundation for plant growth.
2) Vegetation – forests, grasslands, crops, shrubs, and other plant communities.
3) Other biota – animals, microorganisms, and other living organisms.
4) Ecological processes – nutrient cycling, decomposition, biodiversity interactions, and ecosystem functioning.
5) Hydrological processes – infiltration, water retention, runoff, groundwater recharge, and water movement.
6) Productivity and ecosystem functions – the capacity of land to support ecosystems, agriculture, livelihoods, and other environmental services.

Around the Rift Valley, lakes of southern Ethiopia Land degradation and wetland loss well documented. In the western part of Lake Abaya, Getaneh et al. (2024) used supervised classification, field observation and FGDs to show that vegetation and wetland cover declined markedly between 1990 and 2022, with mean NDVI falling from 0.368 to 0.135, while cropland, settlement and water classes expanded a pattern that closely parallels the Loka Abaya findings in this fact sheet. Their study attributes the change to proximate drivers (agricultural expansion,

settlement growth, firewood collection and charcoal production) layered on underlying causes of population growth, poverty and weak land-use policy enforcement (Getaneh et al., 2024).

Further south, in the Abaya-Chamo lake-wetland system, Zekarias and Gelaw (2023) combined household surveys, satellite vegetation/water/turbidity indices and FGDs to document a 48.9% loss of swamp (wetland) area between 1990 and 2019, driven by farm expansion, siltation, irrigation development, open-access resource use and rapid population growth; they conclude that continued degradation is likely without a clear wetland policy and legal framework. Getachew (2015), examining the Chano area of Lake Abaya, similarly found that human pressure on wetland margins was reducing the flow of ecosystem benefits to surrounding communities.

On the policy and institutional side, Dixon, Wood and Hailu (2021) review two decades of Ethiopian wetland research and practice and find that, despite national interest generated since the Ethiopian Wetlands Research Programme (1997–2000), wetland policy remains fragmented across sectors and often overlooks local livelihoods and indigenous management knowledge echoing earlier findings by Wood, Hailu, Abbot and Dixon (2002) that community-based, locally grounded management frequently out-performs top-down regulation alone. At the national scale, Gebrelassie, Gashaw and Mehari (2014) synthesize the causes (population pressure, drainage for agriculture, overgrazing, poor enforcement), consequences (biodiversity loss, reduced water regulation, declining productivity) and remedies (policy, community participation, integrated catchment management) of wetland degradation across Ethiopia. On the response side, government-led Sustainable Land Management and community-based watershed programmes have been shown to improve farm incomes and food security by roughly 50% on average where fully implemented, though outcomes vary widely between sites (Gebregziabher et al., 2016; World Bank, 2013).

Taken together, this literature indicates that the Loka Abaya wetland's 2020–2026 decline is consistent with a broader, well-documented regional pattern of Rift Valley wetland conversion, and that the response measures identified in the SOER indicator table (Section 4) align with approaches shown elsewhere in Ethiopia to be effective when implemented jointly by government and local communities.

2.1.1 State and trend of Loka Abaya Wetland –Land use/Land Cover Change Degradation

The Loka Abaya wetland, in Loka Abaya Woreda of the Sidama Region, Ethiopia, has undergone marked land use/land cover (LULC) change between 2015 and 2026. Wetland extent was broadly stable through 2020 (3,879 ha to 4,046 ha) but then contracted sharply to 2,089 ha by 2026 a loss of roughly 46% relative to 2015 and 48% relative to the 2020 peak as settlement, cropland and forest classes expanded into the catchment. This fact sheet applies the SOER/DPSIR (Driver – Pressure – State – Impact – Response) framework, extended with Outlook and Scenario components, to organize the satellite-derived LULC evidence, kebele-level population context, focus group discussion (FGD) input, field observation, and recent peer-reviewed literature on Lake Abaya-area wetlands into a single decision-support document. It closes with concrete response actions disaggregated by government and community/society responsibility, and a referenced literature base.

Land degradation and wetland conversion in the Loka Abaya wetland catchment. Loka Abaya Woreda lies in the Sidama Region of Ethiopia's Great Rift Valley, bordered by Lake Abaya to the southwest (CSA, 2007; Wikipedia contributors, n.d.). Wetlands of this type provide multiple ecosystem services — dry-season grazing and hay, water storage and purification, flood buffering, and biodiversity habitat — which are widely reported to be under increasing pressure across the wider Lake Abaya–Chamo basin (Zekarias & Gelaw, 2023; Getaneh et al., 2024). This fact sheet synthesizes the SOER (State of Environment Report) DPSIR indicator table, satellite-derived LULC change data for 2015, 2020 and 2026, focus group discussion (FGD) input, and field observation, into a State – Driver – Impact – Response – Outlook – Scenario framework.

The LokaAbaya wetland area lies between 6.548954° N and 6.689171° N latitude and between 37.876589° E and 38.041334° E longitude, which places it in the rift valley part of Ethiopia.

The regional inset map in the left corner shows Ethiopia, with the South Ethiopia Region highlighted in green. The wetland is administratively within this region. The next panel zooms in to the South Ethiopia zone boundary marked in red. It shows that the wetland sits in the part of that zone close to Awasa (Hawassa).

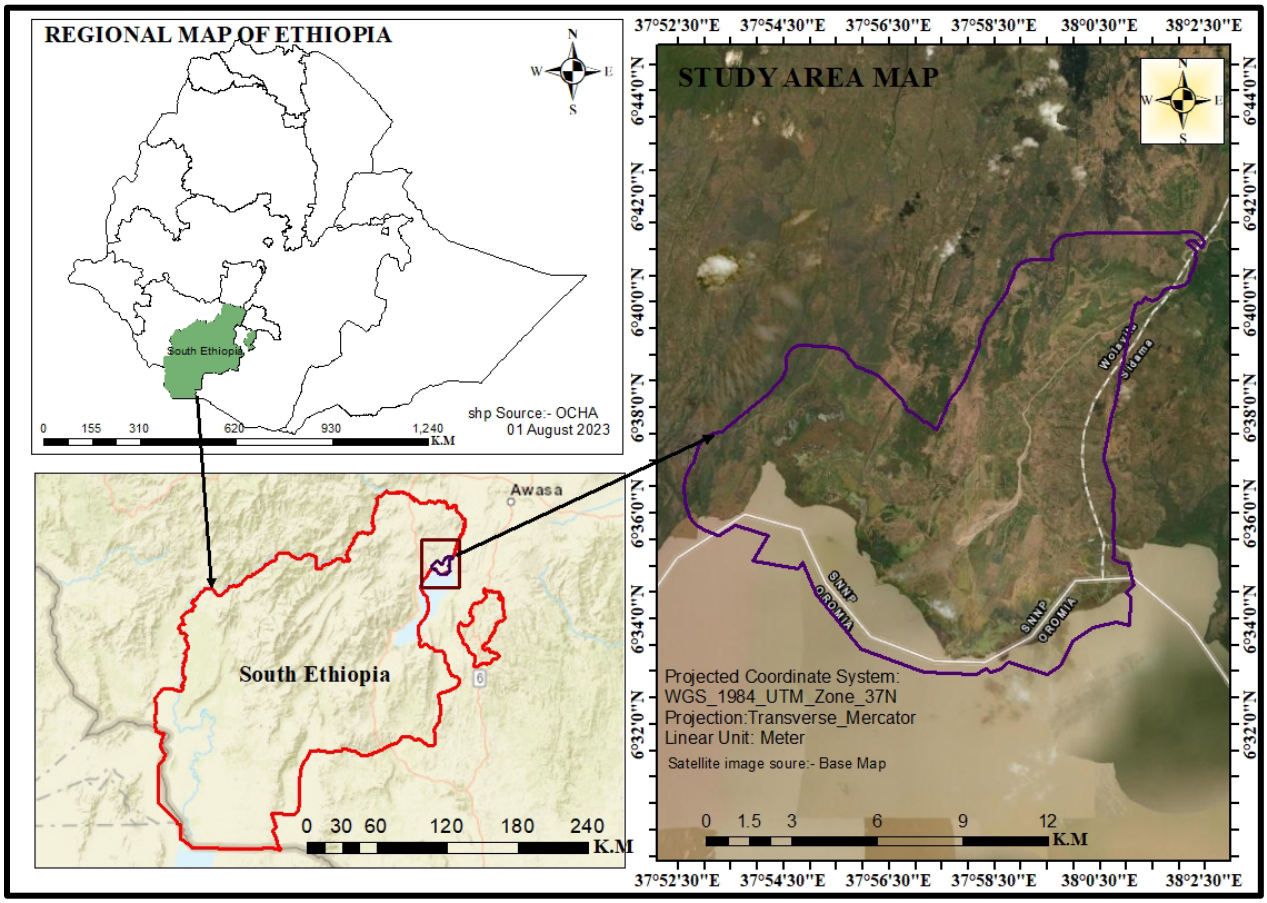


Figure 1 Loka Abaya map

2. Spatial extent

The bounding box is 14 km from north to south (6.549°–6.689° N) and about 18 km from east to west (37.877°–38.041° E). It describes an irregularly shaped area that is roughly 140–150 km² at most. The real wetland polygon is irregular, so it covers less than the bounding box would suggest.

3. Shape and boundary characteristics

The purple-outlined boundary of the study area is very irregular. It looks jagged and stretched with a northern part and a wide southern base near the lake.This irregular shape is common for wetlands and lake-margin ecosystems because they follow natural water flow and land shape rather than straight administrative lines.

4. Land cover context (from the satellite basemap)

The satellite imagery underlying the study area shows a mix of:

Water/wetland surface (as the light tan or beige area in the south, likely part of Lake Abaya's margin or an associated wetland)

Vegetated/agricultural land (green-brown tones across the centre and north)

A road network (pale lines that cross the area labelled with what looks like a Wolayta–Jimma route), which shows that people can reach the wetland and that there may be some pressure on the land.

5. Coordinate system and projection

The map uses the WGS_1984_UTM_Zone_37N coordinate system. It is a Transverse Mercator projection. Uses meters for distance. This zone covers longitudes 36°° E, which is correct for this part of Ethiopia. I find this useful for measuring the wetland's area and perimeter accurately, unlike a latitude/longitude system.

6. Geographic significance

Because the wetland sits near Lake Abaya, one of the lakes in the Ethiopian Rift Valley, it likely helps the region's water system. It may act as a flood buffer and filter water. Provide home for

waterfowl and fish. That is why scientists map it as a wetland area instead of just part of the lake or nearby farmland.

7. Drainage Network and Stream Order

Stream order is a numbering system used in hydrology to describe the position of a channel within a drainage network, based on how tributaries joins. A headwater channel with no tributaries feeding into it is a 1st-order stream. When two 1st-order streams meet, they form a 2nd-order stream; when two 2nd-order streams meet; they form a 3rd-order stream, and so on (the Strahler method). A lower-order stream joining a higher-order one does not increase the order of the larger channel. In practice, 1st-order streams are the small, steep tributaries near the catchment edges; 2nd- and 3rd-order streams are the larger channels further downstream that carry more concentrated flow toward the wetland and Lake Abaya.

The stream order map, derived from the SRTM 30 m digital elevation model (DEM) in the same WGS_1984_UTM_Zone_37N projection used elsewhere in this fact sheet, delineates the drainage network draining into the Loka Abaya wetland alongside catchment elevation (high: 2,618 m; low: 0 m) and the mapped water and wetland classes. The network dominated by numerous 1st-order streams originating in the higher-elevation, forested and cultivated land to the north and east, which converge into a smaller number of 2nd- and 3rd-order channels running roughly north-to-south into the wetland and Lake Abaya. This dense first-order network explains why land-use change on the surrounding slopes (deforestation, cultivation and settlement expansion, Sections 5 and 6) translates so directly into runoff, sediment and nutrient delivery into the wetland: nearly every hectare of the catchment drains through a short headwater channel before reaching a higher-order stream. The convergence of several 3rd-order streams at the wetland margin also indicates where flood energy and sediment loads are most concentrated, and where the response measures in Section 8 (buffer-zone delineation, watershed management works, and gully rehabilitation) would have the greatest effect on reducing degradation pressure on the wetland.

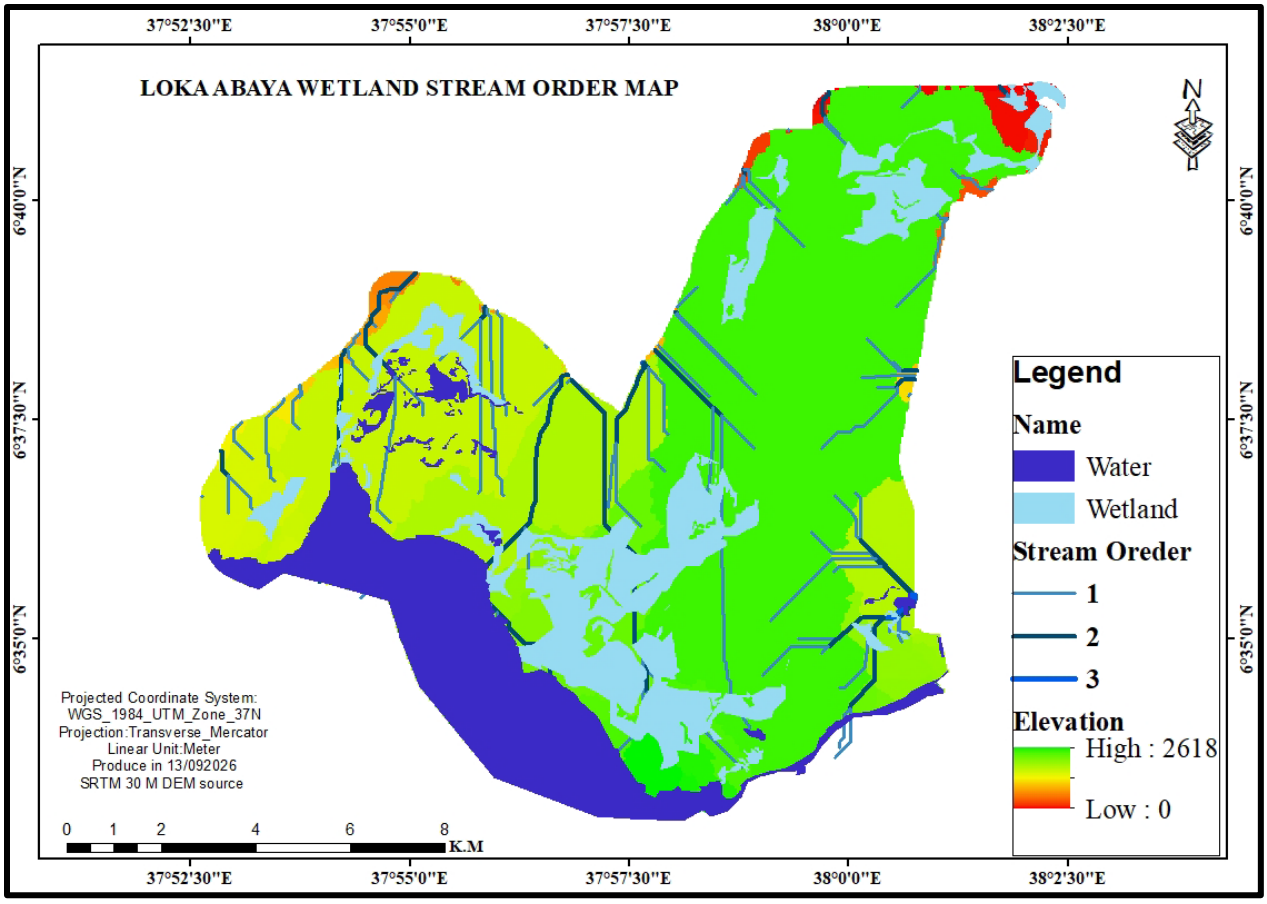


Figure 2: Loka Abaya wetland catchment stream order map (Strahler stream order 1–3), draining into the wetland and Lake Abaya, overlaid on SRTM 30 m DEM-derived elevation (SEDSRD GIS, 2026).

The wetland catchment falls within, and is used by, several kebeles (the lowest administrative unit in Ethiopia) of Loka Abaya Woreda, including Felka, Aldabo, Felqana Aldabo and Mrera. Population pressure identified in the indicator table as a primary driver of land degradation is best understand at this kebele scale, since it is kebele-level farming, settlement and livestock-keeping decisions that directly act on the wetland margin.

Table 5: **Population of the wetland-adjacent kebeles (Felka, Aldabo, Felqana Aldabo, Mrera) and Loka Abaya Woreda total (CSA, 2007; population projected to 2022 by the Ethiopian Statistics Service, cited in citypopulation.de, 2022)**

Kebele	Male	Female	Total population	Source
Loka Abaya Woreda (total, all kebeles)	**66,583**	**63,956**	**130,539**	CSA/EthStat, 2022 proj.

At Woreda level, Loka Abaya's population was recorded at 99,233 in the 2007 national census and is projected at 130,539 for 2022 — an increase of about 32% in fifteen years, corresponding to the "human population growth rate" driver identified in the SOER indicator table (CSA, 2007; Ethiopian Statistics Service, cited in citypopulation.de, 2022). This growth rate, concentrated in and around the kebeles bordering the wetland, is consistent with the settlement-class expansion of over 300% recorded in the LULC data (Section 4).

2.1.1.1 State (Current Condition and Trend) Loka Abaya
Land use land cover change/ LULCC

Satellite-based LULC classification (Sentinel-2 imagery, produced by SEDSRD GIS) shows substantial reconfiguration of the Loka Abaya wetland catchment between 2015 and 2026. The wetland class expanded slightly from 3,879 ha (2015) to 4,046 ha (2020), then contracted sharply to 2,089 ha by 2026 — a net loss of about 46% of its 2015 extent, and a loss of roughly 1,957 ha (48%) relative to its 2020 peak. Over the same period, open water expanded by 45%, settlement area more than quadrupled (+324%), cropland grew by 61%, and forest cover more than doubled (+141%), while grazing land fell by 49% and bare land fell by 34%.

Table 6: **Loka Abaya wetland land use/land cover change, 2015, 2020 and 2026 (Area in hectares)**

Land Use / Land Cover Class	2015 (ha)	2020 (ha)	2026 (ha)	Change 2015–2026
Wetland	3,879	4,046	2,089	**-46.1%**
Water	1,537	1,530	2,232	**+45.2%**

Land Use / Land Cover Class	2015 (ha)	2020 (ha)	2026 (ha)	Change 2015–2026
Shrub Land	1,017	1,045	1,039	**+2.2%**
Settlement	86	105	365	**+324.4%**
Grazing Land	3,990	1,803	2,025	**-49.2%**
Forest	1,312	3,312	3,162	**+141.0%**
Cropland	1,952	2,372	3,152	**+61.5%**
Bare Land	868	328	577	**-33.5%**
Total	**14,641**	**14,541**	**14,641**	**—**

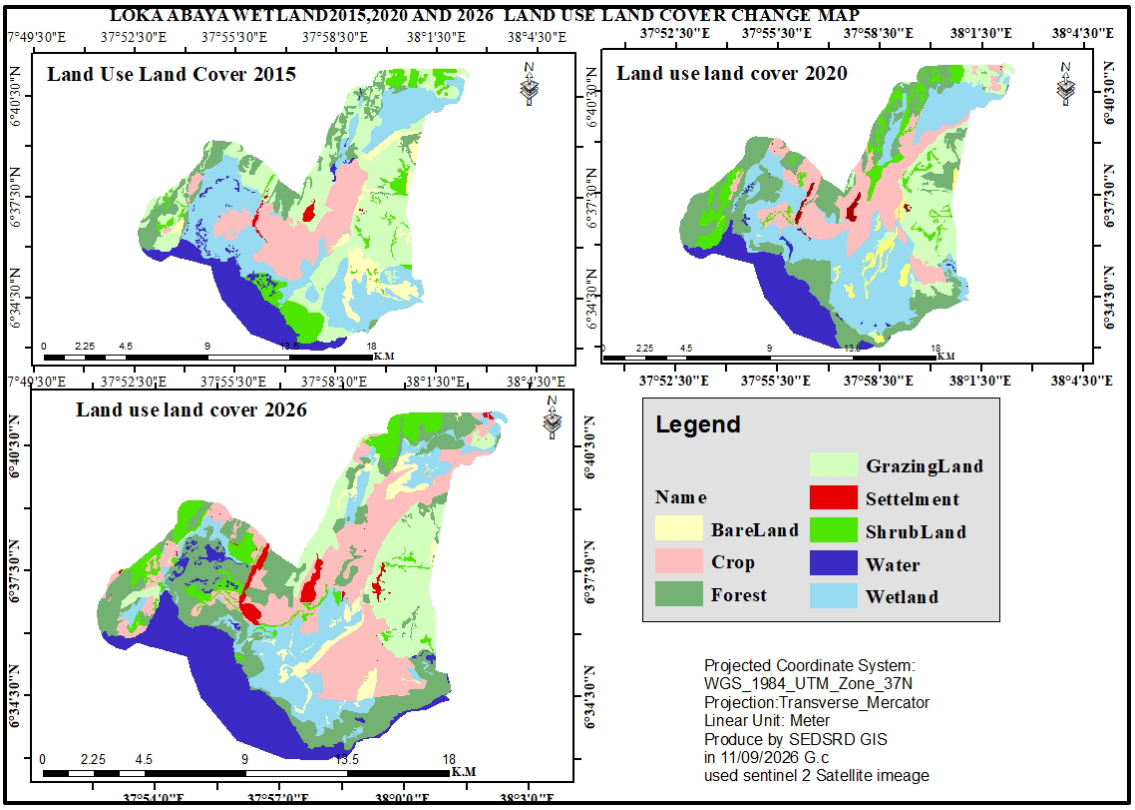


Figure 3: Loka Abaya wetland LULC change map, 2015, 2020 and 2026 (Sentinel-2 derived, SEDSRD GIS, 2026)

Read together, the trend indicates that the wetland held its area through 2020 but underwent rapid drainage, in-filling and conversion between 2020 and 2026 — consistent with the SOER "state/trend" indicators for erosion, flooding and area affected by degradation — while the adjacent cropland, settlement and forest classes absorbed the converted land. The near-constant catchment total (14,641 ha in both 2015 and 2026) confirms this is primarily a reclassification/conversion process rather than a change in catchment boundary.

Land Use/Land Cover Change Transition Matrix (2015–2026)

The cross-tabulation (transition) matrix below disaggregates the net changes summarized in Table 1, showing the area (ha) that transitioned from each 2015 land use/land cover class (rows) to each 2026 class (columns). Diagonal cells represent area that remained in the same class; off-diagonal cells represent conversions between classes over the 2015–2026 period.

Table 7: Loka Abaya wetland LULC change transition (cross-tabulation) matrix, 2015–2026 (area in hectares). Rows = 2015 class; columns = 2026 class. Source: Sentinel-2 derived LULC change detection, SEDSRD GIS, 2026.

2015 LULC \ 2026 LULC	BareLand	Crop	Forest	GrazingLand	Settlement	ShrubLand	Water	Wetland	Grand Total
BareLand	**868**	1,737	868	868	868	868	868	868	**7,815**
CropLand	1,952	**1,952**	1,952	1,952	3,903	1,952	1,952	3,903	**19,516**
Forest	1,312	2,625	**2,625**	2,625	2,625	2,625	1,312	1,312	**17,060**
GrazingLand	3,990	11,971	11,971	**7,980**	7,980	11,971	3,990	3,990	**63,843**
Settlement	—	86	86	86	**86**	86	—	86	**515**
ShrubLand	1,017	3,052	3,052	1,017	1,017	**2,034**	2,034	2,034	**15,258**
WaterBody	—	1,537	1,537	1,537	1,537	1,537	**1,537**	1,537	**10,759**
Wetland	3,879	3,879	7,757	3,879	3,879	3,879	7,757	**7,757**	**42,664**
Grand Total	**13,018**	**26,836**	**29,847**	**19,943**	**21,895**	**24,951**	**19,451**	**21,488**	**177,429**

Reading the matrix by row shows where each 2015 class ended up by 2026. Grazing land shows the widest spread, with roughly 11,971 ha moving into cropland, forest and shrub land alike, alongside 7,980 ha remaining grazing land — consistent with the net 49% decline reported in Table 1. Wetland shows the largest single transition into forest and into water (7,757 ha apiece), reflecting the combination of in-filling/afforestation of drained margins and open-water expansion described in Section 5. Cropland and shrub land both show a comparatively large share of their 2015 area shifting into settlement (3,903 ha each), consistent with the more than four-fold growth of the settlement class. The diagonal cells (shaded green) mark area that stayed in the same class across the period; every other cell is a conversion between classes. Note that the row and column grand totals in this matrix (177,429 ha) are far larger than the 14,641 ha catchment total in Table 1, so these transition figures should be treated as provisional pending reconciliation with the underlying pixel-level change-detection output before they are used for area accounting.

2.1.2 Driver and pressure for Land Degradation

Consistent with the indicator table, the underlying drivers of change are:

- Human population growth rate — rising demand for settlement, farmland and water within the catchment.
- Animal population growth rate — expanding livestock numbers increasing demand for grazing and watering points.



Figure 4: over grazing

- Deforestation — clearing of natural vegetation for farmland, settlement and fuelwood, which in turn accelerates runoff and sediment delivery into the wetland.

These drivers translate into the pressures recorded in the indicator table

Intensive farming, agro-chemical/fertilizer use, overgrazing and continued deforestation which directly act on the wetland and its surrounding land. This mirrors the driver structure reported for the wider Lake Abaya basin, where population growth, poverty and weak enforcement are repeatedly identified as the underlying causes behind proximate drivers such as farm and settlement expansion (Getaneh et al., 2024; Zekarias & Gelaw, 2023).

2.1.3 Impact of Land Degradation

Impacts are organized below into social, economic and environmental dimensions, drawing on the SOER impact indicators (rate of reduction in agricultural productivity, change in agriculture value added of GDP, area of abandoned agricultural land) together with the observed LULC change and FGD/field evidence.

Social Impact

• Loss of wetland-based livelihoods (grazing, water access, hay/forage cutting — confirmed by field observation of cut wetland grassland) as wetland extent shrinks.
• Growing competition and potential conflict over remaining grazing land, water points and farmland among community members, as raised in the focus group discussion.
• Increased vulnerability of downstream/adjacent settlements to flooding as the wetland's natural water-regulation capacity declines.
• Pressure for resettlement and changing land-use rights as settlement area expands by over 300% into former wetland and grazing land.

Economic Impact

• Reduction in agricultural productivity and rising rate of land abandonment where erosion, salinization or flooding degrade cropland.
• Shift in the composition of agriculture's contribution to local/regional GDP as cropland area grows but productivity per hectare is put at risk by degradation.
• Decline in the economic value of grazing-based livelihoods, with grazing land falling by nearly half (3,990 ha to 2,025 ha).
• Potential loss of ecosystem-service value the wetland provides free of charge water storage, flood buffering, dry-season grazing/hay reserve, and water purification.

Environmental Impact

• Direct loss of wetland habitat and associated biodiversity as wetland area contracts by roughly 46% since 2015.
• Increased land affected by wind, sheet and gully erosion, desertification, salinization and flooding, per the SOER state indicators, as vegetative and wetland buffer cover is removed.
• Higher sediment and agro-chemical (fertilizer) loading into remaining water bodies, consistent with the 45% expansion of the open-water class, which can reflect both flooding and siltation.
• Reduced natural water regulation and flood-buffering capacity for the catchment, with knock-on effects for downstream hydrology.

2.1.4 Response Actions to Tackle Loka Abaya Wetland Degradation

The indicator table identifies four institutional responses conservation strategy/policy, Integrated Watershed Management, resettlement, and Sustainable Land Management (SLM). Evidence from comparable Ethiopian programmes shows these are most effective when government-led investment and enforcement are matched by active community/society participation (Wood et al., 2002; Dixon et al., 2021; Gebregziabher et al., 2016). The actions below disaggregate the response by implementing actor.

Actions to be Implemented by Government

Policy & regulation	Formalize and enforce a wetland conservation strategy and buffer-zone delineation for Loka Abaya wetland at Woreda level, consistent with national guidance on wetland degradation remedies (Gebrelassie et al., 2014); register the wetland boundary and restrict conversion of the core zone identified in the LULC map.

Watershed investment	Scale up Integrated/Community-Based Watershed Management works (soil and water conservation structures, gully rehabilitation, afforestation of upper-catchment slopes) in the micro-watersheds draining into the wetland, following the national Sustainable Land Management Programme (SLMP) model (World Bank, 2013; Gebregziabher et al., 2016).
Resettlement & land-use planning	Implement the identified resettlement programme for households currently settled within the wetland buffer, paired with secure land-tenure certification elsewhere in the Woreda to reduce pressure to re-encroach.
Extension & regulation of inputs	Regulate agro-chemical/fertilizer use and enforce grazing carrying-capacity limits through the Woreda agriculture and natural resource offices, with monitoring tied to the SOER pressure indicators (agro-chemical use, overgrazing).
Monitoring & early warning	Institutionalize periodic (e.g., 3–5-year) Sentinel-2/Landsat LULC monitoring of the wetland, of the kind used to produce Table 2 and Figure 1, so that a repeat of the 2020–2026 contraction is detected early.
Financing	Channel resources through existing national mechanisms (SLMP-type investment, GEF/IDA-supported watershed projects) rather than creating parallel funding streams, to align with proven national delivery models (World Bank, 2013).

Actions to be Implemented by the Community/Society

Community-based wetland governance	Establish or strengthen local wetland-use bylaws/agreements (grazing and hay-cutting schedules, no-go core zones) building on the organized forage-cutting practice already observed in the field and referenced in the FGD, consistent with indigenous wetland-management approaches shown to work elsewhere in Ethiopia (Wood et al., 2002; Dixon et al., 2021).
Sustainable farming practices	Adopt soil and water conservation measures on farmland bordering the wetland (contour bunds, terracing, agroforestry), reduce agro-chemical overuse, and practice rotational rather than continuous grazing.
Afforestation and buffer restoration	Community tree-planting and natural regeneration along the wetland margin and gully heads to reduce sediment and runoff delivery into the wetland.
Livelihood diversification	Reduce direct dependence on wetland resources by taking up alternative or supplementary livelihoods (off-farm income, improved livestock productivity on existing grazing land) supported through Woreda cooperatives, easing pressure without requiring an abrupt loss of income.
Participation & awareness	Engage in FGD-type consultative platforms and Woreda planning processes so that conservation rules reflect local knowledge and gain community buy-in, which the literature identifies as decisive for programme durability (Dixon et al., 2021).
Reporting & vigilance	Community-level reporting of illegal drainage, encroachment or dumping to kebele/Woreda authorities to support enforcement of the wetland buffer.

Field observation (cut/mown wetland grassland, Figure 2) and FGD testimony from the community (Figure 3) indicate that local wetland use for forage and grazing is already active and

organized, which is a practical foundation on which formal community-based wetland-use agreements can be built to make the overall response durable.

2.1.5 Outlook

The 2015–2020 data alone would have suggested a stable or slowly improving wetland (area grew by 4%). The 2020–2026 data reverses this picture sharply, with an approximately 48% loss of wetland area in six years. If the 2020–2026 rate of conversion continues unaddressed, the wetland's remaining extent is at risk of further, potentially accelerating, and decline as settlement and cropland continue to expand into the catchment. Conversely, the fact that wetland area was stable-to-growing as recently as 2020 indicates the degradation trend is recent and, with prompt response, may still be reversible rather than structurally locked in.

Scenario Framework (to ~2036)

Three indicative scenarios are present to frame decision-making, built from the observed 2015–2026 trend and the response options in Section 8. They mirror the trajectories reported for comparable, unmanaged versus managed wetland catchments in the Lake Abaya basin (Zekarias & Gelaw, 2023) and for community watershed programs elsewhere in Ethiopia (Gebregziabher et al., 2016).

Scenario	Key assumptions	Projected outcome by ~2036
A. Business-as-usual (no new intervention)	• Cropland, settlement and grazing-driven encroachment continue at the 2020–2026 pace • No enforcement of buffer zones; watershed management not implemented • Population and livestock numbers keep rising	• Wetland area continues to shrink well below the 2,089 ha (2026) level; possible fragmentation into isolated patches • Further siltation and reduced water regulation/flood-buffering capacity

Scenario	Key assumptions	Projected outcome by ~2036
		• Intensifying resource-use conflict and declining fish/forage yields
B.Moderate intervention (partial response)	• Conservation policy and SLM programmes are adopted but only partially enforced • Some watershed and resettlement measures implemented in priority micro-watersheds • Agro-chemical use and overgrazing only partly regulated	• Rate of wetland loss slows but does not reverse • Erosion and sedimentation indicators stabilize in intervention areas, worsen elsewhere • Modest improvement in agricultural productivity in managed zones
C. Sustainable management (full response)	• Integrated Watershed Management, resettlement and SLM programmes fully implemented and enforced • Community-based wetland governance (informed by FGD input) established with clear buffer/no-go zones • Alternative livelihoods reduce direct pressure on the wetland core	• Wetland extent stabilizes and begins to recover toward the 2020 level (~4,046 ha) • Erosion, salinization and flooding indicators trend downward • Agricultural value added and rural incomes improve while conflict over land declines

Supporting Evidence

The following field observation and focus group discussion (FGD) photographs, taken during ground-truthing of the LULC classification, support the state and impact findings above.



Figure 5: **Field observation cut/mown wetland grassland, evidencing active forage/hay use of the wetland margin.**



Figure 6: **Focus group discussion (FGD) with community members on wetland use, change and management.**

Box 1. Voices from the Focus Group Discussion (FGD)

> *“Ten years ago we could cut grass from the wetland almost the whole year; now the wetland dries up earlier and the grazing area is much smaller than before.”*
>
> *— FGD participant, Felka kebele*

> *“More people are building houses close to the wetland edge. When it floods now, it affects homes that were never flooded before.”*
>
> *— FGD participant, Aldabo kebele*

> *“We used to share grazing land without much conflict. Now that the grazing area has shrunk, disputes between herders and farmers happen more often.”*
>
> *— FGD participant, Mrera kebele*

> *“If the government and the community agree on clear boundaries for the wetland, we are willing to follow them — but people need to be part of making that decision.”*
>
> *— FGD participant, Felqana Aldabo kebele*

These statements are illustrative, anonymized excerpts from the FGD sessions conducted with wetland-adjacent kebeles during the ground-truthing of the LULC classification; they are presented to give qualitative context to the quantitative State, Impact and Response findings above and do not identify individual respondents.

2.2 Biodiversity

2.2.1 State and trend of Biodiversity in the Loka AbayaWetland Ecosystem

The state of biodiversity in Loka AbayaWetland remains important but increasingly vulnerable. The wetland contains diverse plant communities and provides habitat for aquatic organisms and wildlife, while the wider Loka Abaya National Park supports at least 198 documented plant species and 28 medium- and large-sized mammal species (Assefa et al, 2024). According to information obtained from FGD the state of biodiversity of Loka Abaya wetland is under increasing pressure from agricultural expansion, livestock grazing, invasive alien species, sedimentation and agricultural chemicals and pesticide pollution. Due to demarcation of Loka Abaya national park, the current state should therefore be consider relatively rich but vulnerable, requiring continuous biodiversity monitoring, habitat restoration, invasive-species management and stronger community-based conservation.

Wetlands characterized by a life support system and immense biodiversity due to their hydrological and ecological functions (Bezabih and Mosissa, 2017). The wetlands of Ethiopia are prominent shelters of aquatic and terrestrial biodiversity such as endemic fishes, birds and lower invertebrates (Babu, 2015). The Loka Abaya Wetland ecosystem is an important biodiversity component of the Loka Abaya landscape and Loka Abaya National Park. Its biodiversity includes wetland vegetation, mammals, birds, fish, amphibians, reptiles and aquatic organisms. However, biodiversity is increasingly expose to pressures from agricultural expansion, livestock grazing, invasive species, habitat disturbance, pollution and changes in hydrological conditions.

State and Trends of Flora Resources in the Loka AbayaWetland Ecosystem

The flora of the Loka Abaya Wetland is diverse and ecologically important. Lake Abaya wetland vegetation documented 92 plant species belonging to 66 genera and 34 families, including important emergent, floating and wetland-associated plants such as Cyperus articulatus, Cyperus laevigatus, Typha angustifolia, Leersia hexandra, Nymphaea nouchali, Pistia stratiotes and Eichhornia crassipes (Gojamme, D. U., 2024). .

According to information obtained from Loka AbayaWoreda Environment, Forest Protection Office, *Cordiana Africana,Olea europaea, Vachellia spp., Ficus ovataVahl, Ficus vasta, Juniperus procera, Dodonaea angustifolia L.f., Capparis tomentosa Lam.,Terminalia brownii*

Fre- sen., Linnaeus, Acokanthera schimperi and Acacia etbaica Schweinf are ome of plant species identified in Loka Abaya wetland ecosystem.

Threatened Flora Species in the Loka AbayaWetland Ecosystem

The International Union for Conservation of Nature (IUCN) defines threatened flora as plant species that are at high risk of extinction in the wild. During focus group discussion, the participants identified that Cordiana *Africana, Olea europaea, Vachellia spp, Ficus vasta and Juniperus procera* are the threatened flora species from the catchments that surrounds the Loka Abayawetland Ecosystem. As explained by the community members who participated in the FGD, before the establishment of Loka AbayaNational Park, there was extensive deforestation in the area. In particular, the population of Vachellia spp. Has declined due to climate change and the cutting and burning of trees for charcoal production. Similarly, the population of Olea europaea has been declining because local communities use it for house construction.

Table 8: Floral resources in Loka AbayaWetland Ecosystem

No	**Vernacular Name**	**English name**	**Scientific name**
1	ቃራርኾ	Poison arrow tree	Acokanthera schimperi (A.DC.) Schweinf
2	ጋሆ	Rutaceae	Capparis tomentosa Lam.
3	ብሰና	Ethiopian birch	Millettia ferruginea
4	ዋንዛ	African coral tree	Cordiana Africana
5	ዶዶኒያ	Narrow-leaved hopbush	Dodonaea angustifolia
6	ሾላ	Fig tree	Ficus ovataVahl
7	ዋርካ	Sycamore fig	Ficus sycomorus
8	ዝግባ	Ethiopian cedar	Juniperus procera
9	ወይራ	Ethiopian Olive	Olea europaea subsp. cuspidata
10	ሩኬሳ	East African Terminalia	Terminalia brownii Fre- sen.
11	ግራር	Acacia	Vachellia abyssinica

12	ዋርካ	Large-leaved fig	Ficus vasta
13	በደና		
14	ክትክታ		
15	አነበሬሳ		
16	የበራሃ ሎሚ		
17	ኦሮሪሳ		
18	በደና		
19	አማረሰ		
20	ጀርሜ		
21	ቦሮዳ		
22	ጣጣሌ		
23	ሎና		
24	ጦሮላ		
25	ቀሚሳ		
26	ሚኤሳ		
27	ዋሉ		

Source: - (FGD, 2026)

Note: - Plants listed from numbers 13–27 could not be identified by their English and scientific names; therefore, their vernacular (local) names have been retained.

Table 9: The Threatened plant species in Loka AbayaWetland Ecosystem

No	Vernacular Name	English name	Scientific name
1	ዋንዛ	African Cordia / Sudan teak	Cordiana Africana
2	ወይራ	African wild olive / East African olive	Olea europaea
3	ግራር	Acacia trees	Vachellia spp
4	ዋርካ	East African fig / Large-leaved fig	Ficus vasta

5	ዝግባ	Podocarpus	Podocarpus falcatus.
6	ኦሮሪሳ		
7	አማሬንሶ		

Source: - (FGD, 2026)

Medicinal plants

Loka AbayaWetland and its surrounding woodland, riverine and wetland vegetation constitute an important reservoir of medicinal plant resources. Species such as *Salvadora persica*, *Withania somnifera*, *Asparagus flagellaris*, *Asparagus racemosus*, *Ehretia cymosa*, *Clerodendrum myricoides* and *Stephania abyssinica* have been documented in the Loka AbayaNational Park vegetation inventory as medicinally important plants. Habitat conversion, vegetation clearance, and overharvesting, grazing and other anthropogenic pressures threaten these resources. Conservation of their natural habitats, sustainable harvesting, community medicinal-plant gardens and documentation of indigenous knowledge should therefore be incorporate into the management of Loka AbayaWetland (Asefa, 2024).

According to information obtained from FGD Aloe sp., Dodonaea angustifolia, Dodonaea viscosa sub- sp. angustifolia (L.f.) J.G.West, Euphorbia candelabrum, Trémaut ex Kotschy, Olea europaea , ኦካ and ጉደቶ known by their local names are used to treat different of human health and livestock diseases.

Table 10: Medicinal plant species in Loka Abayawetland Ecosystem

No	Vernacular Name	Scientific name	Usage
1	ሬት	Aloe sp.	Traditionally used for wounds and abdominal pain.
2	ታዳ	Dodonaea angustifolia	Traditionally used as a remedy for dental pain.
3	ኢንታልቻ	Dodonaea viscosa sub-sp. angustifolia (L.f.) J.G.West	Traditionally used to treat malaria.
4	ካርቶ	Euphorbia candelabrum	Traditionally used to treat common cold.

		Trémaut ex Kotschy	
5	ወይራ	Olea europaea	Traditionally used as medicine for livestock.
6	ጉደቶ		Traditionally used for treatment of abdominal pain.
7	ኦካ		Traditionally used to treat dental pain.

Source: - (FGD and Woreda EFCCO, 2026)

Invasive alien species in Loka AbayaWetland Ecosystem

The International Union for Conservation of Nature (IUCN) describes invasive alien species as organisms introduced outside their natural distribution that become established and spread, causing negative impacts on native biodiversity and ecosystems, and potentially on human well-being and economies. According data obtained from Loka Abaya Environment, Forest and Climate Change Office and FGD Eichhornia crassipes, Lantana camara L., Xanthium strumarium, Parthenium hysterophorus, Striga hermonthica, Argemone ochroleuca and Opuntia stricta have been identifie as invasive species in the Loka Abayawetland area. A total area of 1000 hectares of lands occupied by invasive species. According information obtained from FGD the introduction of invasive species into the areas causing significant impacts on the local community by degrading agricultural land, reducing crop yields, and reducing the availability of livestock feed. Invasive plant species found particularly along the banks of the Billate River, indicating that waterways may serve as pathways for the spread and expansion of invasive species and introduce by Abaya Lake in to the area.



Figure 7: Invasive alien species

Table 11: Invasive alien species in Loka Abaya Wetland Ecosystem

No	Vernacular name	Common name	Scientific name
1	እንቦጭ	Water hyacinth	Eichhornia crassipes
2	የወፍ ቆሎ	Latana	Lantana camara L.
3	የኮክልበር አረም	Common cocklebur	Xanthium strumarium
4	ፓርቴኒየም አረም	Parthenium weed	Parthenium hysterophorus
5	ሐምራዊ የጠንቋይ አረም	Purple witchweed	Striga hermonthica
6	ቁልቋል / ቀጋ	Prickly pear	Opuntia stricta
7	ነጭ ለበሽ	Mexican prickly poppy	*Argemone ochroleuca*

Source: - (FGD, 2026)

States and trends of Faunal Resources in Loka Abayawetland Ecosystem

Mammals:- According to information obtained from FGD with local community participants *Madoqua spp.,Vulpes spp.,Canis spp.,Panthera tigris,Panthera pardus,us scrofa domesticus, Panthera leo, Tragelaphus scriptus, Cervidae spp., Hystrix cristata, Tragelaphus strepsiceros, Papio spp., Lycaon pictus, Tragelaphus scriptus, Crocuta crocuta , Hippopotamus amphibious, Phacochoerus africanus, Lepus spp.,Chlorocebus aethiops* are major mammals identified in Loka

Abaya wetland Ecosystem. Canis lupus, Panthera pardus, Hippopotamus amphibious, Lycaon pictus and Tragelaphus strepsiceros are threatened mammalian species found in Loka Abaya wetland ecosystem and its surrounding Loka Abaya National park.

Panthera leo, Loxodonta Africana and Syncerus caffer are extinct mammalian species found in Loka Abayawetland ecosystem and its surrounding Loka Abaya National park in other way the number of Papio spp. and Crocuta crocuta mammalian species are increasing.

According to information obtained from FGD around 1983 in the Ethiopian calendar, during the fall of the Derg regime, many lions (Panthera leo) were killed with weapons because firearms became widely available among the local communities. The remaining lions (Panthera leo) were forced to move to other areas. This was partly because the local communities were predominantly pastoralists, and lions preyed on their livestock. In addition, killing a lion (Panthera leo) was culturally regarded as an act of bravery or heroism within the community.

Loxodonta africana and Syncerus caffer were reported to have inhabited the area for a long period in the past. However, the respondents were unable to explain the reasons for the disappearance of these large mammals from the area. Determining the factors that may have contributed to the disappearance of these species requires further investigation and additional research. According information obtained from FGD the number of wolves may have declined because wolves are social animals that live in groups or packs. Over the past five years, heavy rainfall in the catchment area has caused flooding, which may have resulted in the death of some wolves and consequently contributed to a decline in their population.

Table 12: Identified Major mammal Species found in Loka AbayaWetland Ecosystem.

No	Vernacular Name	English name	Scientific name
1	ሚደቆ	Dik-dik	Madoqua spp.
2	ቀበሮ	Fox	Vulpes spp.
3	ተኩላ	Wolf	Canis simensis
4	አሳማ	Domestic pig	Sus scrofa domesticus
5	አንበሳ	Lion	Panthera leo

6	አጋዘን	Common bushbuck	Tragelaphus scriptus
7	አጋዘን	deer	*Cervidae* spp.
8	ከርካሮ	Porcupine	Hystrix cristata
9	ኩዱ	Greater kudu	Tragelaphus strepsiceros
10	ዝንጀሮ	Baboon	Papio spp.
11	የአፍሪካ ዱር ውሻ	African wild dog	Lycaon pictus
12	ድኩላ	Wolf	Tragelaphus scriptus
13	ጂብ	Spotted hyena	Crocuta crocuta
14	ጉማሬ	Hippopotamus	Hippopotamus amphibious
15	ጥርኝ	Warthog	Phacochoerus africanus
16	ጥንቸል	Rabbit	Oryctolagus cuniculus
17	ጦጣ	Monkey	*Chlorocebus aethiops*

Source: - (FGD, 2026)

Table 13: Identified threatened mammal Species Found in Loka AbayaWetland Ecosystem.

No	Vernacular Name	English name	Scientific name
1	አንበሳ	Lions	Panthera leo
2	ተኩላ	Wolf	Canis lupus
3	ነብር	Leopard	Panthera pardus
4	ጉማሬ	Hippopotamus	Hippopotamus amphibius
6	የዱር ውሻ	Wild dog	Lycaon pictus
7	ታላቁ ኩዱ	Greater kudu	Tragelaphus strepsiceros
8	ዝሆን	Elephant	Loxodonta africana
9	ጎሽ	Buffalo	Syncerus caffer

Source: - (FGD, 2026)

Table 14: Identified extinct mammal Species Found in Loka AbayaWetland Ecosystem.

No	Vernacular Name	English name	Scientific name
1	አንበሳ	Lions	Panthera leo
2	ዝሆን	Elephant	Loxodonta africana
3	ጎሽ	Buffalo	Syncerus caffer

Source: - (FGD, 2026)

Reptiles' species: - During FGD the identified Reptiles' species in the Loka Abayawetland Ecosystem are Anura (order), Serpentes (suborder), Crocodylus niloticus, Actinopterygii, Python sebae and Testudinidae (family).

Table 15: Identified reptile species in Loka AbayaWetland Ecosystem.

No	Vernacular Name	English name	Scientific name
1	እንቁራሪት	Frog	Anura (order)
2	እባብ	Snake	Serpentes (suborder)
4	አዞ	Crocodile	Crocodylus niloticus
5	ዓሣ	Fish	Actinopterygii
6	ዘንዶ	python	Python sebae
7	ዔሊ	Tortoise	Testudinidae (family)

Source፡:- (FGD, 2026)

Bird species: - Loka AbayaNational Park and the wetlands around Lake Abaya support a high diversity of birds. According to (Demeke et al., 2019) survey reports Loka Abayanational park is rich in avian and supports high diversity of birds' species including rare, uncommon and migratory birds and a total of 134 bird species belonging to 99 genera, 53 families and 18 orders were recorded from riverine forest, wood grass land and wetland habitats. During FGD the identified identified bird species in the Loka Abayawetland Ecosystem are *Threskiornis aethiopicus, Alopochen aegyptiaca, Bubulcus ibis, Bostrychia hagedash, Egretta garzetta and Struthio camelus*.

Table 16: Identified bird species in Loka AbayaWetland Ecosystem

No	Vernacular Name	English name	Scientific name
1	ጅግራ	Sacred ibis	Threskiornis aethiopicus
2	ጨቴ	Egyptian Goose	Alopochen aegyptiaca
3	ደክዬ	Cattle egret	Bubulcus ibis
4	ሻሉ	Hadada ibis	Bostrychia hagedash
5	ነጭ ወፍ	White bird	Egretta garzetta
6	ሰጎን	Ostrich	Struthio camelus

Source: - (FGD, 2026)

Fish: The fisheries of Loka Abaya Wetland are an important ecological and socioeconomic resource. Nile tilapia, Nile perch, African sharptooth catfish and silver catfish constitute the principal commercially important species, while species such as Synodontis schall, Hydrocynus forskahlii, Labeobarbus intermedius, Mormyrus caschive, Marcusenius cyprinoides and Schilbe intermedius contribute to the broader aquatic biodiversity. However, increasing fishing pressure, habitat degradation, sedimentation, pollution and hydrological changes threaten the long-term sustainability of these resources. Sustainable, community-based fisheries management integrated with wetland conservation is therefore essential (Samson Debebe Sime, 2015). The Loka Abaya Wetland is ecologically connected with Lake Abaya and its tributary rivers and streams and therefore provides aquatic and wetland habitats that support fish biodiversity. Fish species documented from the Lake Abaya system include Nile tilapia (Oreochromis niloticus), Nile perch (Lates niloticus), African sharptooth catfish (Clarias gariepinus), silver catfish (Bagrus docmak), schall catfish (Synodontis schall), African barb (Labeobarbus intermedius), tigerfish (Hydrocynus forskahlii), African butter catfish (Schilbe intermedius), elephant-snout fish (Mormyrus caschive) and Marcusenius cyprinoides (Lemmens et al, 2017). According to information obtained from FGD confirmed that the Loka AbayaWetland is connected with Lake Abaya and they share similar fish species with it.

2.2.2 Driver and pressure for Biodiversity in Loka Abaya wetland Ecosystem

Deforestation within a wetland catchment will be a starting point for an accumulation of silt within a wetland ecosystem. Loss of vegetation within the catchment will result in accelerated soil erosion and consequently lead to land degradation, which in general is a major cause for an accumulation

of silt within the wetland. The accumulation of silt within the wetland will lead to a complete change in the wetland ecosystem. It might result in a complete change in the biodiversity, affect the water holding capacity of the wetland and in the worst cases cause a collapse of the wetland itself (Afework Hailu, 2005). The biodiversity of the Loka Abayawetland ecosystem is influenced by a combination of underlying drivers and the direct pressures generated by drivers. Loka AbayaWetland is ecologically important because it forms part of the Lake Abaya–Loka Abayalandscape, supporting wetland vegetation, aquatic organisms, birds, mammals, fish and other wildlife. The Loka AbayaNational Park contains 198 vascular plant species belonging to 72 families and 139 genera, with woodland, wooded grassland, riverine and lake-associated wetland vegetation (Assefa, 2024).

Drivers

a. **Population growth:** The FGD participants explained that, because the community, which previously lived a predominantly pastoralist lifestyle, gradually settled in one area and established rural settlements, the population in the wetland surrounding area has been increasing over time. As a result of this population growth, the demand for farmland, grazing land, fuelwood, water, fish and other natural resources increase which is resulting in greater pressure on the Loka Abayawetland ecosystem.
b. **Agricultural expansion:** According to information obtained from FGD the expansion of agricultural investment around the Loka Abayawetland and the transformation of the local livelihood system from predominantly pastoralism to more settled agricultural production have contributed to the expansion of farmland and settlement areas. As people increasingly settled together and established rural settlements, the demand for agricultural land increased, resulting in the conversion and encroachment of wetland and its surrounding buffer areas for crop production. The FGD participants further explained that agricultural fields have progressively expanded toward the wetland, and during periods of rainfall, soil, fertilizers and agricultural chemicals from cultivated fields can reach the wetland through surface runoff. This creates risks of sedimentation, nutrient enrichment and chemical pollution, which may negatively affect wetland vegetation, fish, amphibians, aquatic life and other biodiversity.
c. **Land-use/land-cover change:** Conversion of natural vegetation and wetlands into agricultural land and settlements fragments habitats and changes ecological processes. During FGD

participants explained that land-cover changes have occurred due to the expansion of agricultural land and establishment of local urban areas around the wetland.

d. **Weak institutional and management capacity**: During FGD participants explained that there is no intervention taken by the kebele, Woreda, zonal, and regional relevant authorities to conserve and protect Loka Abayawetland so far. As we can understand from the FGD there is limited enforcement, inadequate coordination and insufficient protection to the natural resources leads encroachment, resource overuse and habitat degradation of the areas. Therefore, it needs adequate wetland policy/legal framework and government, development partners and local communities' attention to protect the wetland.
e. **Climate variability and drought:** During FGD participants explained that lack of rainfall in this year and the occurrence of climate change have caused water levels to decrease, planted crops to dry up and fail, and banana plants to wither. Therefore, changes in rainfall, temperature and water availability can alter wetland hydrology, vegetation composition and habitat suitability for aquatic and terrestrial species.

Pressures

a. **Agricultural encroachment:** Expansion of farmland into wetland margins is one of the major pressures. It results in loss and fragmentation of natural habitats, removal of native vegetation and disturbance of wildlife. During FGD Participants explained that agricultural investments cultivating avocado, banana, and orange around the wetland are increasingly using water from the wetland and discharging chemicals and fertilizers into it. As a result, the wetland ecosystems are being affected. Therefore, there should be a clear buffer zone demarcation between agricultural land and the wetland needed, and the discharge of fertilizers and chemicals from agricultural investments into the wetland must be prevented in order to protect the wetland ecosystem.
b. **Overgrazing:** During our field data collection we observed that there is livestock grazing near the wetland areas. Heavy livestock grazing around Loka Abayawetland can reduce vegetation cover, prevent natural regeneration and cause soil compaction. Livestock entering wetland areas can also disturb bird nesting and feeding habitats. To prevent the wetland from being subjected to various forms of degradation, livestock entering the boundary of the wetland should be controlled and restricted. Similarly, greater attention

should be given to improving livestock breeds and establishing designated grazing areas to reduce pressure on the wetland ecosystem by the local communities.

c. **Vegetation and forest resource exploitation**: During FGD Participants explained that there is cutting of trees and shrubs for fuelwood, charcoal, house construction reduces vegetation cover and wildlife habitat.
d. **Soil erosion and sedimentation:** During FGD Participants explained that cultivation, deforestation and overgrazing in the catchment and near the wetland increase soil erosion. Sediment transported from different areas in different directions from the catchments enter into the wetland can reduce water depth of water. There is a need to take appropriate soil, water conservation method by governments, local communities and different developments partners to protect the wetland from further damage.
e. **Agricultural pollution:** During FGD Participants explained that due to agricultural investment expansion near the wetland fertilizers, pesticides and other agricultural chemicals can enter the wetland through surface runoff. For these reason may be excess nutrients enter into the wetland can contribute to eutrophication, while pesticides can adversely affect aquatic organisms and other wildlife.

2.2.3 Impact of loss of Biodiversity losses in Loka Abaya wetland Ecosystem

Biodiversity loss in the Loka Abayawetland ecosystem has ecological, economic and social consequences. The loss of plant, fish, bird, mammal, and reptile and amphibian species can reduce ecosystem stability and weaken the wetland's capacity to provide important ecosystem services (Assefa, 2024)

According to information obtained from FGD explained that conversion of wetland and surrounding vegetation to farmland, grazing areas and other land uses reduces natural habitats for mammals, birds, reptiles, amphibians and fish. Removal of natural vegetation, grazing and expansion of invasive species can decrease crop yield, reduce native plant abundance and diversity. The loss of plant diversity also affects organisms that depend on plants for food, nesting, shelter and reproduction.

2.2.4 Response for Biodiversity on biodiversity loses in Loka Abaya wetland Ecosystem

Effective forest and watershed management are valuable for long-term sustainability of water resources. Governments and other stakeholders should develop policies and implement

programmers that promote holistic, multi-disciplinary and multi-stakeholder approaches that link forests, water, watersheds, the environment and people (Shiga Declaration, 2002). The response to biodiversity loss in the Loka Abaya Wetland Ecosystem requires coordinated action by local communities, Woreda and regional government institutions and other relevant stakeholders.

Community and Government

The response to biodiversity loss in the Loka Abaya wetland ecosystem should be a shared responsibility between local communities, governments and other stakeholders.

Government

- Provides laws, technical support, finance and enforcement to protect flora and fauna of Loka Abaya wetland
- Government should clearly demarcate Loka Abaya wetland boundaries and buffer zones, prevent further agricultural expansion, and free grazing.
- Strengthen biodiversity and wetland management plans
- Government should establish a coordinated program for the control of Eichhornia crassipes (water hyacinth) and other invasive plants.

Community

- Local Communities can participate in protecting wetland boundaries, wildlife habitats and natural vegetation.
- Communities can restore degraded riverbanks, wetland margins and surrounding hillsides by planting indigenous species.
- provides local knowledge, participation, monitoring and resource stewardship

2.2.5 Outlook

If the current trends of agricultural expansion, overgrazing, invasive alien species, habitat fragmentation, sedimentation and unsustainable resource exploitation continue without effective intervention, loss of native species, biodiversity and reduction of ecosystem services are likely to decline further. Conversely, effective wetland protection, restoration of degraded habitats, invasive-species management, catchment conservation, sustainable resource use, biodiversity

corridors and active community participation can improve the ecological condition of the Loka Abaya wetland.

Recommendations

- Clearly demarcate the boundaries of Loka Abaya wetland, establish and enforce appropriate wetland buffer zones.
- Prevent agricultural expansion, settlement and other incompatible land uses within sensitive wetland areas.
- Integrate wetland conservation into Woredas, zonal and regional land-use planning.
- Restore degraded wetland margins, riverbanks and natural vegetation.
- Replant indigenous trees, grasses and wetland plants using locally appropriate species in connection with green legacy.
- Control water hyacinth (Eichhornia crassipes) and other invasive plants through environmentally appropriate methods.
- Prevent livestock from entering ecologically sensitive wetland areas and develop improved livestock-feed production outside sensitive wetland areas.
- Promote fodder development and agroforestry to reduce dependence on natural wetland vegetation.
- Prevent further conversion of natural wetland vegetation into agricultural land.
- Implement watershed based soil and water conservation to reduce sedimentation.
- Strengthen community based fisheries management and monitoring.
- Strengthen community participation and awareness creation in wetland restoration, invasive-plant removal, wildlife protection, sustainable grazing, fisheries management, biodiversity monitoring, and environmental awareness programs.
- Strengthen coordination among government institutions and local communities.

2.3 Forest

2.3.1 State and trend of Forest in the Loka Abaya Wetland Ecosystem

Wetlands are transitional ecosystems between terrestrial and aquatic environments where water is the dominant factor controlling ecological processes, soil formation, and the distribution of plant and animal communities (Convention on Wetlands, 2025). Wetlands are among the most productive ecosystems on Earth and provide essential ecosystem services that support both

biodiversity and human well-being. These services include freshwater supply, groundwater recharge, flood regulation, shoreline stabilization, water purification, nutrient cycling, carbon sequestration, climate regulation, fisheries production, and recreation. Peatlands and coastal wetlands are particularly important carbon sinks, storing significant quantities of carbon and helping mitigate climate change (Global Wetland Outlook, 2025).

Wetlands are 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 metres" (Ramsar Convention Secretariat,2025).

According to the (Global Wetland Outlook, 2025) approximately 1.4 billion hectares of wetlands remain worldwide. Since 1970, however, an estimated 411 million hectares (about 22%) have been lost, and nearly one-quarter of the remaining wetlands are in degraded ecological condition. Major drivers of wetland degradation include agricultural expansion, urbanization, pollution, infrastructure development, hydrological alteration, invasive species, and climate change. The annual economic value of wetland ecosystem services is estimated at up to US$39 trillion, emphasizing their importance for sustainable development.

Africa possesses one of the world's richest wetland resources, encompassing inland floodplains, river systems, lakes, deltas, peatlands, mangroves, and coastal wetlands. Major wetland systems include the Okavango Delta, Sudd, Inner Niger Delta, Lake Victoria, and the Niger Delta. These wetlands support exceptional biodiversity and millions of people through fisheries, agriculture, livestock grazing, transportation, and tourism. Although wetlands occupy only a relatively small proportion of Africa's land area, they are indispensable for maintaining ecological integrity and socio-economic development. African wetlands provide habitats for migratory birds, endemic species, and numerous threatened mammals, reptiles, amphibians, and fish. They also regulate river flows, reduce flooding, improve water quality, and contribute to climate resilience (Ramsar Convention Secretariat, 2025). However, African wetlands are increasingly threatened by Agricultural encroachment, Population growth, Urbanization, Industrial pollution, Mining, Deforestation, Overgrazing, Water abstraction, Dam construction and Climate change. These pressures have resulted in habitat fragmentation, declining biodiversity, reduced water availability, and deterioration of ecosystem services. Strengthening integrated wetland management,

improving governance, and enhancing transboundary cooperation remain priorities across the continent.

Ethiopia possesses a diverse range of wetlands owing to its varied topography, climate, geology, and extensive river systems. The country contains wetlands associated with 12 major river basins, numerous lakes, marshes, swamps, floodplains, reservoirs, and seasonal wetlands. There is no complete documentation and studies of wetlands have been made in Ethiopia. It is estimated that there are 77 wetlands in Ethiopia including lakes that cover an area of 13,700 km2, which is about 1.14 percent of the country's landmass (Karlsson, 2015).

Ethiopian wetlands provide multiple ecosystem services, including domestic and livestock water supply, irrigation, fisheries, flood regulation, groundwater recharge, sediment retention, water purification, carbon storage, biodiversity conservation, and ecotourism. They also support traditional livelihoods through fishing, papyrus harvesting, grazing, and crop cultivation. Despite their ecological and socio-economic importance, Ethiopian wetlands face severe degradation due to Agricultural expansion and wetland drainage, urban development. Industrial and domestic wastewater pollution, Sedimentation from upstream catchment degradation, Unsustainable water abstraction, Invasive alien species, Climate variability, drought, Weak institutional coordination, and limited enforcement. Recent national wetland inventories emphasize the need for integrated watershed management, improved policy implementation, restoration programs, and community-based conservation to safeguard Ethiopia's wetland ecosystems (Fentaw, F., et al., 2025).

Loka Abaya Wetland is an important freshwater wetland system associated with Lake Abaya and the surrounding Loka Abaya National Park in Sidama Regional State, southern Ethiopia. It forms part of the Central Rift Valley landscape and is closely connected with Lake Abaya, seasonal and permanent rivers, floodplains, riverine forests, grasslands, and surrounding woodland ecosystems. The wetland is therefore best understood as part of a larger interconnected lake–river–wetland ecosystem, rather than as an isolated water body. The Loka Abaya wetland landscape ecosystem contains a combination of lake and lake-shore habitats, marsh and floodplain vegetation, seasonal and permanent rivers, riverine forests, wet grasslands, woodland and wooded grassland, riparian vegetation, flood-prone areas and shallow-water habitats (Asefa, 2024). Loka Abaya National Park identified approximately 30 km² of wetland habitat, alongside wooded grassland, hilly scrubland and riverine forest habitats (Diriba, 2020).

Loka Abaya Wetland is associated with the Lake Abaya catchment and contains marshes, swamp vegetation, floodplains, and wetland forests. It is recognized for its high biodiversity and its role in maintaining ecological connectivity between terrestrial and aquatic ecosystems.

Ecological significance like habitat for fish, amphibians, reptiles, mammals, and birds, important breeding area for water birds, supports indigenous wetland vegetation, enhances groundwater recharge and Reduces flood impacts and current threats like expansion of agriculture, deforestation, overgrazing, wetland drainage, climate variability and unsustainable resource extraction.

Accordinging to (Diriba, T., et al., 2020) the Loka Abaya Wetland is an ecologically important freshwater wetland ecosystem located in Loka Abaya District, Sidama Region, southern Ethiopia, within the Central Rift Valley. It forms part of the broader Loka Abaya National Park, established in 2009, and is closely associated with Lake Abaya, the Bilate River, the Gidawo River, seasonal streams, floodplains, marshes, and riverine forests. The protected area covers about 500 km², including approximately 52 km² of Lake Abaya water surface, and ranges in elevation from about 1,000–1,800 m above sea level.

Loka Abaya Wetland should be consider a high-value biodiversity and ecosystem-service area because it combines aquatic, wetland, riverine and terrestrial habitats within one interconnected landscape. The establishment of Loka Abaya National Park provides an important institutional basis for conservation. However, effective protection requires integrated management of the Loka Abaya wetland, Lake Abaya, Bilate rivers, catchment, agricultural lands and surrounding communities, rather than focusing on the wetland alone. According to data obtained from land use land cove change map of Loka Abaya Wetland ecosystem indicates that the forest area increased from 1,312 ha in 2015 to 3,162 ha in 2026, an increase of about 1850 ha (141.0 %). Similarly, Shrub Land increased from 1,017 ha in 2015 to 1,039 ha by 2026. Possible reasons for the increasing of forest and shrub lands are protection and demarcation of Loka Abaya national park, tree planting, watershed management, restoration initiatives can increase vegetation cover and allowed indigenous trees and shrubs to regenerate.

2.3.2 Driver and Pressure of Forest Degradation in the Loka Abaya Wetland Ecosystem

Despite the diverse benefits that wetlands provide, lack of effective management has led to their continued degradation that includes unsustainable activities such as converting wetlands into

agricultural and grazing lands, using them as waste disposal sites, and overexploitation of resources. Misconception about wetlands and considering them as wastelands and breeding grounds of mosquitoes and also absence of clearly defined tenure right on wetlands are further challenges that exacerbate wetlands' degradation (Tadessse Amsalu and Solomon Addisu 2014).

According to (Assefa et al, 2024), the ecological integrity of Loka Abaya Wetland can be affected by several pressures, including agricultural expansion, conversion of wetland and riparian habitats, deforestation and vegetation clearance, overgrazing, soil erosion, sedimentation of water bodies, water abstraction, pollution from agricultural and domestic activities, invasive species, unsustainable harvesting of natural resources, habitat fragmentation, climate variability and drought, increasing human and livestock pressure.

Loka Abaya's forest and wetland vegetation remain an important ecological asset with high plant diversity and multiple vegetation communities. Nevertheless, increasing land-use pressure, grazing, selective tree removal, charcoal production and agricultural expansion pose significant risks to forest integrity and regeneration. Strengthening forest protection, restoration, community participation and systematic vegetation monitoring is therefore essential for maintaining the ecological integrity of the Loka AbayaWetland Ecosystem (Assefa, 2024).

Drivers and pressures are causing habitat loss and fragmentation, declining biodiversity, deterioration of water quality, sediment accumulation, reduction of ecosystem services, and weakening of the wetland's ecological resilience. Effective conservation therefore requires integrated catchment management, control of agricultural encroachment, sustainable water use, invasive-species management, pollution control, restoration of degraded areas, and stronger community-based and institutional wetland governance.

The principal drivers of forest degradation in the Loka AbayaWetland Ecosystem are population growth, agricultural expansion, livelihood dependence on natural resources, increasing demand for fuelwood and charcoal, and weak resource-management systems. These drivers generate direct pressures including forest clearing for agriculture, charcoal production, fuelwood collection, overgrazing, settlement expansion, illegal tree cutting and wetland-buffer cultivation. Together, these pressures reduce forest cover and regeneration, fragment habitats, accelerate soil erosion and

sedimentation, and undermine the ecological integrity of the Loka Abaya wetland ecosystem (Alemu et. al, 2026). This finding reveals FGD.

The main driver and Pressure for forest degradation of Loka Abaya wetland Ecosystem are-

a. Population growth

The FGD participants explained that, because the community, which previously lived a predominantly pastoralist lifestyle, gradually settled in one area and established rural settlements, the population in the wetland surrounding area has been increasing over time. Because of this population growth, the demand for farmland, grazing land, fuelwood, water, fish and other natural resources increase which is resulting in greater pressure on the forest of Loka Abaya wetland ecosystem.

b. Deforestation

According to information obtained from Loka Abaya Environment, Forest and Climate change offices the total forest coverage of forest cover is about 12,000 ha. As explained by the community members who participated in the FGD, before the establishment of Loka Abaya National Park, there was extensive deforestation in the area due to cutting of trees for house construction and burning of trees for charcoal production. However, after the establishment of Loka Abaya National Park, deforestation rate was decrease. According to data obtained from land use land cove change map of Loka Abaya Wetland ecosystem indicates that the forest area increased from 1,312 ha in 2015 to 3,162 ha in 2026, an increase of about 1850 ha (141.0%). Similarly, Shrub Land increased from 1,017 ha in 2015 to 1,039 ha in 2026, an increase of about 22 ha (2.2%). Possible reasons for the increasing of forest and shrub lands are protection and demarcation of Loka Abaya national park, tree planting, watershed management, restoration initiatives can increase vegetation cover and allowed indigenous trees and shrubs to regenerate.

c. Agricultural Expansion

Traditional and modern agricultural expansions, continuous land degradations, urbanizations and industrializations, lack of policies and institutional arrangements, lack of capacities, natural and ecological problems are the most dominant challenging factors of wetlands in Ethiopia (Gebresllassie et al., 2014). According to the information obtained from the FGD participants, due to lack of clear wetland land demarcation there is conversion of natural forest areas into cultivated land. This in turn, contributing to the degradation of the forest wetland ecosystem. Similarly, due

to the expansion of agricultural investment involving avocado, orange, and banana farming established around the wetland, as well as due to population growth, the agricultural land is increasingly expanding into the wetland areas. This makes the wetland more vulnerable to chemical and fertilizer runoff, which is causing degradation of the wetland ecosystem. According to data obtained from land use land cove change map of Loka Abaya Wetland ecosystem indicates that the cropland area increased from 1,952 ha in 2015 to 3,152 ha in 2026, an increase of about 1200 ha (61.5 %). Cropland coverage in the Loka Abaya wetland area increased mainly because of agricultural expansion increasing pressure on land and water resources.

d. Overgrazing

Throughout Ethiopia, wetlands have been, and still are, important sites for livestock grazing. Wetlands are the last destination for grazers during the dry months in the country from North to South and East to West. It might not be overestimating to say that the survival of the country's livestock is unthinkable without the existence of these precious resources. However, through time with the increase in the livestock population, shortages of fodder and the expansion of agricultural activities upslope have increased grazing pressure on wetlands. The pressure from grazing has resulted in a change in the characteristics of wetlands, some that have changed into rough grazing land. The threats from grazing can arise from overstocking in the wetland, year round grazing which excludes ecological recovery and soil poaching by livestock due to grazing in wetlands during the wet season (Afework Hailu, 2005). According to the information obtained from the FGD participants, because the wetland land is not demarcate and prolonged dry conditions due to climate change, local communities release their livestock near the wetland including buffer zone areas for grazing. According to data obtained from land use land cove change map of Loka Abaya Wetland indicates that the cropland area decreased from 3,990 ha in 2015 to 2,025 ha in 2026 decreased of about 1965 ha (49.2%). The grazing-land coverage around Loka Abaya Wetland decreased mainly because grazing areas have been convert to cropland, settlement and increasing human and livestock pressure.



Figure 8: Free grazing catties on Loka Abayawetland

e. Invasive Alien Species

Invasive alien species (IAS) are non-native organisms that become established and spread in an ecosystem and can cause ecological, economic, or social impacts. According to the Ethiopian National Biodiversity Action Plan, about 35 alien and indigenous invasive species have been identified in Ethiopia. These species are negatively affecting agricultural lands, rangelands, national parks, waterways, lakes, rivers, power dams, roadsides and urban green spaces with huge economic as well as social consequences on the national economy and local livelihoods. Furthermore, invasive species have been threatening local biodiversity and Ecosystem services (EBI, 2015). According to information obtained from Loka Abaya Woreda environment, forest and climate change office Invasive Alien Species like water hyacinth (Eichhornia crassipes), Lantana camera, Parthenium hysterophorus, Xanthium strumarium, Striga hermonthica and Opuntia stricta are seen around the wetland areas.

Due to the presence of dangerous crocodiles in the wetlands makes it difficult to remove the water hyacinth manually by human labor. As a result, the water hyacinth has continued to increase and spread over time, causing the water to gradually move toward the Loka Abaya local town. Therefore, the concerned government bodies, relevant stakeholders and development partners have

been requested to provide appropriate machinery/equipment for removing the water hyacinth safely and effectively from the wetland.

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2.3.3 Impact of forest in the Loka AbayaWetland Ecosystem

The Wetlands in Ethiopia are impacted by a combination of social, economic, development related and climatic factors that lead to their destruction. Correspondingly, the Wetlands holding a considerable biodiversity potential in the country lack adequate management (Israel and Timar, 2019). The impacted wetlands provide various socioeconomic and ecological benefits to society, which are or have the ability to significantly improve the livelihood of the communities surrounding the wetland systems. As the level of wetland degradation increases their benefit is also reduced (Kassa and Teshome, 2015). Wetlands in Ethiopia provide multiple ecosystem services; they are highly affected because of Natural processes, anthropogenic activities, and limited policy attention (Zekarias, T., and Gelaw, A., 2023). Forest degradation in the Loka Abaya Wetland Ecosystem is contributing to biodiversity and habitat loss, reduced vegetation regeneration, increased soil erosion and surface runoff, sedimentation of Lake Abaya, deterioration of wetland and water quality, and declining ecosystem services. The loss of forest and natural vegetation also weakens the ecological buffer around the wetland, increasing the movement of sediments and agricultural pollutants into the lake. These environmental changes ultimately threaten fisheries, agriculture, tourism, climate regulation and other livelihood benefits provided by the Loka Abaya wetland ecosystem (Alemu et al, 2026). Forest degradation in the Loka Abaya Wetland ecosystem contributes to biodiversity loss, habitat fragmentation, soil erosion, sedimentation, declining water quality and loss of ecosystem services. These ecological changes can subsequently affect agricultural productivity, natural-resource availability and the livelihoods

of communities dependent on the wetland ecosystem. According to information obtained from FGD participants, plant such as Olea europaea and Vachellia spp threatened due to cutting of trees for house construction and charcoal production.

2.3.4 Response to Forest Degradation in the Loka Abaya Wetland Ecosystem

Watershed management programs and payment for ecological service mechanisms have been designed and implemented to help correct some of the market failures that result in actions that are harmful to both the affected Ecosystem and economy. From a policy aspect, it is crucial that the linkages between water, Wetlands and forests are take into consideration to adequately protect our water resources and related Ecosystems (Blumenfeld et al, 2009). The response to forest degradation in the Loka Abaya Wetland Ecosystem should focus on integrated forest landscape restoration, protection of wetland and riparian buffer zones, sustainable agricultural and grazing practices, control of illegal tree cutting and charcoal production, community-based natural-resource management, invasive-species control, soil and water conservation, and strengthened institutional and legal enforcement.

Government and community

According information obtained from FGD, there no intervention take by government and local communities to protect forest degradation of Loka Abaya wetland ecosystem. Therefore, the forest degradation of the Loka Abaya Wetland ecosystem requires coordinated responses from government institutions and local communities. Government action is important for policy, law enforcement, land-use planning, restoration, monitoring and financing, while local communities are essential for day-to-day conservation, sustainable resource use and protection of the wetland. Because many of the pressures originate in the surrounding catchment, management should extend beyond the wetland boundary to Loka Abaya national park and Lake Abaya. Integrated wetland and watershed management, combined with strong community participation and government enforcement, is essential for maintaining forest, ecosystem services and local livelihoods. Strengthening government–community co-management is essential to reduce forest degradation, restore ecosystem functions and sustain the biodiversity and ecosystem services of the Loka Abaya Wetland Ecosystem.

2.3.5 Outlook

Without intervention and with continued agricultural expansion, population pressure, over grazing, deforestation, overgrazing, invasive species, sedimentation and resource overuse could lead to further forest degradation. With moderate intervention of effective regulation, monitoring and improved land-use practices could slow forest degradation and stabilize important wetland functions. With integrated catchment restoration, wetland rehabilitation, invasive-species control, sustainable land use, engagement of government and community participation could restore the degraded forest and improve the long-term resilience of Loka Abaya Wetland.

Recommendation

- Strengthen wetland protection and management by clearly demarcate and legally protect forest, wetland, riverine, and buffer areas.
- Prevent further conversion of natural forest and wetland vegetation into agricultural land
- Integrate wetland conservation into Woreda, zonal and regional land-use planning
- Restore degraded forest areas using indigenous and locally adapted tree species.
- Strengthen enforcement against illegal wetland cultivation, overgrazing, deforestation for purpose of house construction and charcoal production.
- Reduce Charcoal Production and Unsustainable Fuelwood Collection by Strengthen control of illegal charcoal production and commercial tree cutting and promote energy-efficient cooking technologies and alternative household energy sources.
- Involve local communities in planning, protection, restoration, and monitoring of forest resources.
- Provide alternative land-management and livelihood options for households dependent on wetland cultivation.
- Control invasive plants through appropriate mechanical and integrated management approaches.
- Construct appropriate soil and water conservation structures to control erosion and sediment transport into the wetland.
- Manage livestock grazing sustainably by establishing controlled grazing areas.

- Strengthen environmental awareness to farmers; pastoralists and livestock owners; youth; women; schools and local community leaders to protect forest from degradation.
- Strengthen coordination between Abaya Lake and Loka Abaya National Park management and surrounding local communities to protect the forest and wetland.
- Integrate climate-change adaptation by restoring degraded catchments and developing community climate-adaptation measures.
- Improve institutional coordination among different stake holders

2.4 Climate

2.4.1 State and Trend of climate change/Variability for Loka AbayaWetland

Climate is the long-term average pattern of weather in a particular place, usually measured over 30 years or more. It describes the typical conditions of an area rather than the day-to-day weather (Houghton, 2002).

Climate change is the long-term change in Earth's average temperature and weather patterns. While Earth's climate has changed naturally over millions of years, the current period of climate change is happening much faster, mainly because of human activities. In simple terms, climate change is the long-term warming of the Earth caused mainly by human activities, leading to major changes in weather and the environment (Houghton, 2002)

Climate includes factors such as:

- Temperature
- Rainfall
- Humidity
- Wind
- Sunshine and Seasonal patterns

The biggest cause of climate change is the release of greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4). These gases come from:

- Burning fossil fuels (coal, oil, and natural gas)
- Cutting down forests
- Agriculture and livestock
- Industrial activities

For this fact sheet, we use Loka Abaya meteorological data for 30-year maximum and minimum temperature and rainfall girded data.

Loka Abaya wetland found in Sidama region, Loka Woreda, Wetlands are diverse ecosystems that include salt marshes, freshwater wetlands, riparian areas, and peatlands. They support a wide variety of plants and animals and provide important ecological and socioeconomic benefits, including biodiversity conservation, carbon sequestration, and freshwater purification, fisheries, and fuelwood resources. However, wetlands face increasing threats from both human activities and natural processes. This review highlights the importance of wetlands, major threats to their sustainability, and key areas for effective management and conservation (Sudipto, January 2020).

2.4.1.1 State and Trend of Rainfall, Maximum, and Minimum Temperature of Loka Abaya wetland

Maximum temperature trends in Loka Abaya Woreda from 1981–2022,

During the Focus Group Discussion (FGD), community members reported that they have observed significant changes in local climatic conditions over recent years. According to participants, average temperatures have increased, rainfall has become increasingly variable, and the frequency and severity of climate-related hazards, particularly droughts and floods have increased. Community members perceived that these changes become more pronounce during the last four years.

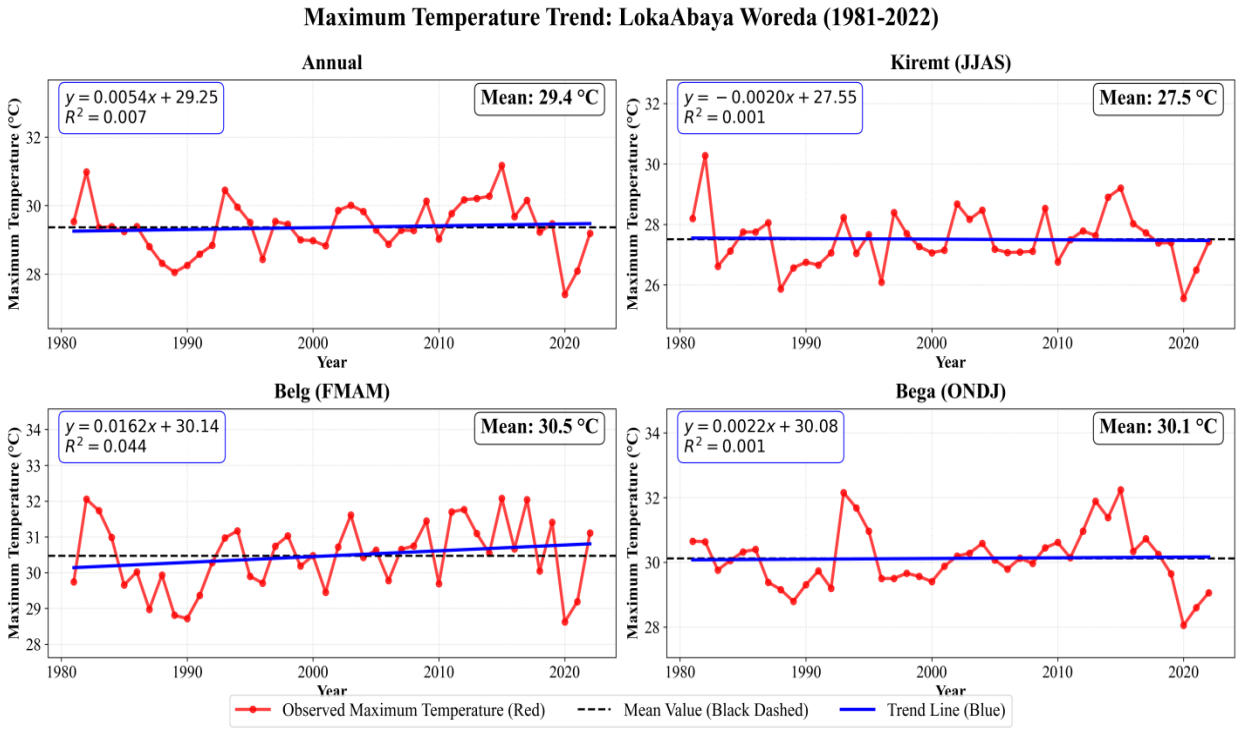


Figure 9: Loka Abya Maximum Temperature trend for different seasons

The above figure indicates that maximum temperature has varied considerably from year to year, but the long-term trends are generally weak. The annual maximum temperature shows a slight increasing trend, while Kiremt shows a very slight decreasing trend. Belg and Bega show increasing trends.

Table 17 : Maximum temperature trend

Period	Mean Maximum Temperature	Trend (°C/year)	R^2	Interpretation
Annual	29.4°C	+0.0054	0.007	Very weak increase
Kiremt (JJAS)	27.5°C	−0.0020	0.001	Very weak decrease
Belg (FMAM)	30.5°C	+0.0162	0.044	Weak increase
Bega (ONDJ)	30.1°C	+0.0022	0.001	Very weak increase

Annual maximum temperature

The annual trend line has the equation:

$y = 0.0054x + 29.25$

This means that annual maximum temperature increased by approximately 0.0054°C per year, equivalent to about 0.22°C over the 41-year period.

However, the $R^2 = 0.007$, which is extremely low. This means that the linear trend explains only about 0.7% of the year-to-year variation. Therefore, although the trend is upward, the increase is very weak and the annual temperatures are highly variable.

The mean annual maximum temperature during the period was 29.3°C.

Kiremt season (June–September)

Kiremt has a trend of:

$y = -0.0020x + 27.55$

The trend indicates a very small decrease of approximately 0.002°C per year, equivalent to about 0.08°C over the study period.

The $R^2 = 0.001$, meaning that the trend explains only about 0.1% of the observed variation. Therefore, there is essentially no strong long-term linear trend in Kiremt maximum temperature.

The mean Kiremt maximum temperature was approximately 27.5°C.

Belg season (February–May)

Belg shows the strongest increasing trend among the four periods:

$y = 0.0162x + 30.14$

The maximum temperature increased by approximately 0.0162°C per year, equivalent to approximately 0.66°C over 1981–2022.

The $R^2 = 0.044$, meaning that the trend explains about 4.4% of the observed variability. This is still relatively low, so the result describe as a weak increasing trend, rather than a strong trend.

The mean Belg maximum temperature was approximately 30.5°C.

Bega season (October–January)

Bega has a slight increasing trend:

$y = 0.0022x + 30.08$

This corresponds to an increase of approximately 0.0022°C per year, or about 0.09°C over the 41-year period.

The $R^2 = 0.001$, indicating that the linear trend explains only about 0.1% of the variation. Thus, Bega maximum temperature is characterize mainly by interannual variability rather than a consistent long-term trend.

The mean Bega maximum temperature was approximately 30.1°C

One notable feature is the large year-to-year fluctuation in maximum temperature. For example, several relatively high temperatures occur during the 1990s and 2010s, while particularly low values appear around 2020–2021 in several seasons.

The graph therefore suggests that:

- **Annual maximum temperature:** slight warming tendency.
- **Belg:** the clearest warming tendency, although still weak statistically.
- **Bega:** almost stable, with a very slight increase.
- **Kiremt:** almost stable, with a very slight decline.
- **Interannual variability:** considerably larger than the long-term linear tre

The analysis of maximum temperature in Loka Abaya Woreda for 1981–2022 shows substantial interannual variability, with generally weak long-term trends. Annual maximum temperature increased at a rate of approximately 0.0054°C per year, equivalent to about 0.22°C over the study

period. The Belg (FMAM) season exhibited the strongest warming tendency, increasing by approximately 0.0162°C per year, or about 0.66°C over the period. In contrast, Kiremt (JJAS) maximum temperature showed a very slight declining trend of 0.0020°C per year, while Bega (ONDJ) showed a marginal increase of 0.0022°C per year. The low R^2 values (0.001–0.044) indicate that the linear trends explain only a small proportion of the observed variability. Overall, the results suggest a weak warming tendency in annual, Belg, and Bega maximum temperatures, while Kiremt temperatures remained relatively stable, with substantial year-to-year fluctuations dominating the long-term trend.

The figure provides evidence of weak warming in Loka Abaya's maximum temperature, particularly during Belg, but the very low R^2 values show that the changes do not follow a strong linear trend, while natural year-to-year variability substantially influences the observed patterns.

Minimum temperature trend in LokaAbaya Woreda from 1981–2022,

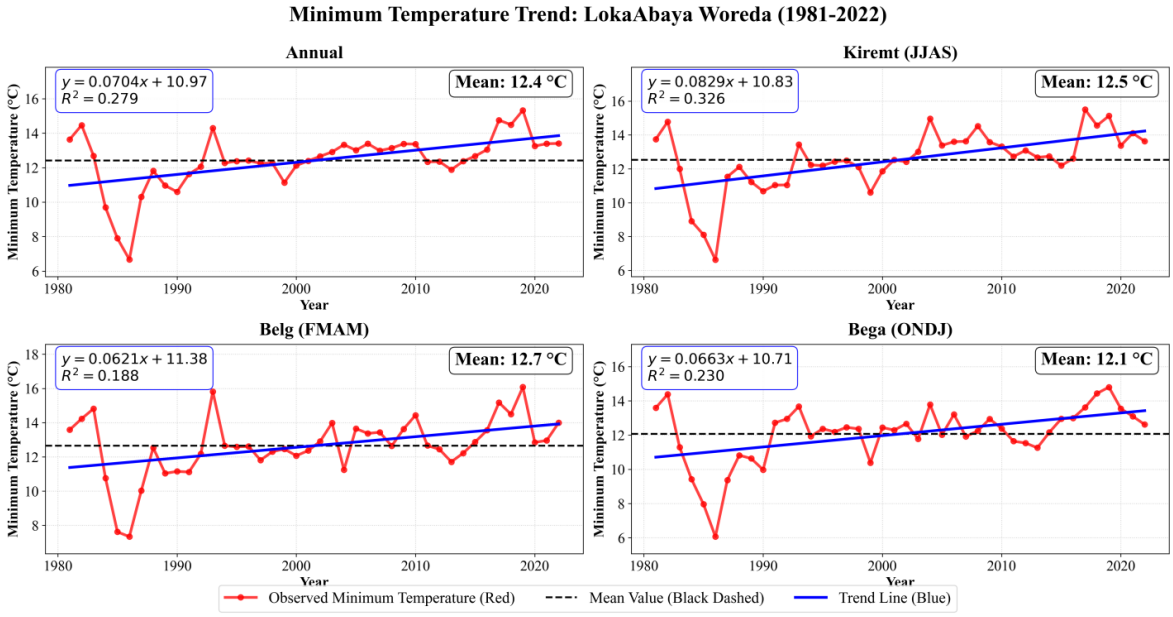


Figure 10: Loka Abaya Minimum Temperature trend for different seasons

Table 18: Minimum Temperature trend

Period	Mean Minimum Temperature	Trend (°C/year)	R^2	Approx. change, 1981–2022
Annual	12.4°C	**+0.0704**	0.279	**+2.89°C**
Kiremt (JJAS)	12.5°C	**+0.0829**	0.326	**+3.40°C**
Belg (FMAM)	12.7°C	**+0.0621**	0.188	**+2.55°C**
Bega (ONDJ)	12.1°C	**+0.0663**	0.230	**+2.72°C**

Annual minimum temperature

The annual trend is:

$y = 0.0704x + 10.97$

This indicates that minimum temperature increased by approximately 0.0704°C per year, equivalent to about 2.9°C over 1981–2022.

The $R^2 = 0.279$, meaning the linear trend explains approximately 27.9% of the variation in annual minimum temperature. This is substantially stronger than the annual maximum-temperature trend you showed previously ($R^2 = 0.007$).

The mean annual minimum temperature was 12.4°C.

Kiremt minimum temperature

Kiremt shows the strongest warming trend:

$y = 0.0829x + 10.83$

The temperature increased by approximately 0.083°C per year, equivalent to roughly 3.4°C over the study period.

The $R^2 = 0.326$, meaning approximately 32.6% of the variation is explained by the linear trend. Among the four periods, this is the highest R^2.

This suggests a relatively clear warming tendency in Kiremt nighttime/cold-period temperatures.

Mean Kiremt minimum temperature = 12.5°C.

Belg minimum temperature

Belg has the trend:

$y = 0.0621x + 11.38$

This represents an increase of approximately 0.062°C per year, or about 2.55°C during 1981–2022.

The $R^2 = 0.188$, meaning the trend explains approximately 18.8% of the observed variation.

Mean Belg minimum temperature = 12.7°C.

Although the trend is positive, considerable year-to-year variability remains.

Bega minimum temperature

Bega shows:

$y = 0.0663x + 10.71$

This corresponds to an increase of approximately 0.066°C per year, or about 2.72°C over the study period.

The $R^2 = 0.230$, indicating that approximately 23.0% of the variation is associated with the linear trend.

Mean Bega minimum temperature = 12.1°C.

The most important result from this figure is that minimum temperatures increased much more strongly than maximum temperatures.

From two figures:

- Annual maximum temperature: +0.0054°C/year
- Annual minimum temperature: +0.0704°C/year

Therefore, the minimum temperature is warming at a rate approximately 13 times greater than the maximum temperature based on these fitted slopes.

This suggests stronger warming of nighttime/cool-season temperatures than daytime maximum temperatures in Loka Abaya Woreda.

The analysis of minimum temperature in Loka Abaya Woreda during 1981–2022 demonstrates a consistent warming trend across annual and seasonal periods. Annual minimum temperature increased at a rate of 0.0704°C per year, corresponding to an estimated increase of approximately 2.9°C over the study period. Kiremt exhibited the strongest warming trend, with minimum temperature increasing by 0.0829°C per year, equivalent to approximately 3.4°C over the period, and had the highest coefficient of determination ($R^2 = 0.326$). Belg and Bega also showed increasing trends of 0.0621°C/year and 0.0663°C/year, respectively. The R^2 values of 0.188 for Belg and 0.230 for Bega indicate moderate but variable relationships between time and minimum temperature. Overall, the a clear warming tendency in minimum temperatures across Loka Abaya Woreda, the Kiremt season shows the strongest warming results indicate trend. Compared with maximum temperature, minimum temperature exhibits a substantially stronger warming trend, suggesting that nighttime and cooler-period temperatures have increased more rapidly than daytime maximum temperatures.

When the maximum-temperature figure and this minimum-temperature figure are considered together, the evidence suggests that Loka Abaya Woreda has experienced a stronger increase in minimum temperatures than maximum temperatures over 1981–2022. This is an important indicator of warming because rising minimum temperatures can reduce the frequency of cold nights and alter agricultural conditions, evapotranspiration, crop development, and ecosystem processes.

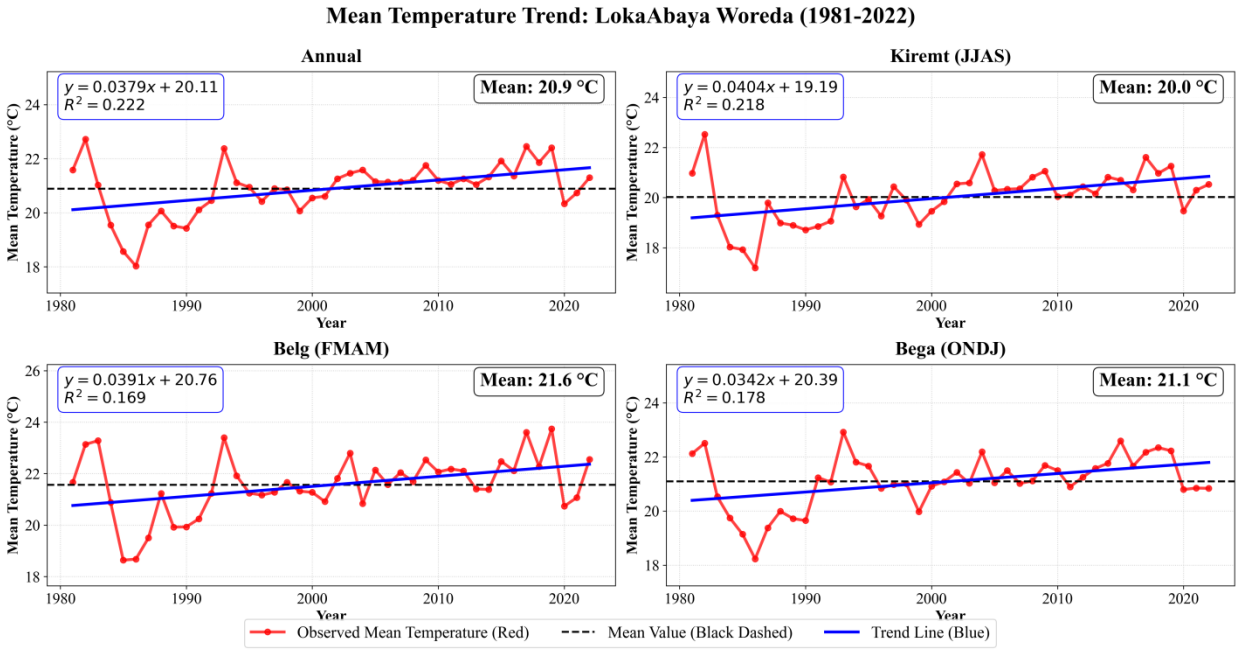


Figure 11: Loka Abaya Mean temperature for different seasons

This figure shows the mean temperature trend in Loka Abaya Woreda from 1981–2022, including annual temperature and the three seasonal periods: Kiremt (JJAS), Belg (FMAM), and Bega (ONDJ).

Table 19: Mean Temperature trend for different seasons

Period	Mean Temperature	Trend (°C/year)	R^2	Approx. increase, 1981–2022
Annual	20.9°C	+0.0379	0.222	+1.55°C
Kiremt (JJAS)	20.0°C	+0.0404	0.218	+1.66°C
Belg (FMAM)	21.6°C	+0.0391	0.169	+1.60°C
Bega (ONDJ)	21.1°C	+0.0342	0.178	+1.40°C

Annual mean temperature

The annual trend equation is:

y = 0.0379x + 20.11

This indicates an increase of approximately 0.038°C per year. Over the 1981–2022 period, this corresponds to approximately 1.55°C warming. The $R^2 = 0.222$, meaning that about 22.2% of the variation in annual mean temperature is explained by the linear time trend. The average annual temperature was **20.9°C**.

Kiremt (JJAS)

Kiremt has the trend:

y = 0.0404x + 19.19

This is the highest warming rate among the four periods, at approximately 0.0404°C per year, equivalent to about 1.66°C over the study period. The $R^2 = 0.218$, indicating that about 21.8% of temperature variability is associated with the long-term trend. Mean Kiremt temperature is 20.0°C.

Belg (FMAM)

Belg shows:

y = 0.0391x + 20.76

The trend corresponds to approximately 0.0391°C/year or about 1.60°C over 1981–2022. The R^2 is 0.169, so approximately 16.9% of the variation explained by the trend. Belg has the highest mean temperature, at 21.6°C.

Bega (ONDJ)

Bega shows:

y = 0.0342x + 20.39

This indicates warming of approximately 0.0342°C per year, equivalent to around 1.40°C over the study period. The R^2 is 0.178, meaning approximately 17.8% of the variation explained by the linear trend. Mean Bega temperature is 21.1°C. The most important feature of this figure is that all four periods show positive warming trends.

Unlike the maximum-temperature figure, where the trends were very weak, the mean temperature shows a consistent warming tendency across all seasons.

The R^2 values (0.169–0.222) also indicate that the trends explain a meaningful, although not dominant, portion of the observed year-to-year variability.

Temperature indicator	Annual trend
Maximum temperature	+0.0054°C/year
Mean temperature	+0.0379°C/year
Minimum temperature	+0.0704°C/year

This shows that minimum temperature is increasing much faster than maximum temperature.

Therefore, the warming in Loka Abaya appears to be particularly pronounced in minimum/nighttime temperatures. The mean temperature also shows a consistent warming trend, reflecting the combined influence of increasing minimum and maximum temperatures.

The analysis of mean temperature in Loka Abaya Woreda for the period 1981–2022 indicates a consistent warming trend across annual and seasonal periods. Annual mean temperature increased at a rate of 0.0379°C per year, corresponding to an estimated warming of approximately 1.55°C over the study period. Kiremt recorded the highest rate of warming at 0.0404°C per year, followed by Belg at 0.0391°C per year and Bega at 0.0342°C per year. The corresponding R^2 values ranged from 0.169 to 0.222, indicating that the long-term trends explain approximately 17–22% of the observed temperature variability. Overall, the results demonstrate a consistent warming tendency across LokaAbaya Woreda, with Kiremt experiencing the strongest increase in mean temperature. When considered together with the maximum and minimum temperature analyses, the results indicate that warming has been particularly noticeable in minimum temperatures, suggesting a substantial increase in nighttime and cooler-period temperatures over the study period.

Annual and seasonal rainfall trends for LokaAbaya Woreda from 1981–2022.

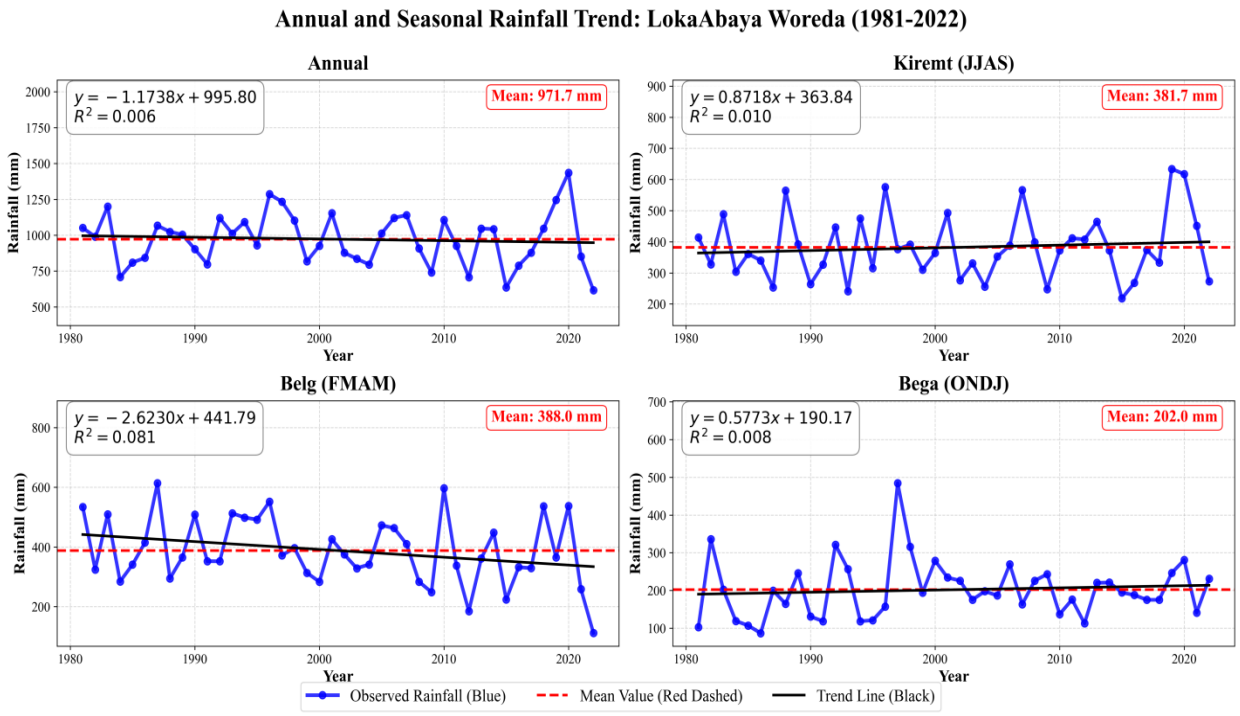


Figure 12 Loka Abaya Rainfall trend for different seasons

The above figure shows that the analysis indicates that rainfall is highly variable from year to year, while the long-term linear trends are generally weak.

Annual rainfall trend

The mean annual rainfall is approximately 971.7 mm.

The trend equation is:

$$y = -1.1738x + 995.80$$

The negative slope (−1.17 mm/year) indicates a slight long-term decline in annual rainfall.

Over the 41-year interval from 1981 to 2022, this corresponds to an approximate decline of 48 mm.

However, the R^2 is 0.006, which is extremely low. This means that the linear trend explains only about 0.6% of the variation in annual rainfall. Therefore, the apparent decline should interpreted as weak and statistically uncertain based on the trend line alone.

The graph also shows considerable interannual variability, with some years receiving substantially more or less rainfall than the long-term mean.

Kiremt rainfall trend (JJAS)

Kiremt is the major rainy season. Mean Kiremt rainfall is 381.7 mm

Trend equation:

$y = 0.8718x + 363.84$

The positive slope (+0.87 mm/year) suggests a slight increase in Kiremt rainfall. Across 1981–2022, the fitted increase is approximately 36 mm. However, R^2 is 0.010, meaning the trend explains only about 1.0% of rainfall variability. Thus, Kiremt rainfall shows a very weak increasing tendency, while year-to-year variability remains much stronger than the long-term trend. There are several years with exceptionally high Kiremt rainfall, particularly around 1988, 1997, and 2019–2020, while some years experienced relatively low rainfall.

Belg rainfall trend (FMAM)

Belg rainfall shows the clearest negative tendency among the seasons. Mean Belg rainfall: 388.0 mm

Trend equation:

$y = -2.6230x + 441.79$

The slope of −2.62 mm/year indicates a decline in Belg rainfall. Over 1981–2022, the fitted decline is approximately 108 mm. R^2 is 0.081, meaning the trend explains about 8.1% of the variation.

Compared with the other periods, Belg has the strongest decreasing trend. Nevertheless, the R^2 remains relatively low, so substantial interannual variability exists.

The graph particularly shows relatively low Belg rainfall in some recent years, including **2022**, when rainfall was around **100 mm**, compared with several earlier years when Belg rainfall exceeded 500–600 mm.

Bega rainfall trend (ONDJ)

Bega is the dry-season period. Mean Bega rainfall: 202.0 mm

Trend equation:

$y = 0.5773x + 190.17$

The positive slope (+0.58 mm/year) indicates a very slight increasing tendency. The fitted increase from 1981 to 2022 is approximately 24 mm. However, R^2 is 0.008, indicating that only 0.8% of the variation is explain by the trend. Therefore, Bega rainfall has no strong long-term linear trend, although substantial fluctuations occur between years.

Table 20 Loka Abaya rainfall trend

Rainfall period	Mean rainfall	Trend	Approx. change, 1981–2022	R^2	Interpretation
Annual	971.7 mm	−1.17 mm/year	−48 mm	0.006	Very weak decline
Kiremt (JJAS)	381.7 mm	+0.87 mm/year	+36 mm	0.010	Very weak increase
Belg (FMAM)	388.0 mm	−2.62 mm/year	−108 mm	0.081	Strongest declining tendency
Bega (ONDJ)	202.0 mm	+0.58 mm/year	+24 mm	0.008	Very weak increase

The most important feature of the rainfall record is not a strong overall linear trend, but rather substantial year-to-year variability. Annual rainfall shows a slight declining tendency, which appears to be influenced particularly by the decline in Belg rainfall. In contrast, Kiremt and Bega rainfall show slight increasing tendencies, but these increases are very weak.

The low R^2 values for all four rainfall periods indicate that time alone does not explain much of the observed rainfall variability. Other factors, including atmospheric circulation, ENSO, Indian Ocean Dipole (IOD), local topography, and other climate processes, may contribute substantially to the observed fluctuations.

For Loka Abaya, the results suggest that rainfall change is characterize more by increasing variability and seasonal redistribution than by a consistent long-term decline in all seasons. The decline in Belg rainfall is particularly important because changes in the timing and amount of seasonal rainfall can affect crop production, soil moisture, water availability, groundwater recharge, and ecosystem conditions, even when total annual rainfall does not show a strong statistical trend.

Rainfall analysis for Loka Abaya during 1981–2022 indicates substantial interannual variability in both annual and seasonal rainfall. Mean annual rainfall was approximately 971.7 mm and exhibited a slight declining trend of 1.17 mm/year, although the very low R^2 value (0.006) indicates that the linear trend explains only a negligible proportion of the observed variability. Kiremt rainfall had a mean of 381.7 mm and showed a weak increasing trend of 0.87 mm/year ($R^2 = 0.010$), while Bega rainfall also showed a very weak increasing tendency of 0.58 mm/year ($R^2 = 0.008$). In contrast, Belg rainfall exhibited the strongest declining tendency, decreasing at approximately 2.62 mm/year, equivalent to about 108 mm over the study period, with an R^2 of 0.081. Overall, the findings suggest that rainfall variability in Loka Abaya is more pronounce than the long-term linear trend, with the decline in Belg rainfall potentially contributing to the slight reduction in annual rainfall. These seasonal changes may have implications for agricultural water availability, crop production, soil moisture, and ecosystem functioning.

Seasonal and Annual Mean Temperature Anomalies for Loka Abaya (1981–2022)

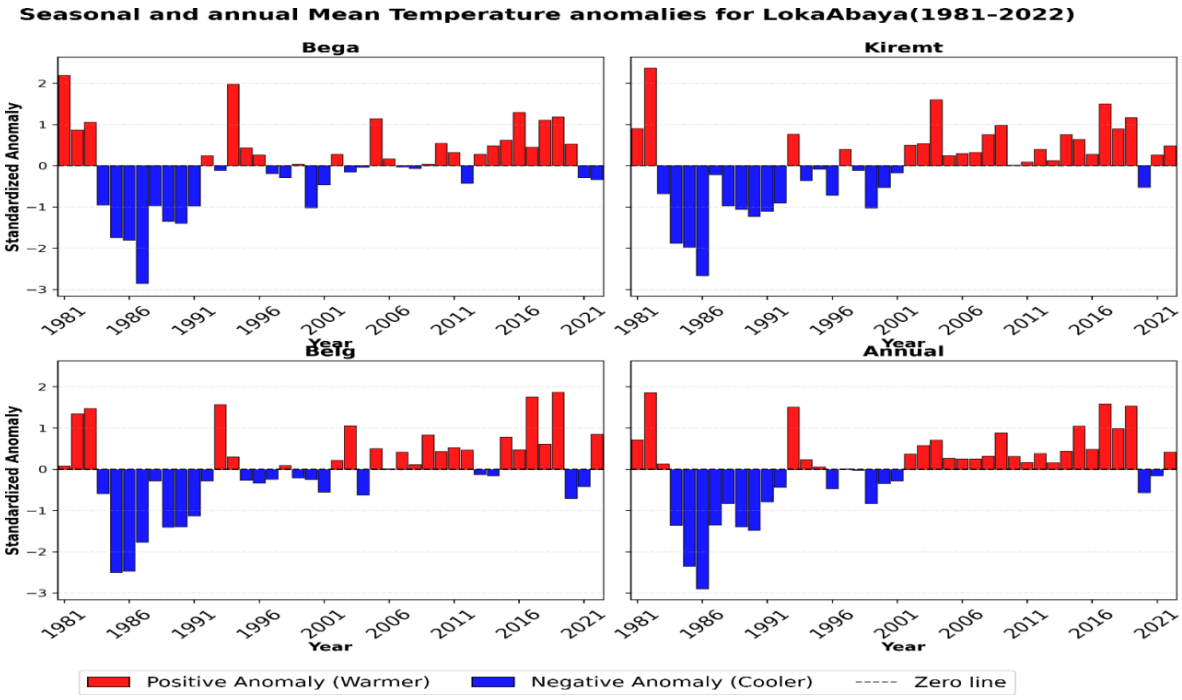


Figure 13: Loka Abya Mean Temperature anomalies for different seasons

The above figure shows standardized temperature anomalies for three seasons Bega, Kiremt, and Belg and for the annual mean temperature from 1981 to 2022. Red bars represent warmer-than-average conditions (positive anomalies), while blue bars represent cooler-than-average conditions (negative anomalies).

Overall temperature trend

The most important feature of the figure is a clear shift from predominantly negative temperature anomalies in the 1980s to predominantly positive anomalies after about 2000.During the early and mid-1980s, Loka Abaya experienced mostly negative anomalies, indicating relatively cooler conditions. The strongest cooling occurred around 1985–1987, particularly in the annual and Belg seasons. The annual anomaly reaches approximately −3-standardized units around 1986. From the 1990s onward, temperature conditions became more variable, with alternating warm and cool years. After approximately 2000, positive anomalies become increasingly frequent. The period 2014–2019 is particularly notable for persistent warm conditions. The recent years show some variability, including cooler anomalies around 2020–2021, followed by a return to warmer

conditions in 2022. Overall, the figure provides evidence of long-term warming accompanied by considerable year-to-year variability.

Bega season

The Bega panel shows a substantial change over time. The beginning of the record contains several positive anomalies, especially in 1981–1983. This is follow a long period of predominantly negative anomalies from approximately 1984 to 1990. The strongest Bega cooling occurs around 1986, with an anomaly close to −3. Around 1992, a strong positive anomaly appears. After 2000, positive anomalies become more common. Particularly warm Bega conditions occur around 2004 and 2014–2019. The strongest recent positive values appear around 2015–2017, while 2020–2022 show a return toward cooler conditions

Kiremt season

The Kiremt season also demonstrates a strong warming transition. The early 1980s contain positive anomalies, followed by predominantly negative anomalies during approximately 1984–1990. The largest negative anomaly occurs around 1986, reaching approximately −2.7. The 1990s show relatively mixed conditions. From around 2000 on ward, positive anomalies become increasingly frequent. Strong warming is visible around 2002, 2005, and especially 2016–2018.A cooler anomaly appears around 2020, followed by warmer conditions in 2021–2022.

Belg season

The Belg panel shows a similar but particularly pronounced pattern. Strong negative anomalies dominate much of the 1980s. The coldest Belg conditions occur around 1985–1987, with anomalies below −2 and approaching −2.5 in some years. A strong positive anomaly occurs around 1992. During the late 1990s, anomalies are mostly slightly negative. After 2000, positive anomalies become much more frequent. The period 2014–2019 shows particularly strong warming, with some anomalies approaching +2. Cooler conditions return around 2020–2021, followed by a positive anomaly in 2022.

Annual temperature anomalies

During approximately 1981–1990, annual anomalies are predominantly negative. The most pronounced annual cooling occurs around 1985–1987, when anomalies reach approximately −2 to −3. From the 1990s, the pattern becomes more variable. However, beginning around 2000, positive anomalies become increasingly dominant. The period from approximately 2014 to 2019 stands out as a particularly warm period, with several consecutive years showing positive anomalies. The highest annual anomalies appear around 2016–2018, reaching approximately +1.5 to +1.6 standardized units. The years 2020–2021 show a temporary return to negative anomalies, but 2022 becomes positive again.

The temperature anomaly record for Loka Abaya from 1981–2022 indicates a clear shift toward warmer conditions over time. The 1980s were characterize by persistent and sometimes severe negative temperature anomalies, whereas the period after 2000 particularly 2014–2019 was dominate by positive anomalies. This pattern occurs across Bega, Kiremt, Belg, and annual temperatures, suggesting that warming is not restricted to one particular season.

However, the warming trend is not uniform every year. Cooler years, such as 2020 and 2021, still occur, demonstrating substantial interannual variability. Therefore, the figure suggests long-term warming superimposed on short-term temperature fluctuations.

The analysis of standardized seasonal and annual temperature anomalies for Loka Abaya during 1981–2022 indicates a distinct shift toward warmer climatic conditions. The 1980s were characterize predominantly negative temperature anomalies, with particularly strong cooling during 1985–1987 across Bega, Kiremt, Belg, and annual temperatures. From the 1990s onward, temperature variability increased, followed by a progressive dominance of positive anomalies after 2000. The strongest and most persistent warming occurred during approximately 2014–2019, when positive anomalies were observe across all seasons and in the annual mean. Although relatively cooler conditions occurred in 2020–2021, the positive anomaly recorded in 2022 indicates a return to warmer conditions. Overall, the results indicate a long-term warming tendency in Loka Abaya, accompanied by considerable interannual and seasonal variability.

Seasonal and Annual Rainfall Anomalies for Loka Abaya (1981–2022)

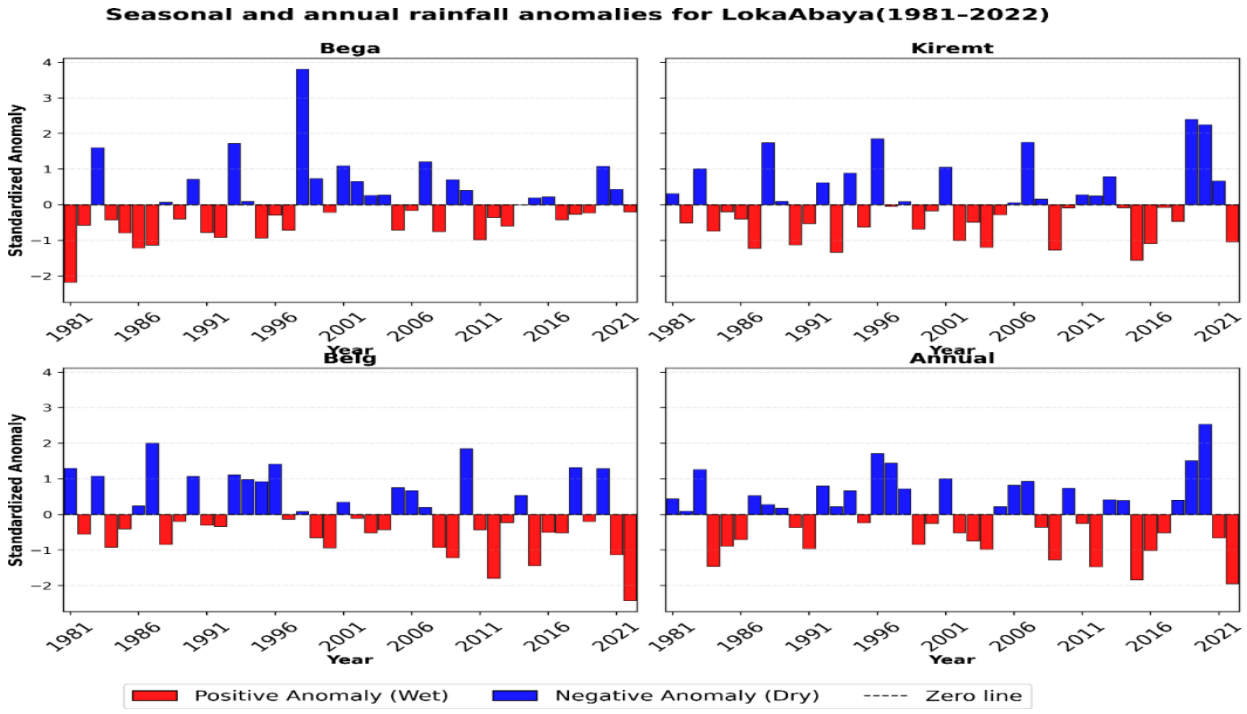


Figure 14 Loka Abya rainfall anomalies for different seasons

The figure presents standardized rainfall anomalies for the Bega, Kiremt, Belg, and annual periods from 1981–2022. According to the legend, red indicates positive rainfall anomalies (wetter conditions), while blue indicates negative rainfall anomalies (drier conditions). The dashed line represents normal rainfall conditions.

Overall rainfall pattern

The figure indicates strong year-to-year variability in rainfall, with alternating wet and dry years across all seasons. Unlike the temperature figure, the rainfall series does not show a simple, consistent long-term increase or decrease. Instead, the dominant feature is high interannual variability, with several periods of rainfall deficits and occasional extreme wet years.

A particularly important feature is the occurrence of strong dry anomalies in some years and strong wet anomalies in others, suggesting increasing rainfall irregularity rather than a uniform rainfall trend.

Bega rainfall

The Bega season shows substantial variability: 1981 experienced a strong negative anomaly, indicating a very dry Bega season. The mid-1980s were characterize mainly by negative anomalies, suggesting relatively dry conditions. Strong positive anomalies occurred around 1982, 1992, and especially 1997. The anomaly around 1997 is the strongest Bega positive anomaly, reaching approximately +3.8 standardized units, indicating an exceptionally wet year. The early 2000s show several positive anomalies, although dry years also occur. Around 2010–2013, negative anomalies become more frequent. The later period shows mixed conditions, with a notable positive anomaly around 2020, followed by relatively small anomalies in 2021–2022. Bega rainfall is highly variable, with alternating wet and dry conditions rather than a clear directional trend.

Kiremt rainfall

Kiremt also demonstrates considerable rainfall variability. The early 1980s contain both wet and dry conditions. Several dry anomalies occur during the mid-to-late 1980s. Positive anomalies appear in 1988, 1992, 1994, and 1996. The late 1990s and early 2000s are relatively mixed. A strong positive anomaly occurs around 2006. A notable dry period occurs around 2014–2016, with approximately 2015 showing a strong negative anomaly. The most striking feature is the strong positive rainfall anomaly around 2019–2020, reaching more than +2 standardized units. Rainfall becomes negative again in 2022. Kiremt rainfall exhibits strong interannual fluctuations, including episodes of both severe dryness and unusually wet conditions. The recent extreme wet period is particularly important.

Belg rainfall

Belg shows a somewhat different pattern from Bega and Kiremt. The early 1980s include several positive rainfall anomalies. A strong wet anomaly occurs around 1986, reaching approximately +2. The early-to-mid 1990s contain several consecutive positive anomalies. Around 1998–2002, negative anomalies become more frequent. A strong wet anomaly occurs around 2010, approximately +1.8. The period around 2011–2015 contains several strong negative anomalies, indicating relatively dry Belg conditions. Another relatively wet period occurs around 2018–2020.

The strongest negative Belg anomaly occurs around 2022, reaching approximately −2.5, indicating an exceptionally dry Belg season. Belg rainfall has experienced pronounced fluctuations, with particularly important dry conditions during parts of 2011–2015 and 2022.

Annual rainfall anomalies

The annual rainfall panel provides the clearest representation of overall rainfall variability. From 1981–1990: Variable but relatively dry the period contains both wet and dry years, but several negative anomalies indicate rainfall deficits, particularly during the mid-1980s. From 1991–1997: Relatively wet and variable several positive anomalies occur, culminating in strong positive rainfall around 1995–1996. From 1998–2005: More frequent rainfall deficits Negative anomalies become more common, although some wet years interrupt the dry conditions. From 2006–2010: Mixed conditions There are several positive rainfall anomalies, particularly around 2006–2007 and 2010, but dry years are also present. From 2011–2016: Predominantly dry this is one of the more important dry periods in the record. Several years show negative annual rainfall anomalies, with particularly strong deficits around 2012–2015. From 2017–2020: Strong wet period the rainfall pattern changes substantially. Positive anomalies become dominant, with 2019–2020 showing exceptionally high rainfall anomalies. The peak appears around 2020 at approximately +2.5 standardized units. From 2021–2022: Return to dry conditions the positive period is follow by negative anomalies, particularly in 2021–2022, indicating renewed rainfall deficits.

Important extreme rainfall years

Period/Year	Main condition	Approximate anomaly	Significance
1981	Bega dry	−2.1	Strong rainfall deficit
1986	Belg wet	+2.0	Very wet Belg
1997	Bega wet	+3.8	**Extreme wet anomaly**
2012–2015	Annual/seasonal dry	~−1 to −2	Important dry period
2015	Kiremt dry	~−1.5	Strong Kiremt deficit

Period/Year	Main condition	Approximate anomaly	Significance
2019–2020	Kiremt/Annual wet	>+2	**Exceptional wet period**
2022	Belg dry	~−2.5	**Very strong dry anomaly**

The most important conclusion from this figure is that Loka Abaya's rainfall does not exhibit a straight forward linear trend over 1981–2022. Instead, rainfall is characterize by:

- High interannual variability
- Alternating wet and dry periods
- Occasional extreme rainfall anomalies
- Pronounced seasonal differences
- Recent episodes of both extreme wetness and dryness

For example, the very wet period around 2019–2020 is followed by negative anomalies in the subsequent years. Similarly, the relatively dry period around 2011–2016 demonstrates that rainfall deficits can persist for several years.

Temperature: Increasing tendency toward warmer conditions, particularly after 2000.

Rainfall: Strong variability, with alternating wet and dry periods rather than a clear linear trend.

Therefore, Loka Abaya appears to be experiencing a combination of long-term warming and increasingly variable rainfall conditions. This combination can increase climate-related risks because warmer temperatures can increase evaporation and water demand, while irregular rainfall can make water availability less predictable.

The analysis of seasonal and annual rainfall anomalies in Loka Abaya from 1981 to 2022 reveals substantial interannual and seasonal variability, characterized by alternating wet and dry conditions. The rainfall record does not show a consistent linear trend but rather a sequence of relatively dry and wet periods. The mid-1980s were characterized by several rainfall deficits, while exceptionally wet conditions occurred in some years, including the strong Bega anomaly in 1997 and the pronounced Kiremt and annual rainfall anomalies around 2019–2020. A relatively dry

period is evident during approximately 2011–2016, while 2022 was characterize by a particularly strong negative Belg anomaly. Overall, the results indicate that rainfall variability and the occurrence of extreme wet and dry years are major characteristics of the climate of Loka Abaya. When considered together with the observed warming tendency, the rainfall variability may increase pressure on water resources, agriculture, wetlands, and ecosystem services, particularly during consecutive dry periods.

2.4.2. Driver and pressure for climate change/ Variability on the Loka AbayaWetland Ecosystem

Deforestation

During FGD Participants identified deforestation and changes in land use as important factors contributing to environmental degradation and increasing local vulnerability to climate change. They explained that, in the past, the area had extensive natural forest cover but due to increasing the demand for fuelwood, construction materials, and agricultural land. When trees and other vegetation around wetlands removed causes increasing local surface temperatures, Evaporation can increase Soil moisture decreases, Carbon stored in vegetation, and soil can be release as CO_2.

Agricultural expansion

Increasing population pressure has resulted in the expansion of agricultural land, settlement areas, and demand for fuelwood. The conversion of forest and other natural areas to farmland and residential areas has reduced vegetation cover and weakened the ecosystem's capacity to retain water and regulate local environmental conditions. Most part of Loka Abaya wetland converted into cropland or grazing land. Even as FGD participants explained that 1000ha part of the wet land, give to Belyne Kende for large agricultural investment. This can make wetlands drier and more vulnerable to high temperatures and rainfall variability.

Population growth

Increased demand for land, water, food, energy, and housing leads to land-use change and resource pressure and leads to changes in wetland hydrology, vegetation, temperature, and greenhouse-gas emissions.

Over grazing

During FGD, the community told us they have on average 30 livestock is this cause over grazing can remove vegetation cover, compact soil, and increase erosion, reduce infiltration of rainfall increase runoff and sediment entering wetlands. These changes can reduce the wetland's ability to retain water.



Table 21: Grazing on the Loka AbayaWetland ecosystem

Source: Field observation

2.4.3. Impact of climate change/variability on the Loka AbayaWetland ecosystem

Wetlands are important as they reduce the impact of floods, control pollution, and regulate climate (Vikrant Balkrishna Berde, 2022). Community members described substantial changes in the timing, amount, and distribution of rainfall. In the past, the main rainy season was generally expect to occur from April to August, providing relatively predictable conditions for agricultural activities. However, participants reported that rainfall has declined in recent years and has become increasingly

irregular. Rainfall no longer consistently begins or continues during the historically expected period, creating difficulties for farmers in planning agricultural activities.

The community also reported a significant decline in local water availability. Participants recalled that ponds were previously common in the area and served as important sources of water, but many of these ponds have now disappeared or dried up. The loss of ponds, combined with reduced and irregular rainfall, has increased pressure on water resources for households, livestock, and agricultural production.

Changes in climate and rainfall patterns have directly affected agricultural production and seasonal farming activities. Community members reported that the timing of planting and harvesting has changed considerably, making traditional agricultural calendars less reliable. For example, soybean was previously planting around July; however, due to changes in rainfall patterns and climatic conditions, planting during this period is no longer consistently possible.

Participants further indicated that prolonged dry conditions have contributed to declining agricultural productivity, increased crop losses, and greater livelihood insecurity. Farmers who depend primarily on rain-fed agriculture are particularly vulnerable because irregular rainfall and prolonged dry periods reduce crop growth and make agricultural planning more difficult.

The FGD participants reported that drought has become more frequent and persistent. In the past, they described drought as an event that might occur approximately once a year, whereas in recent years, dry conditions have persisted for consecutive years, with the community-experiencing drought for approximately four successive years. This prolonged drought has increased household vulnerability and dependence on external assistance.

Because of the prolonged drought, the number of people receiving safety-net assistance in Felka Kebele reportedly increased from approximately 249 to 700 people. This increase illustrates the growing pressure that climate-related shocks are placing on household food security and livelihoods.

The drought has also had serious consequences for livestock. Community members reported that approximately 50 livestock died during the recent drought, reflecting the effects of inadequate

pasture and water availability. Since livestock are an important source of food, income, and household assets, livestock losses further reduce the resilience of affected households.

Participants also associated changing climatic conditions with increasing health risks. They reported the occurrence or perceived increase of diseases such as malaria and respiratory illnesses. Changes in temperature, rainfall patterns, water availability, and environmental conditions may contribute to changing patterns of disease exposure and transmission. The community therefore viewed climate change not only as an environmental and agricultural issue but also as an emerging public health concern.

Although drought was identify as one of the most significant climate-related hazards, participants also reported an increase in heavy rainfall events and flooding. They provided a recent example from April 2026, when heavy rainfall resulted in flooding that caused substantial damage to housing.

According to the FGD participants, the April 2026 flood completely destroyed five houses and damaged or destroyed three temporary/tent houses. This event demonstrates the increasing exposure of households to climate-related hazards and highlights the need for stronger disaster preparedness, resilient housing, improved drainage, and effective early-warning and response mechanisms.

2.4.4 Response for climate change/ variability

The community reported that local government officials at the Woreda and Kebele levels have been conducting awareness-raising activities to increase community understanding of climate change, environmental degradation, and appropriate response measures. These activities are intend to encourage community participation in environmental protection and climate adaptation.

Community members also reported that participating in tree-planting and environmental restoration activities due to green legacy initiative. In 2025, local leaders and the community reportedly worked together to plant approximately 300 trees as part of efforts to restore vegetation cover and reduce environmental degradation. Such community-based actions are important for

improving ecosystem resilience, reducing soil degradation, restoring vegetation, and strengthening local adaptation to climate variability.

Overall, the FGD findings indicate that the community is experiencing multiple and interconnected climate-related changes, including increasing temperatures, declining and increasingly variable rainfall, prolonged droughts, loss of surface water sources, changes in agricultural seasons, crop and livestock losses, increased health concerns, and occasional destructive floods. These impacts are compound by deforestation, population growth, agricultural expansion, settlement development, and increasing demand for fuelwood, which have reduced natural vegetation cover and increased the vulnerability of local communities and ecosystems.

The findings also demonstrate that climate change is affecting not only the physical environment but also food security, household income, livestock production, water availability, public health, housing, and the need for social protection. Strengthening local adaptation therefore requires an integrated approach that combines forest and watershed restoration, sustainable land management, climate-smart agriculture, water harvesting and conservation, drought-resilient livelihoods, livestock management, disaster preparedness, early-warning systems, and continued community-based awareness and tree-planting initiatives.

2.4.5 Outlook for climate change /variability on the Loka Abya wetland

The analyses of annual and monthly maximum temperature, annual and monthly minimum temperature, and annual rainfall collectively indicate that the study area is experiencing noticeable climatic changes characterized by rising temperatures and slightly declining rainfall. The annual maximum temperature exhibits an increasing trend of approximately 0.038°C per year, while the annual minimum temperature shows a more pronounced increase of about 0.102°C per year, suggesting that nighttime warming is occurring faster than daytime warming. In contrast, annual rainfall demonstrates a slight declining trend accompanied by high interannual variability, including extreme drought years and irregular rainfall distribution.

These climatic trends have important implications for the future condition of wetlands. Continued warming expected to increase evapotranspiration rates, resulting in greater water loss from wetland

ecosystems. At the same time, declining rainfall will reduce surface runoff, groundwater recharge, and the duration of seasonal inundation. Together, these processes are likely to accelerate wetland shrinkage, lower water tables, and reduce the capacity of wetlands to provide essential ecosystem services.

The combined effects of climate change and anthropogenic activities, including agricultural expansion, drainage, deforestation, and unsustainable water abstraction, are likely to further accelerate wetland degradation. This may result in declining biodiversity, deterioration of water quality, increased greenhouse gas emissions from drying wetland soils, and reduced ecosystem resilience. Consequently, wetlands may lose their ability to regulate floods, recharge groundwater, store carbon, and support local livelihoods.

Despite these challenges, proactive conservation and climate adaptation measures can improve the resilience of wetland ecosystems. Restoration of degraded wetlands, protection of riparian buffer zones, integrated watershed management, sustainable agricultural practices, and efficient water-use technologies can reduce the impacts of climate variability. Strengthening community participation, improving environmental governance, and integrating climate adaptation into land-use planning will also be essential for safeguarding wetlands.

Overall, the climate outlook for Loka Abaya indicates a warmer and increasingly uncertain climate environment, rather than simply a uniformly drier one. Temperature records provide relatively strong evidence of warming, particularly in minimum temperatures, while rainfall records show substantial interannual variability and seasonal changes with no strong overall linear trend. The combination of warming, rainfall irregularity, prolonged drought episodes, occasional heavy rainfall and flooding and continued human pressure on the wetland is likely to increase the vulnerability of the Loka Abaya Wetland ecosystem.

Therefore, the principal future concern is not necessarily a continuous decline in annual rainfall, but rather greater uncertainty in when, where, and how much rainfall occurs, occurring alongside increasing temperatures and declining ecosystem resilience. If land degradation and wetland conversion continue, relatively moderate climatic changes could produce disproportionately large impacts on water availability, agriculture, biodiversity, and local livelihoods. Conversely,

protecting the remaining wetland, restoring degraded catchments, improving water retention, strengthening climate-smart livelihoods, and maintaining community participation could substantially increase the wetland's capacity to withstand future climate variability.

2.5 Water

2.4.1 State and Trend of Water Availability in the Loka Abayawetland ecosystem

Water is consider the solution of life in the world. It would not be an overemphasis to say that without effective water resource management, the world's social and economic development will be severely constrained or even threatened in the future. Both developed and developing countries need to implement more effective water management policies and practices for better water quality and ensure the availability of water in nature (UNEP, 2010). Water is one among the foremost, important, and most precious natural resources. Without it, there would be no life on earth. It is essential to the survival of civilization. However, the majority of people in the globe, mostly in Africa and Asia, do not have access to better water supplies or sanitation services (WHO/UNICEF, 2017). Sub-Saharan African countries are at the front of the water scarcity problem, one among which is Ethiopia, despite the fact that the country has abundant groundwater, major lakes, and large volumes of rainfall (WHO and UNICEF, 2019).

According to Prasifka (1994), water covers about three-quarters of the earth's surface. However, it is worth noting that freshwater is unevenly distribute across the world. To illustrate, only the Amazon River carries one-fifth of the water discharged by all the world's rivers. The Amazon is theoretically enough to supply twice the worlds freshwater needs. The great river of China, Yangtze Kiang, has enough water to supply every person on the planet with about 500 liters of water in a day. As water is nowadays a limiting factor for the socio-economic development of any country, international, regional, and local conflicts overutilization of water are increasing significantly. In addition to the impact of global change on water resources in the world due to increasing demand, excessive water extraction from underground aquifers and rapid population growth are among these problems.

Although the increase in water demand in agricultural production has been of great concern worldwide in recent years, water professionals and development experts ignore the provision of

water for energy production. Sustainable development and advanced economic growth, sanitation, wastewater treatment, and water supply cannot be achieve without adequate energy resources, especially in developing countries. Similarly, it is not possible to produce electricity on a large scale without large quantities of water (Asit, 2008).

According to WWAP (2012), water management is not only a technical term but also encompasses various scientific disciplines and activities. It requires a combination of practices and measures, including policies, regulations, principles, prices, and other incentives, and changes in physical infrastructure and facilities. Integrated Water Resources Management (IWRM), which is intensively voice nowadays, focuses on the necessary integration of water management between sectors, policies, and institutions. These can divided into three categories: Management of resources, Management of water services, and Management the necessary balance between supply and demand. Management of water resources refers to the management of rivers, lakes, and groundwater. It includes water allocation, assessment and protection from pollution, natural and manufactured infrastructure, and groundwater discharge to maintain, distribute and store water-related ecosystems and water quality. Water service management extends from the water supplier to the end user's demand. Management of balancing supply and demand also involves a wide range of socio-economic interests, administrative activities related to allocation, authorization, and agreements (Tortajada and Biswas, 2009).

A chain of lakes varying in size, hydrological and hydrogeological setting characterizes the Ethiopian Rift. Some of the lakes and tributary rivers are use for irrigation, soda abstraction, commercial fish farming and recreation; and they support a wide variety of endemic birds and wild animals. Few lakes shrunk due to excessive abstraction of water; others expanded due to increase in surface runoff and groundwater flux from percolated irrigation water. Excessive land degradation, deforestation and over-irrigation resulted in sedimentation in lakes and increase in soil salinity. Water is essential to sustain life, and a satisfactory (adequate, safe, and accessible) supply of drinking water should be available to all (Okorafor et al., 2012, Mboto et al., 2019). Improving access to safe drinking water may result in tangible benefits to health. So that, every effort should be made to achieve drinking water that is as safe as practicable (WHO, 2017). The availability and accessibility of good water quality is crucial for both social and economic growth, as well as for ensuring public health, environmental protection, and sustainable development (WHO, 2008).

Lack of safe water remains one of the world's most urgent health issues. People in developing countries have no access to safe and adequate drinking water despite access to safe drinking water is a global priority agenda. In 2015, it was estimated that 56% of the world's population had an unsafe water source.

Ethiopia has the lowest water supply and sanitation coverage (WHO and UNICEF, 2019). Ethiopia is one of the developing countries in Sub-Saharan Africa, facing most of the common challenges in providing water services to its citizens. According to data from WHO and UNICEF estimated in 2015, only 11% of the total population had access to improved water supply, 59% had access to unimproved sanitation (WHO/UNICEF, 2017). Safely managed beverage services are improved sources accessible to the premises, available when needed, and free from fecal and specify chemical contamination (WHO and UNICEF, 2019).

According to report by the Central Statistical Agency of Ethiopia (2017), nationally 13 percent of the population is consider using safely managed services (CSA, 2017). Limited access to drinking water services continues to be a major public health problem in Ethiopia.

In Ethiopia, provision of safe, accessible, and reliable water is very critical. In rural areas of Ethiopia during 2016, 4% have safely managed services, 30% have basic services, and 26% have limited services. This leaves 40% of the country's rural population with unimproved water services. According to Ministry of Water, Irrigation and Electricity (MoWIE) estimates, rural water supply coverage reached 63% by mid-2016 (or 57% according to the Ethiopian Demographic and Health Survey 2016).Source-based water safety measures and protecting water from cross contamination at point of use are important strategies to improve water quality in the water supply system and to minimize associated health consequences. Source-based interventions include designing and construction of improved source that have the potential to protect water from contamination and deliver safe water; community-driven sanitation to protect pollution of the catchment area from human, animal, and agricultural wastes; and source-based water treatment.

The study was conducted in sidama region Loka AbayaWoreda Loka Abaya ecosystem. The regional state has been striving to provide equal access to safe and affordable drinking water supply for all inhabitants. In 2018 E.C the regional pure water access coverage in urban and rural areas is 58% .According to the data obtained from sidama region water and Mining Office, the percentage

of the worda population with access to safe drinking water is 58 % . The highest demand of water in the worda is population, agriculture and live stocks. The major sources of potable water supply for rural and urban community are natural Tap water, springs, Deep-water burrow, hand dug wells and shallow wells.

2.4.2. Driver and pressure for Water of Water Resource Degradation in the Loka AbayaWetland ecosystem

Population Growth

According to Loka Abaya Woreda water mineral and energy office, the amount of waste water generated from urban area residences and other households increasing from time to time. Construction or increment of rural city development increases runoff and sedimentation, leading to erosion and loss of wetland function these indicate expansion of Urbanization is one of the major causes for massive waste water disposal and sever water degradation in the ecosystem. Agricultural Practices-

Agricultural practices significantly drive water degradation in Loka Abaya wetland ecosystems through several mechanisms. Soil Erosion-poor soil management, such as over-tilling, monoculture, and lack of cover crops, can lead to soil erosion. Sediment runoff can smother aquatic habitats and reduce water quality. Intensive irrigation can deplete local water resources, reducing the availability of water for wetlands and other ecosystems. Over-extraction can also lower groundwater levels, affecting nearby water bodies.

Livestock population -Runoff from livestock operations can introduce pathogens and nutrients into water bodies. Overgrazing can also lead to soil compaction and increased erosion.

Use of Invasive Species-Some agricultural practices promote the use of invasive species, which can out compete native vegetation, alter habitat structures, and negatively impact local water dynamics.

Changes in Land Cover-Converting natural landscapes to agricultural and urban settlement land reduce vegetation cover, impacting water retention and increasing runoff and erosion.

3. Overexploitation of Resources

Overexploitation of resources is a significant driver of water degradation in ecosystems through several key mechanisms:

Excessive Water Withdrawal-over-extraction of groundwater for agricultural, industrial, or domestic use can lower water tables, reducing the flow into rivers, lakes, and wetlands. Excessive withdrawal from surface water sources can lead to reduced stream flow, affecting aquatic habitats and ecosystems that rely on consistent water levels.

Habitat Destruction- resource extraction such as mining, logging, and land conversion for agriculture can lead to habitat loss, disrupting the natural water cycle and diminishing water quality.

Altered Landscapes: Clearing land for resource extraction can lead to increased erosion and sedimentation in nearby water bodies, degrading water quality and aquatic habitats.

Overfishing and Aquatic Resource Harvesting

Overfishing can reduce fish populations and disrupt aquatic ecosystems, leading to imbalances that affect water quality and habitat structure.

Destructive fishing practices can harm the physical environment, leading to further degradation of water quality and habitats.

4. Infrastructure Development -urban development creates impervious surfaces (like roads and buildings) that increase runoff, leading to higher sediment loads and pollutants entering water bodies. Construction activities often disturb soil, leading to increased erosion and sedimentation in nearby rivers and lakes, which can degrade water quality and aquatic habitats. Construction sites can introduce oils, heavy metals, and other pollutants into nearby waterways through storm water runoff.

Disruption of Ecosystems: Infrastructure such as roads, , and urban areas can fragment habitats, limiting wildlife movement and disrupting ecological processes, which can impact water quality and availability.

New infrastructure can facilitate the movement of invasive species, which can out compete native species and disrupt local ecosystems, negatively impacting water quality.

Expanding urban areas typically increase water demand for domestic, industrial, and recreational use, potentially leading to over-extraction of local water resources and degradation of nearby ecosystems.

Infrastructure development often leads to the destruction of wetlands, which play crucial roles in filtering pollutants, absorbing floodwaters, and maintaining water quality.

Loss of vegetation around water bodies reduces the natural filtration capacity, increasing runoff and pollution.

Infrastructure that does not properly manage wastewater can lead to the contamination of local water sources, posing risks to public health and ecosystem integrity

5. Unsustainable Fishing and Harvesting: Overfishing and excessive harvesting of wetland resources can lead to declines in species and ecosystem health.

6. Invasive Species

Invasive alien species (IAS) are non-native organisms that, when introduced to a new environment, can cause significant ecological disruption. They are a major driver of water degradation in ecosystems through several key mechanisms:

Invasive species can introduce new diseases or pests to native populations, further stressing ecosystems and potentially leading to declines in biodiversity and ecosystem health. Invasive species can introduce new predators or competitors that disrupt existing food webs. This can lead to declines in native species that play critical roles in ecosystem functioning, further degrading water quality and habitat integrity. Invasive species often out compete native flora and fauna for resources such as light, nutrients, and space, leading to declines in native populations. This competition can disrupt local ecosystems and alter community structures.

Some invasive aquatic plants can create dense mats that obstruct water flow, affect sedimentation patterns, and reduce light penetration. This can alter aquatic ecosystems, negatively affecting water quality and the organisms that depend on it. Many invasive plants can change the physical environment, such as modifying soil chemistry or water availability. This can lead to changes in hydrology and affect water quality, affecting both aquatic and terrestrial species.

7. Climate Change temperature and precipitation changes altered weather patterns can affect wetland hydrology and biodiversity.

The main pressures on water in wetland ecosystem degradation include:

1. Hydrological Alterations

Water Diversion: Changing natural water flow for agricultural

Can lead to reduced water levels, affecting wetland habitats.

2. Pollution

Nutrient Loading: Runoff from agriculture, urban areas, and industrial sites introduces excess nutrients, leading to eutrophication and harmful algal blooms.

Chemical Contaminants: Pesticides, heavy metals, and pharmaceuticals can contaminate water, harming aquatic life and reducing biodiversity.

3. Sedimentation

Soil Erosion: Land use changes, such as deforestation and agriculture, can increase sediment runoff into wetlands, smothering aquatic plants and degrading habitats.

Urban Runoff: Increased impervious surfaces lead to higher sediment loads in storm water runoff, affecting water quality.

4. Climate Change

Changing Precipitation Patterns: Altered rainfall can lead to periods of flooding or drought, stressing wetland ecosystems.

5. Invasive Species

Competition for Resources: Invasive plants and animals can out compete native species for water and nutrients, degrading habitat quality.

Altered Ecosystem Dynamics: Invasive species can change the structure and function of wetland ecosystems, affecting water retention and quality.

6. Overexploitation

Unsustainable Water Use: Excessive withdrawal for agriculture, industry, or urban development can deplete water resources, stressing wetland ecosystems.

Resource Harvesting: Overfishing and unsustainable harvesting of wetland resources can lead to declines in species and overall ecosystem health.

7. Infrastructure Development

Roads and Canals: These can fragment wetlands, alter hydrology, and disrupt natural water flows, affecting the ecological balance.

Urban Expansion: The encroachment of urban areas can increase pressure on water resources and lead to habitat destruction.

8. Recreational Pressure

Pollution from Activities: Increased human activities such as boating, fishing, and hiking can lead to littering and pollution, degrading water quality.

Habitat Disturbance: Recreational activities can disturb wildlife and damage sensitive wetland areas.

2.4.3. Impact of Water Resource Degradation on the Local Community

Though the region contains a number of perennial rivers of high surface water potential, 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. This is again because most perennial springs and streams exist only in the highlands, whereas there is hardly any surface runoff and perennial springs and streams in areas below 1500 meters above sea level (m.a.sl) that comprise the majority of the region. Even the groundwater, which distributed in the lowlands of the region could not be appropriately developed and utilized because of financial and available technology problems. Such failures in developing and utilizing the region water resources and mismanagement to the sparsely available water have already been reflected as a root cause for overall environmental degradation.

The driving forces for the water quality degradation of the region's surface water resources (Rivers and Lakes) are population growth, agricultural expansion, deforestation, livestock raising,. Loka abaaya Woreda is the one suffering from lack of adequate clean water resource for cattle as well as for human. Flow regime changes cause quicker surface runoff from the catchment which decelerates water infiltration into subsurface layers and decrease the groundwater recharge. As a result, soil erosion and degradation are enhanced resulting in decrease in base flow of the rivers. Due to the degradation of Loka Abaya wetland ecosystems can have significant and far-reaching impacts. Here are some key effects:

1. Water quality decline and reduced source of clean water availability -wetlands act as natural filters, trapping pollutants and sediments. When wetlands degrade, pollutants can enter water bodies unfiltered, leading to higher levels of toxins, nutrients, and pathogens. Poor water quality can lead to health issues for communities relying on surface water sources, increasing healthcare costs.

2. Altered Hydrology

Reduced Water Retention: Wetlands store excess water, helping to mitigate floods. Their degradation can lead to increased runoff and flooding in adjacent areas.

Drought Risk: Loss of wetland areas reduces groundwater recharge, increasing the risk of drought in surrounding regions. As result of these more than 20 water sources areas were dried.

3. Loss of Biodiversity

Habitat Loss: Wetlands provide critical habitats for many species, including fish, birds, and amphibians. Their degradation leads to population declines and potential extinction of sensitive species. The loss of wetland biodiversity affects food webs and ecosystem functions, shortage of drinking clean water for the locale community.

4. Climate Change Effects

Increased Vulnerability: Loss of wetlands exacerbates the impacts of climate change, making the area more susceptible to flooding and extreme weather events or draughts.

5. Social and Economic Impacts-communities that rely on wetland resources for fishing, agriculture, or tourism may experience economic decline as wetland health deteriorates.

6. Exposed for water borne diseases: Due to the loss of water quality by different activities the focus group discussion and key informants told that they are expose to diseases like cholera, diarrhea, bilharzia and other water borne diseases through time. Specifically, women's, children's and animals are going too far distances to get water.

2.4.4 Response for Water to protect water in the Loka Abayawetland ecosystem

In response to water degradation, local communities and Woreda implement some measures aimed at mitigating impacts and restoring water quality. From those measures water shade management (soil and water conservation practices), Lake buffer zone demarcation and development, Community awareness and education programs are often introduce to inform residents about the importance of water conservation and the consequences of degradation.

The outlook for water degradation in Loka Abaya Woreda is increasingly concerning due to rapid population growth, agricultural expansion, urbanization, and climate change. Water bodies are under significant stress from pollution, over extraction, and habitat destruction, leading to decreased, threated water quality and biodiversity loss. Climate change further complicates the situation with altered rainfall patterns and prolonged droughts, affecting water availability and ecosystem health. Rural communities, reliant on these resources face discriminating vulnerability due to health risks and reduced agricultural productivity. Despite these challenges, there is potential for positive change through heightened awareness, community-led conservation, and government initiatives focused on sustainable water management. Strengthening policies and infrastructure, along with fostering community engagement, is vital for reversing degradation trends and enhancing resilience in Ethiopia's water ecosystems.

2.4.5 Outlook

The degradation of wetland ecosystems has profound implications for water quality, biodiversity, climate resilience, and human livelihoods. Protecting and restoring wetlands is essential for maintaining healthy water systems and sustainable ecosystems .Addressing the overexploitation of resources through sustainable management practices is crucial for protecting water quality and ensuring the health of ecosystems. If conditions continues business us usual the Loka AbayaWoreda water problem will aggravate time to time, so that not only the community but also animal will be suffered with water problem. While If implementing conservation strategies, improving resource efficiency, and restoring degraded areas it will help mitigate these impacts. Addressing these pressures is crucial for the conservation and restoration of wetland ecosystems. Sustainable management practices and policies can help mitigate these impacts and promote the resilience of these vital habitats.

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Source data: Loka Abaya Wetland LULC, FGD and Field Observation compilation; SOER/DPSIR indicator matrix; Sentinel-2 derived LULC map produced by SEDSRD GIS (11/09/2026 G.C). Kebele population rows in Table 1 are formatted for insertion of figures from the Loka Abaya Woreda/kebele administration.

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Appendix

Indicator Framework (SOER / DPSIR)

The table below summarizes the Drivers, Pressures, State/Trend, Impact and Response indicators identified for land degradation in the Loka Abaya wetland, as set out in the source indicator matrix.

Drivers	Pressure	State / Trend (indicators)	Impact (indicators)	Response
• Human population growth rate • Animal population growth rate • Deforestation	• Intensive farming activities • Agro-chemical use (fertilizer consumption) • Overgrazing • Deforestation	• % land affected by wind erosion • % land affected by sheet & gully erosion • % land affected by desertification • % land affected by salinization • % land affected by flooding • % area contaminated with chemicals	• Rate of reduction in agricultural productivity • Change in agriculture value added of GDP • Area of abandoned agricultural land	• Conservation strategy and policy • Integrated Watershed Management programme • Resettlement programme • Sustainable Land Management programme

Read across the columns, the table traces a single causal chain: rising human and livestock population combined with deforestation (Drivers) intensify farming, agro-chemical use and overgrazing (Pressure); these pressures register as measurable erosion, desertification, salinization and flooding (State/Trend); which in turn reduce agricultural productivity, shrink GDP contribution and abandon farmland (Impact); prompting the four institutional Response measures — conservation policy, integrated watershed management, resettlement, and Sustainable Land Management — detailed further in Section 8.