THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

ENVIRONMENTAL PROTECTION AUTHORITY

FACT–SHEET OF BUGE WETLAND ECOSYSTEM

IN SOUTH ETHIOPIA 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- Rainfall

T – Temperature

UNEP - United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

UNICEF - United Nations Children's Fund

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 Welayta people (Wolayta or Wolaitta) are one of the most prominent and ancient ethnic groups in southern Ethiopia, possessing a long and rich political and social history that significantly shaped the regional state of "Southern Nations, Nationalities, and Peoples' Region." The Welayta are concentrated in the Welayta Zone, an administrative region that bears their name and is characterized by its high population density and strategic and economic importance stemming from its geographical location and the dynamism of its inhabitants.

The Welayta people have a long history of self-governance prior to their integration into the modern Ethiopian state. The Kingdom of Wolaita was a powerful and well-organized political entity for centuries, ruled by successive dynasties, most notably the Welayta-Mala dynasty and the Tigray dynasty, which ruled until the end of the 19th century.

The kingdom was characterized by a sophisticated centralized administrative system and a well-organized army that was able to protect its borders for extended periods. However, the kingdom's independence ended in 1894 after bloody wars waged by Emperor Menelik II to unify the regions

of Ethiopia. The fall of King Kawo Tona Gaga, the last ruler of the Welayta, was a pivotal moment in their history, as they transitioned from a sovereign entity to part of the Ethiopian Empire, bringing about profound changes in their social and economic structure.

The Welayta people belong linguistically to the Omotic language family, a branch of the Afro-Asiatic languages found exclusively in southwestern Ethiopia. Their language, called Wolaytta, is a means of communication and the vessel that has preserved their oral traditions and customary laws.

Anthropological studies indicate that the Welayta share cultural and linguistic characteristics with neighboring groups such as the Melo, Oyda, and Gamo-Gofa-Dawro, but they maintain a distinct identity stemming from their former royal heritage and rigid social organization.

According to sources:
"The Welayta people use many proverbs. A large collection of them was published in 1987 (Ethiopian calendar) by the Academy of Ethiopian Languages. Fikre Alemayehu's 2012 MA thesis from Addis Ababa University provides an analysis of Wolaytta proverbs and their functions."

"Wolaita people used different type of currencies through their kingdoms for trade purpose. Among them Karetta Sinna and Shalluwa, both of the products of cotton, are the priors. But next to this currencies Wolaita people achieved one of the most important civilizations in the sphere of currency and created a currency made from metal pieces, which is called Marchuwa…"

Welayta society is characterized by a complex social and class system that reflects their long history of exercising power and crafts.

Historically, society is divided into distinct classes. There is the freemen class that owned land and held political and military positions. The specialized castes, which include blacksmiths, tanners, and weavers. Despite the vital role these groups have played in the economy, they have historically faced social marginalization and restrictions on intermarriage with other castes—a sociological pattern common in many Ethiopian highland communities.

The Welayta people are known for their adherence to collective traditions, with music and dance being key elements of their identity. The traditional Welayta dance, characterized by rapid hip and

shoulder movements, is one of the most popular dances in Ethiopia and is performed at national and religious festivals.

Livelihoods in the Welayta region depend almost entirely on mixed farming (crops and livestock). Due to the high population density, the agricultural land there is among the most cultivated and productive in the country.

The enset plant, also known as the false banana, is the primary strategic crop. This plant's stems and roots yield a pulp that, after fermentation, becomes a staple food called kocho. Enset provides food security for the population due to its drought resistance and long shelf life.

The region faces a chronic challenge of land fragmentation. Due to population growth, parents are forced to divide their already small plots of land among their children, reducing production efficiency and driving many young people to migrate to the capital, Addis Ababa, to work in the textile and construction sectors.

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 Welayta Sodo zuriya woreda (2014-2018)

Year.	Rural population			Urban. Population		population on -
	Women	men	total	women	Men	TOTAL
2014	41112	38079	79188	5641	10161	15802
2015	42296	39176	81472	5804	10454	16254
2016	43488	40273	83761	5966	10746	16712
2017	44705	41401	86106	6132	11046	17178
2018	45956	42560	88516	6303	11355	17658

Source:- **Sodo zuriya woreda finance and plan office** *(2019)*

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 buge wetland Ecosystem due to high population the demand for grazing land and agriculture courses the distraction of the ecosystem. Generally

in sodo zuriya woreda the population growth rate is growth rate is 2.8 per year high per year this indicate that 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 Sodo Zuriya *Woreda* for 10 years

NO	Level of School	Students in sodo zuriya Woreda																			
		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	17659	15281	13732	11685	11390	9787	10187	8892	10262	8960	8797	7497	8307	7357	7203	6336	3332	3057	3335	3076
2	Elementary schools dropout	1225	1437	1109	1028	988	892	1021	904	845	749	696	610	420	401	511	366	288	198	511	366
3	Primary School (7-8)	3635	3019	3065	2704	2407	2230	2340	1998	2059	1933	2337	1980	2158	1913	1898	1956	833	819	802	785
4	Primary School dropout	240	200	221	184	198	170	151	145	168	139	104	99	88	80	121	102	41	29	3831	
5	High school (9-12)	2481	1857	2459	1703	2473	1740	2165	1672	2747	2351	2760	2269	2845	2350	2688	232	373	288	375	344

																0					
6	High school dropout	77	109	91	87	54	70	88	62	64	51	72	49	84	67	48	52	19	21	25	18
7	Number of teachers	594	304	566	288	551	270	568	233	555	268	542	291	564	328	581	369	160	108	175	125

Source: Sodo zuriya Woreda education office

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

According to sodo zuriya Education office report school dropout is high in both male and female. School dropout is decreasing in both male and female as compared with the privies years

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 Sodo zuriya woreda gives various services to the area's population.

No	Types of health institutions	years										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	Governmental Health Center	7	7	7	7	6	6	6	6	6	2	2
1.1	Primary Hospital	0	0	0	0	0	0	0	0	0	0	0
	Private pharmacy	1	1	1	1	0	0	0	0	0	0	0
1.2	Health center/post	34	34	34	34	28	28	28	28	28	11	12
1.3	Health post	0	0							0	0	
2	Private Health Centers	1	1	1	1	0	0	0	0	0	0	0
2.1	Primary Health clinics	16	16	16	16	10	10	10	10	10	10	10
2.3	Number of health professionals	340	348	350	354	270	272	288	298	270	76	98

Source: Sodo zuriya 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, 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 Sodo zuriya Woreda. 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 sodo zuriya woreda road transport is one of grate problem for the community .

Table 4: Types and length of Roads, in Sodo zuriya woreda

No	Road type	Length in km	% of population who has access to Road
1	Asphalt	8	
2	All weather rood	93.5	34%
3	Dray weather rood	0	
	Total	101.5	

Source: woreda transport office

The data obtained from the woreda transport office the types and the length of all rood type is improving time to time within 10 years.

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".

According to the sodo zuriya wereda water office report the current water demand of the wereda is 2364 m3 water is required per day however In the Woreda, there is no sufficient drinking water for human and animals,
.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 37.6%. The water demand of household is 2056 3mand also industry is 3083m p/day Because of this risen, the percentage of population who has access to cline water is 37.6%. as result women and children are traveling long distance to fetch water

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. Sodo zuriya *Woreda*, has 24 hours telephone services, from total population 65% 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 sodo zuriya Woreda 25% of the population has access to electric service From both hydroelectric and solar energy. This shows that there is no sufficient power in the woreda

1.3.1.2. Drivers and pressure of social environment

Buge wetland 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 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 buge wetland

- Large amount of agricultural land demand for agricultural use and increasing human population around buge 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;
(iii) Almost 50% of Women are highly participating in water shade management

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 buge wetland 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 buge wetland ecosystem.

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. Before degraded the Buge wetland was serves as a grazing land for the community.

According to FGD Water shortage is one of the problem for expanding agriculture including animal production in Sodo zuriya woreda.

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 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 buge wetland 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 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).

- 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, buge wetland 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

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

The Buge wetland is located in South Ethiopia, within an area bounded approximately by 37°48′–37°51′ E and 6°47′–6°51′ N. The wetland occupies a valley-bottom depression with a gently sloping, elongated central floor and arms that extend to the north-west, north-east and south-east, surrounded by cultivated slopes. The total study area is 1,338.1 ha.

Land use and land cover (LULC) change was analysed for 2016 and 2026 using remote sensing and GIS techniques. The study area remained constant at 1,338.1 ha, so all observed changes result from conversion between land cover classes and not from any change in the study boundary. Seven classes were mapped: grassland, cropland, settlement/built-up, shrubland, forest, bare/degraded land and wetland (Figure 1).

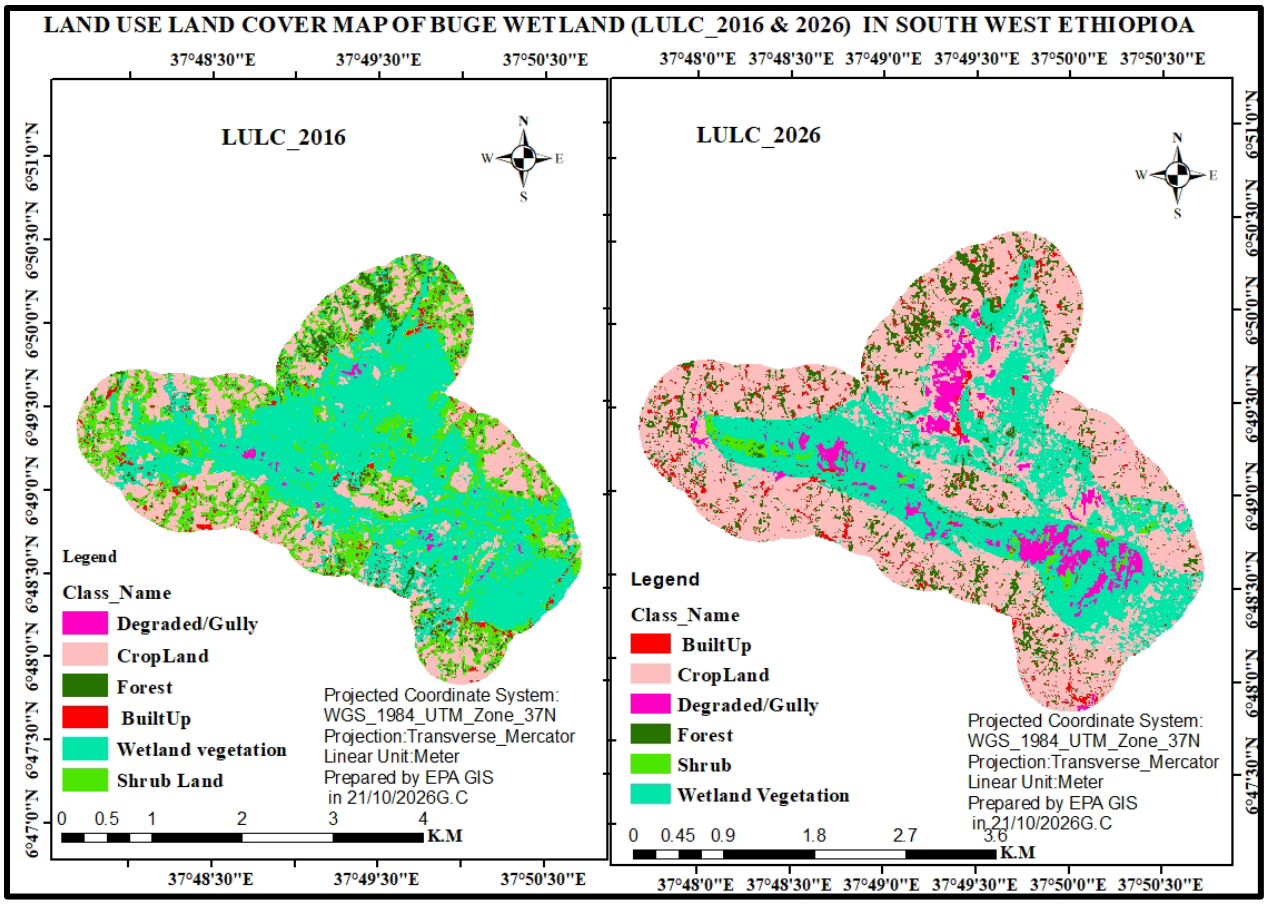


Figure 1: ***Buge wetland land use and land cover change map, 2016 and 2026***

In 2016 the valley floor was mostly grassland (light green) with only small wetland patches (light blue). By 2026 cropland (pink) covers most of the surrounding land, degraded land (magenta) has appeared along the valley floor, and the wetland forms a more continuous band.

Land use and land cover distribution

Table 5: **Buge wetland land use and land cover in hectares and percent, 2016 and 2026**

	LULC_2016		LULC_2026	
Class_Name	AreaHa	Percent	AreaHa	Percent
Wetland vegetation	507.37	37.92	183.56	13.7
Cropland	323.54	24.18	732.11	54.7
Built-up	63.18	4.72	99.43	7.4
shrub Land	339.61	25.38	60.59	4.5

Forest	72.99	5.45	146.28	10.9
Degraded/Gully	31.39	2.35	116.11	8.7
Total	1338.08	100	1338.08	100.00

Source: - Buge wetland LULCC, map analysis 2026

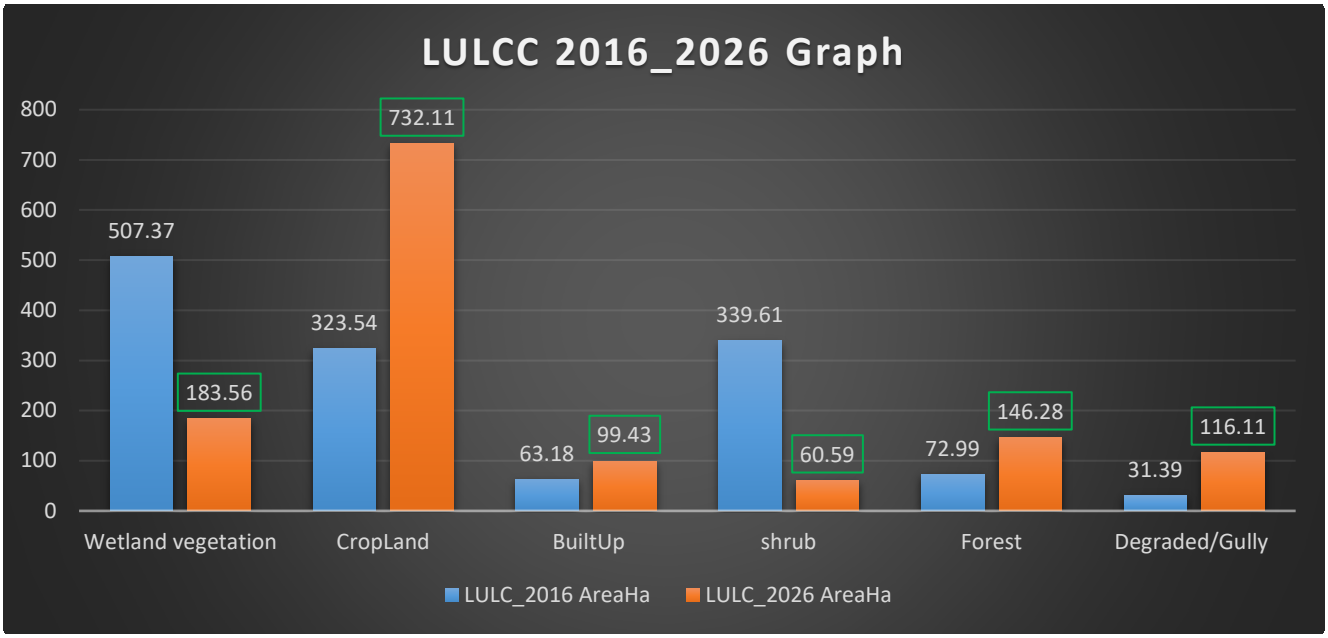


Figure 2: Land use land cover change

Interpretation of land cover changes

Cropland. Cropland shows the largest gain in the landscape. It increased from 323.54 ha (24.2%) in 2016 to 732.11 ha (54.7%) in 2026, a gain of 408.57 ha (126.3%). Cropland has moved from the third-largest class, behind wetland vegetation and shrubland, to the dominant land use, now covering more than half of the study area. This is consistent with agricultural expansion onto former shrubland and the wetland fringe.

Wetland vegetation. Wetland vegetation shows the largest loss of any class. It fell from 507.37 ha (37.9%) in 2016 to 183.56 ha (13.7%) in 2026, a loss of 323.81 ha (63.8%). It was the dominant class in 2016 and is now the second-largest, after cropland. The map shows that a broad cover across the valley floor has contracted to a narrower band along the central channel (Figure 1a). The loss points to conversion of the wetland fringe to crop fields and to the replacement of wetland cover by gully and degraded land on the valley

floor. Part of the apparent change may also reflect differences in the season and date of the images used for the two years, and this should be checked.

Shrubland. Shrubland shows the sharpest proportional decline of any class, from 339.61 ha (25.4%) to 60.59 ha (4.5%), a loss of 279.02 ha (82.2%). The class has almost disappeared from the slopes. This points to clearance of shrub vegetation for crop fields, fuelwood and grazing. Part of the apparent loss may also reflect differences in how shrub, forest and wetland vegetation were separated in the two classifications.

Forest. Forest doubled, from 72.99 ha (5.5%) to 146.28 ha (10.9%), a gain of 73.29 ha (100.4%). This is likely linked to tree-planting campaigns, woodlots and natural regeneration, and to the growth of former shrubland into woody cover. Field observation on 10 October 2026 recorded acacia-type woodland with planted conifers on the wetland margins.

Degraded/gully land. Degraded and gully land expanded from 31.39 ha (2.3%) to 116.11 ha (8.7%), an increase of 84.72 ha (269.9%), or about 3.7 times the 2016 area. The map shows these patches concentrated in the central and northern valley floor, where field observations confirm active gully and badland erosion (Figure 2).

Built-up. Built-up land increased from 63.18 ha (4.7%) to 99.43 ha (7.4%), a gain of 36.25 ha (57.4%). This is the smallest absolute gain, but it indicates a steady expansion of homesteads and infrastructure near the wetland.



Figure 3 *Panorama of the eroded valley floor. A large earth pillar stands on the left with two field team members beside it, and the central gully channel and rill-cut slopes run across the view.*



Figure 4 *: A cone-shaped earth pillar, several metres high and taller than the person beside it, left standing as the surrounding soil was washed away (6.8124° N, 37.8320° E, 06:03). Cattle graze on the eroded ground to the right.*



Figure 5***: Close view of an eroded mound. Rill channels run down the red soil, and a pale crust covers the upper surface, with trees growing behind on the rim.***



Figure 6*: A near-vertical gully wall with horizontal soil layers and deep vertical cracks, with a person for scale. Loose soil has collected as a fan at the base of the wall.*



Figure 7*: Another view of the gully system from the rim, framed by acacia branches. Red and pale soil layers are exposed along the walls, with farmland and hills in the distance.*



Figure 8***: The gully system with a cluster of pinnacles in the centre and a small tree on the rim (6.8112° N, 37.8319° E, 05:54). Hills are visible in the background.***

Figure 2-8: Gully and badland erosion on the Buge wetland margin, observed during the 10 October 2026 field visit; GPS-stamped photos near 6.811° N, 37.832° E

Net change, annual rate and gain–loss ranking (2016–2026)

Net change and annual rate were calculated with the standard formulas:

a) Net change (ha) = Area 2026 − Area 2016;

b) Annual change rate (ha/yr) = Net change ÷ 10 years;

c) Percent change = (Area 2026 − Area 2016) ÷ Area 2016 × 100

Table 6: **LULC net change, annual rate and gain–loss ranking (2016–2026)**

Rank	Class	2016 (ha)	2026 (ha)	Net change (ha)	Annual rate (ha/yr)	% change	Trend
1	Cropland	323.54	732.11	+408.57	+40.86	+126.3	Highest gain
2	Degraded/Gully land	31.39	116.11	+84.72	+8.47	+269.9	Major gain (proportionally largest)
3	Forest	72.99	146.28	+73.29	+7.33	+100.4	Gain
4	Built-up	63.18	99.43	+36.25	+3.63	+57.4	Slight gain
5	Shrub land	339.61	60.59	−279.02	−27.90	−82.2	Major loss
6	Wetland vegetation	507.37	183.56	−323.81	−32.38	−63.8	Highest loss

Total study area = 1,338.08 ha (constant).

Total net gains (about 603 ha) and total net losses (about 603 ha) are balanced, and together they show that at least 45% of the study area changed class between 2016 and 2026. The dominant conversion pathways inferred from the net changes are:

- Shrubland → Cropland / Forest / Degraded land
- Wetland vegetation (fringe) → Cropland
- Wetland vegetation (valley floor) → Degraded (gully) land
- Cropland and shrubland margins → Built-up

These pathways are inferred from net change only.

Forest cover dynamics: afforestation, reforestation and forest loss (2016–2026)

The land cover analysis above shows a net gain in forest. To verify that gain and to show where trees are being established and lost, a dedicated forest-change analysis was carried out for the same 1,338 ha study area. Forest cover in 2016 and 2026 was compared on a pixel basis and the result was grouped into four classes: afforestation (new tree cover on land that was not forest in 2016), forest loss (forest cover present in the earlier date and absent in the later date), stable forest (forest present on both dates) and non-forest (all other land). The results are presented in Figure 9 and Table 7.

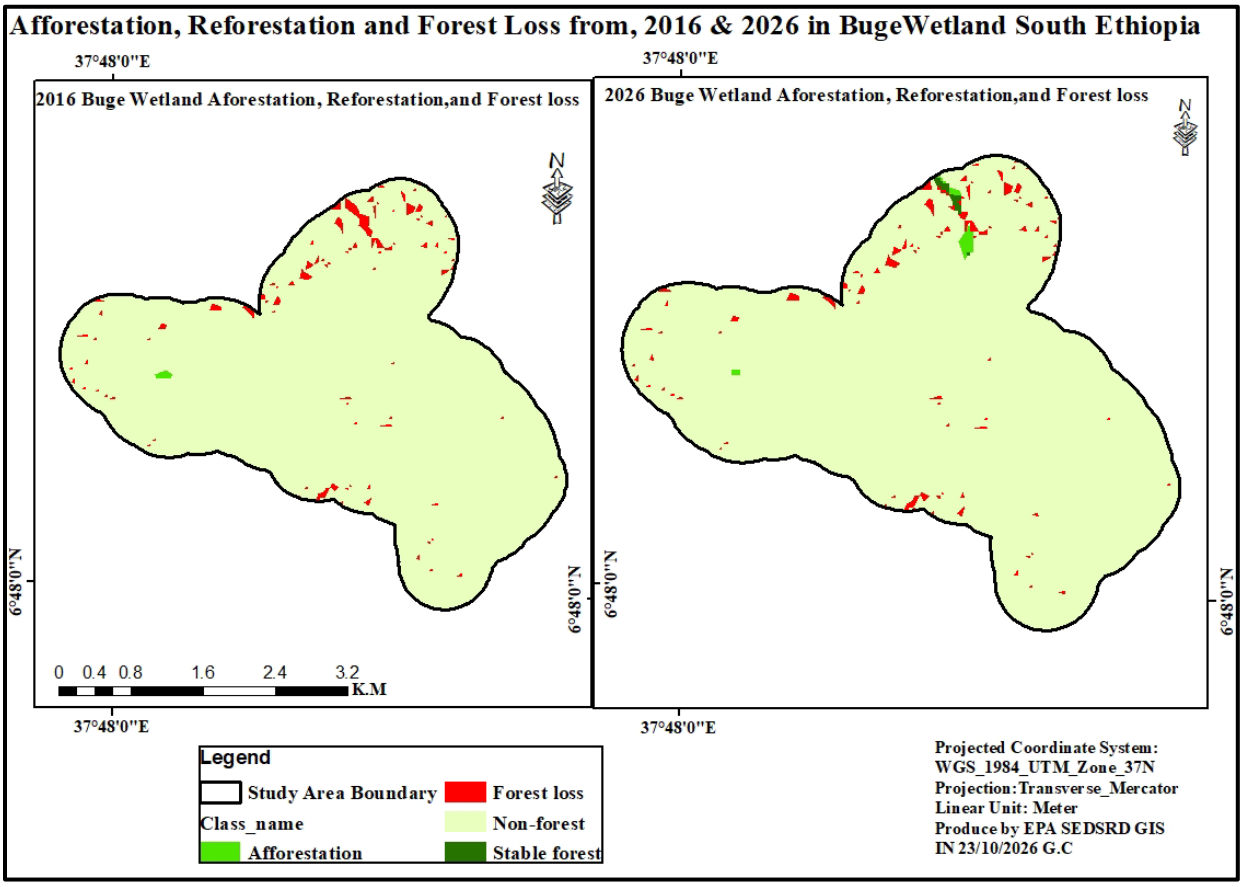


Figure 9 Afforestation, Reforestation and Forest loss in the Buge wetland

Map interpretation. Figure 9 presents the two dates side by side at the same scale and extent (WGS 1984, UTM Zone 37N, scale bar in kilometres). Non-forest land, shown in pale green, covers almost the whole wetland landscape on both dates, which confirms that the Buge wetland is, and remains, a largely treeless valley-bottom system. Forest-related classes occupy only small, scattered polygons.

In the 2016 panel, forest loss (red) is the dominant forest-related class. The polygons are small and fragmented and are concentrated along the northern and north-eastern arm of the wetland and on the north-western margin, with a few isolated polygons on the southern arm. This pattern follows the edge of the wetland, where cultivated slopes and settlements meet the valley floor, and is consistent with clearance for crop fields, fuelwood and grazing. The only afforestation recorded in 2016 is a single small patch (about 1 ha) in the west-central part of the study area.

In the 2026 panel, scattered forest-loss polygons persist along the same northern and north-western margins and along parts of the southern edge, which shows that clearance has continued. The main change is a new cluster of forest-related cover in the north of the wetland. A compact block of afforestation (bright green) lies next to a narrow strip of stable forest (dark green) in the north-central area. The older western patch remains visible but small. Together, these show that tree establishment is localised, and that it is concentrated at a few sites and not spread across the wetland. This agrees with the field observation of a protected conservation woodland with acacia-type trees and planted conifers (Figure 11).

Table 7 **Afforestation, forest loss, stable forest and non-forest area in the Buge wetland, 2016 and 2026**

Class	2016 Area (ha)	2016 (%)	2026 Area (ha)	2026 (%)
Afforestation	1.0	0.1	5.0	0.4
Forest loss	22.0	1.6	19.0	1.4
Stable forest	–	–	3.0	0.2
Non-forest	1,315.0	98.3	1,311.0	98.0
Total	**1,338.0**	**100.0**	**1,338.0**	**100.0**

Total study area = 1,338 ha (constant). Percentages are calculated from the hectare values above as a share of the total study area.

Table interpretation. Table 7 quantifies what the map shows. The forest-related area is small in absolute terms: about 23 ha (1.7% of the study area) in 2016 and about 27 ha (2.0%) in 2026. Non-forest land accounts for 98.3% of the area in 2016 and 98.0% in 2026, a reduction of only 4 ha.

Afforestation. Afforestation increased from 1 ha (0.1%) to 5 ha (0.4%), a gain of 4 ha, or five times the 2016 area. The gain is small, but it shows that planting and protection are producing measurable new tree cover, and that this is occurring where sites have been set aside and protected.

Forest loss. Forest loss decreased from 22 ha (1.6%) to 19 ha (1.4%), a reduction of 3 ha (13.6%). The decline is slight and should not be read as a trend reversal. Loss of 19 ha in 2026 is almost four times the area of new afforestation (5 ha), so gross losses are still larger than gross gains.

Stable forest. Stable forest covers only 3 ha (0.2%) in 2026. This is the surviving core of older tree cover, and it is very small. It is the part of the wetland forest that has kept its cover over the ten years and should be treated as the priority for strict protection.

Non-forest. Non-forest land dominates both years (1,315 ha and 1,311 ha). The ratio of forest-related to non-forest land confirms that tree cover has a minor role in the wetland and that cropland, shrubland and wetland vegetation determine the landscape.

Relation to the LULC results. The forest-change classes in Table 3 (27 ha in 2026) are smaller than the forest class in Table 1 (146.28 ha in 2026). The two analyses use different definitions and should not be added together. Table 1 comes from the six-class land cover classification and includes woodlots, conifer plantations and woody regrowth. Table 3 comes from a forest-specific change detection and records only pixels that meet the forest criterion on the dates compared. The two results agree on the direction of change, that is, some tree establishment alongside continued clearance, but the magnitude of the forest gain differs. The forest definition, canopy threshold and source imagery used for each analysis should be documented, and the two results reconciled before the figures are used for reporting.

Implication. Forest cover in the Buge wetland is small, fragmented and still under pressure. The gain from afforestation is encouraging, but it is too small to offset the 19 ha of forest still being lost along the wetland margin. Protecting the existing 3 ha of stable forest, stopping clearance on the northern and north-western margins, and expanding follow-up care and survival monitoring of planted areas should be priorities.

Overall land use change pattern

1. Cropland became the dominant land use and more than doubled in extent, from 24.2% to 54.7% of the study area.
2. Wetland vegetation declined by almost two-thirds (63.8%) and shrubland nearly disappeared (−82.2%).

3. Forest doubled and built-up land grew by more than half, though both from a small base.
4. Degraded/gully land increased almost four-fold, marking active land degradation on the valley floor.
5. Built-up land expanded steadily (+36.25 ha), reflecting increasing human pressure around the wetland.

2.1.2 Driver and pressure for Land Degradation

The changes between 2016 and 2026 result from the interaction of underlying and proximate drivers (Lambin, Geist & Lepers, 2003).

Population growth is the main underlying driver. A growing rural population increases demand for cropland, grazing, housing and fuel wood, and this demand is concentrated around the fertile, water-rich wetland margin.

Sodo Zuria has no clean continuous population series, because its boundaries and the figures from different sources are not consistent. These are the figures I found:

Table 8 population number

Year	Population	Source type
1994	200,866 (99,979 men, 100,887 women), of whom 36,287 or 18.07% were urban dwellers	National census
2007	134,683	National census
2019	200,911 (98,824 men, 102,087 women)	CSA projection
2022	194,253 (96,120 males, 98,133 females)	Ethiopian Statistics Service projection Sodo Zuria +3

Population numbers trend

1. **1994 to 2007:** The drop from about 200,900 to 134,700 is not a real population decline. The 1994 figure includes Sodo town, with its 36,287 urban residents. In later censuses the town is counted separately, and the woreda boundaries were also revised.
2. **2007 to 2019/2022:** The projections are higher than the 2007 census, so the growth is real. From 134,683 in 2007 to 194,253 in 2022, the rise is about 44%, or roughly 2.5% a year. The 2019 and 2022 projections come from different releases, so the small drop between them (200,911 to 194,253) is probably a revision, not a decline. Check the source before you quote both.
3. **Wolaita context:** The 1994 census recorded Welayta as 92.81% of the population. This is a densely populated highland area, which matters for pressure on the Buge Wache wetland (Wikipedia).

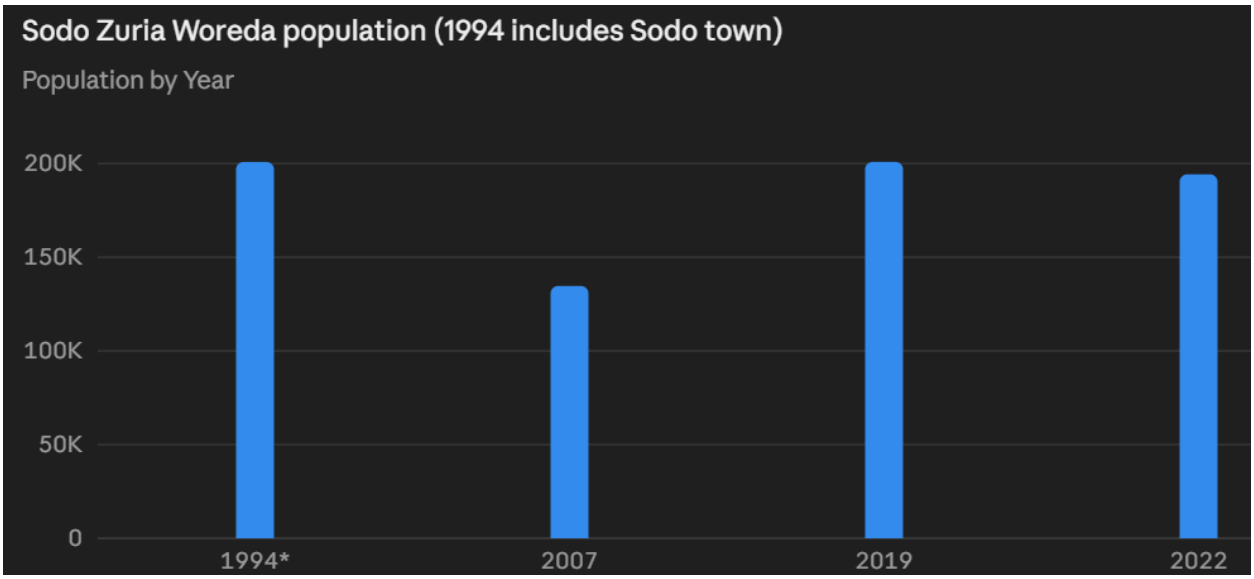


Figure 10 : Sodo Zuria Woreda population (1994 includes Sodo town)

Figure 10 shows the woreda population for 1994, 2007, 2019 and 2022. The 1994 bar (marked *) includes Sodo town and the earlier woreda boundaries, so it is not directly comparable with the later years. The 2007, 2019 and 2022 bars are the usable trend, from the 2007 census and the later official projections.

Generally Sodo Zuria Woreda had a population of 200,866 in the 1994 census, of whom 18.07% were urban dwellers (CSA, 1994). The 2007 census counted 134,683 people (CSA, 2007), a lower figure that reflects the separate counting of Sodo town and boundary changes, not a real decline. Official projections put the population at 200,911 in 2019 (CSA, 2019) and 194,253 in 2022 (ESS, 2022, as compiled by City Population, n.d.). From 2007 to 2022, the population grew by about 44%, or roughly 2.5% a year, which indicates continuing pressure on land and natural resources, including the Buge Wache wetland. Wolaita people made up 92.81% of the woreda's population in 1994 (CSA, 1994).

Economic pressures. Dependence on smallholder rain-fed agriculture and livestock, together with limited off-farm income, pushes households to clear shrub land and wetland fringes for more cropland. Improved market access and road connections increase the value of land close to the wetland and encourage settlement and cash cropping.

Land tenure and institutional factors

Communal grazing areas and wetland margins often lack clear boundaries and registered use rights. Studies of Ethiopian wetlands name weak wetland conservation, poor understanding of wetland value and poor land tenure as the main factors affecting wetland condition (Ambo University, n.d.).

Natural and climatic factors

Gully erosion in Ethiopian highland watersheds has been increasing. In the Chentale watershed, gullies were the main contributor to soil erosion, and the gully area nearly doubled between 2005 and 2013 (Bogale et al., 2020). Rainfall intensity strongly controls this process. Modelling in Ethiopian watersheds showed that 60 mm and 100 mm rainfall events produced about 4–5 and 10–17 times more erosion-triggering potential than a 30 mm event (Land, 2023). Intense storms after dry spells therefore accelerate runoff and soil loss on cleared

slopes. The deep, erodible red clay soils observed in the field, which form pillars and vertical gully walls several metres high, make the Buge Wache landscape highly sensitive to vegetation loss (field observation, EPA SEDSRD GIS, 2026).

Pressures Exerted on Land and Ecosystems

The drivers above translate into the following direct pressures on the wetland and its surroundings:

1. **Agricultural encroachment.** Cropland expanded by 408.57 ha, mainly at the expense of shrub land and wetland vegetation, and now surrounds the wetland on all sides. Cultivation of slopes and wetland fringes removes protective cover and increases runoff and sediment delivery into the wetland.
2. **Grazing pressure.** Loss of wetland vegetation (323.81 ha) and shrubland (279.02 ha) reduces grazing area and concentrates livestock on the remaining pasture and on the wetland itself. Cattle were observed grazing directly on the eroded valley floor during the field visit. Overgrazing causes compaction, loss of ground cover and trampling of banks.
3. **Vegetation clearance and wood extraction.** The sharp loss of shrubland (279.02 ha) reflects clearing for fields, firewood, charcoal and construction material. Fresh cuts and felled acacia branches were seen in the woodland during the field visit.
4. **Gully and soil erosion.** Degraded/gully land increased from 31.39 ha to 116.11 ha. Active gullies and badland forms are advancing into the valley floor and degrading the hydrology of the wetland.
5. **Settlement and infrastructure expansion.** Built-up land increased by 57.4% and brings paths, roads, waste and drainage closer to the wetland.
6. **Hydrological alteration.** Drainage, channelization and gully incision change flow paths and water levels, which can both dry some areas and cause waterlogging and siltation in others.

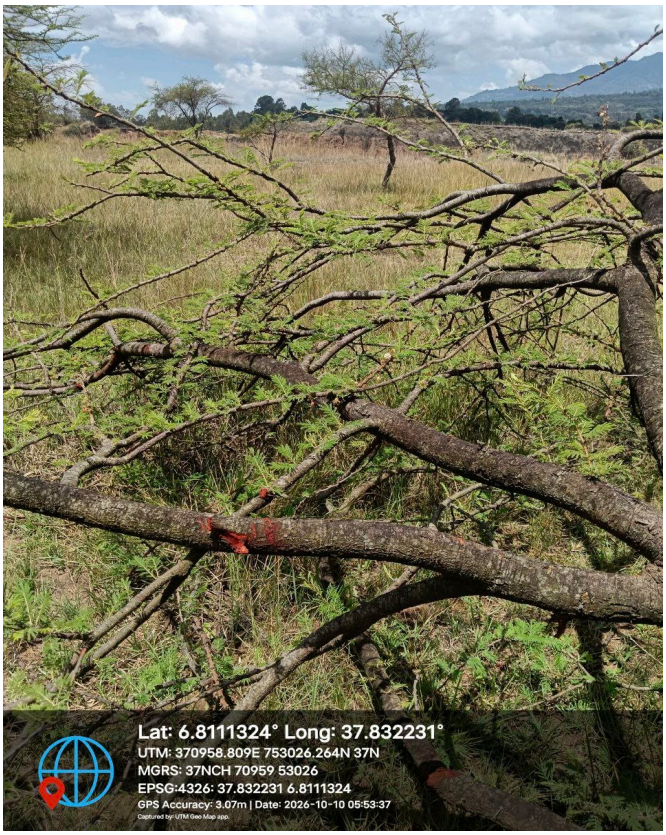


Figure 11*: Felled acacia branch with a fresh cut near the gully rim, field visit 10 October 2026; GPS-stamped photo near 6.811° N, 37.832° E*

These pressures reinforce each other. Clearance of shrub and grass cover exposes soil, which accelerates gully erosion; erosion degrades grazing and crop land, which in turn pushes households to clear new land.

2.1.3 Impact of Land Use and Land Cover Change

Socio-economic impacts

- **Livelihoods.** The expansion of cropland has increased cultivated area, but gains are at risk because cultivation on steep, erodible slopes and wetland margins leads to declining soil fertility and loss of productive land to gullies.
- **Livestock.** Loss of 208.2 ha of grassland and almost all shrubland reduces fodder and browse. This increases the risk of overstocking, lower livestock productivity and conflict over the remaining grazing land.

- **Natural resources for daily life.** Loss of shrubs and trees means longer travel for fuelwood, construction poles and fodder, a burden that falls mainly on women and children.
- **Wetland services.** Households depend on the wetland for dry-season water, grazing, thatching grass and other products. Degradation and siltation reduce the reliability of these services.
- **Land use conflict.** Competition between crop farmers and livestock keepers for shrinking grazing land and wetland margins can lead to conflict, especially without clear boundaries.

Environmental impacts

- **Soil erosion and land degradation.** The eleven-fold growth in bare/degraded land and the presence of deep gullies show severe soil loss. Eroded soil is deposited downstream and into the wetland.
- **Siltation and altered hydrology.** Sediment filling channels and low areas changes water flow, reduces the storage capacity of the wetland and increases flood peaks downstream.
- **Loss of habitat and biodiversity.** Near-total loss of shrubland and conversion of grassland reduces habitat for birds, small mammals and other wildlife, and fragments connectivity around the wetland.
- **Water quality.** Sediment, agrochemicals and animal waste from surrounding fields and settlements reduce water quality.
- **Partial gains.** The increase in forest (52.8 ha) improves cover, carbon storage and slope stability where trees are well established. However, plantations and woodlots of exotic species are not equivalent to the natural vegetation that was lost.
- **Reduced resilience.** Overall, the landscape is more exposed to drought, flash floods and further erosion.

2.1.4 Response Actions to Tackle Buge Wetland Degradation

Federal and regional government responses

National programmes are relevant to the Buge landscape: the Green Legacy Initiative (tree planting and seedling distribution), the Sustainable Land Management Programme (soil and water conservation, area closures, integrated watershed management) and wetland-related policy commitments under Ethiopia's environmental legislation and the Ramsar Convention. These interventions are likely to have contributed to the increase in forest cover. Their effect on gully control and wetland protection appears limited so far, as shown by the expansion of degraded land. Implementation of wetland boundary demarcation, buffer enforcement and land use planning remains weak because of limited capacity, staffing and funding.

Local government responses

Woreda and kebele offices have promoted physical and biological soil and water conservation (terraces, bunds, check dams, grass and tree planting), seedling nurseries and area closure on degraded land. Environmental awareness and extension work has been undertaken but has not been enough to stop encroachment on the wetland margin. (Specific local measures, dates and areas should be confirmed with the woreda environment and agriculture offices.)



Figure 12*a: Conservation area woodland (6.8048° N, 37.8344° E, 08:23). Scattered acacia-type trees and planted conifers stand over dry grass, with two people walking along a path.*



Figure 13*: Panorama inside the conservation area. Two team members stand in open acacia woodland with grass cover and a few conifers.*



Figure 14*: A dense stand of young trees, mostly acacia-type with some conifers, over dry grass (6.8047° N, 37.8343° E, 08:22).*



Figure 15*: A team member holds a thorny acacia branch in open woodland and grass, with the eroded area visible in the distance.*

Figure 12-15: Conservation area (protected woodland) at the Buge wetland, field visit 10 October 2026; GPS-stamped photo near 6.805° N, 37.834° E

Community and civil society responses

Communities adapt through fallowing, manure use, tree planting on private land and traditional grazing management. Community-based area closures and user groups can help where they have clear rules and recognised authority. These responses are limited by poverty, land tenure insecurity and lack of technical and financial support. NGOs and development projects can support restoration and livelihood alternatives, but coordination with local institutions is needed.

Overall, current responses have not been sufficient to reverse degradation. Scaling up gully rehabilitation and strengthening institutions are urgent priorities.

2.1.5 Outlook

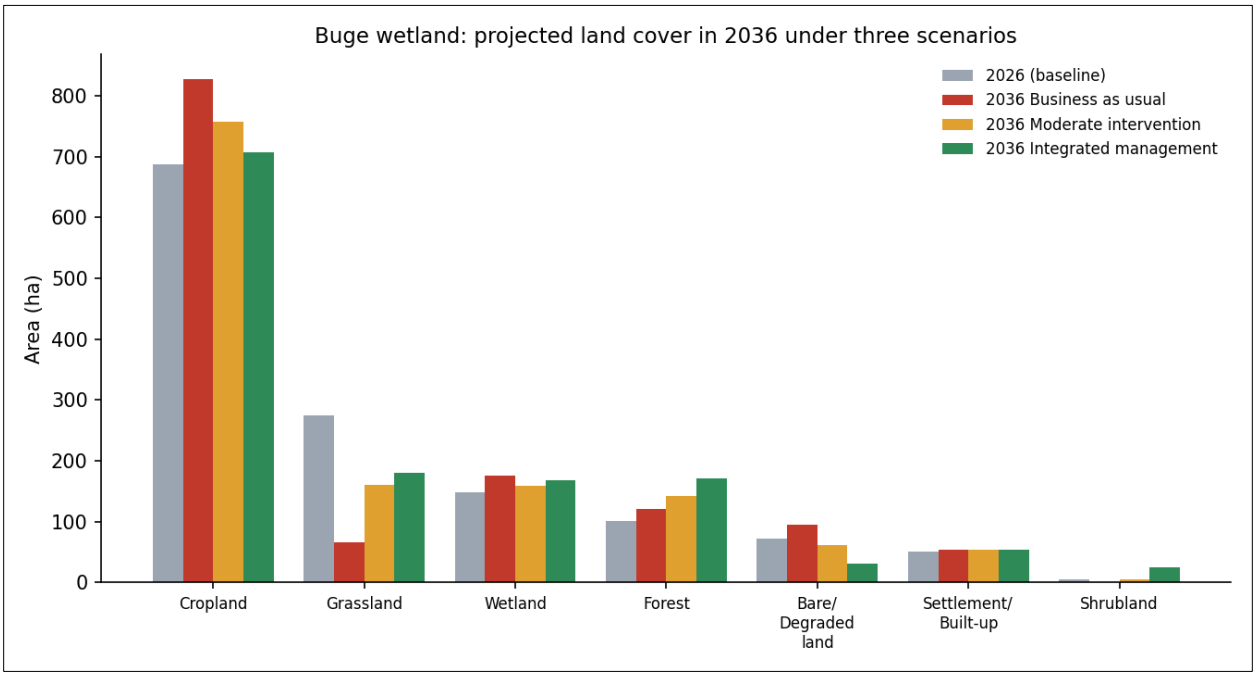


Figure 16: Buge wetland projected land cover in 2036 under three scenarios

Business as usual. If population growth, cropland expansion, free grazing and weak enforcement continue, cropland is likely to expand further onto remaining grassland and wetland margins. Gullies will continue to advance, bare land will keep expanding and siltation will degrade the wetland. The wetland would become a degraded, fragmented grass and bare-soil mosaic with reduced water storage, productivity and biodiversity.

Moderate intervention. With area closure, gully treatment, tree and grass planting and improved grazing management led by communities and local government, degraded land could be stabilised and vegetation could recover on the margins of the wetland.

Integrated landscape management. With legal demarcation of the wetland, enforced buffers, watershed-wide conservation, livelihood alternatives and sustainable financing (for example payment for ecosystem services), the wetland could keep its hydrological and ecological functions and continue to support local livelihoods.

The present outlook depends on how quickly gully expansion is halted and cropland expansion near the wetland is controlled. The recent gains in forest cover show that restoration can work when planting is followed up and protected.

Future option

1. **Demarcate and legally protect the wetland.** Delineate the wetland boundary with the community, set and enforce buffer zones between the wetland and cultivated land and settlement, and register the wetland as a protected area.
2. **Rehabilitate gullies and degraded land.** Prioritise gully control in the central and northern valley floor with check dams, vegetative stabilisation, area closure and slope treatment of the contributing catchment.
3. **Integrate land use planning.** Prepare and enforce participatory land use plans at woreda and kebele level that separate cropland, grazing, settlement and conservation zones.
4. **Promote sustainable agriculture.** Support conservation agriculture, terracing, agroforestry and water harvesting so that production increases without further expansion into natural habitats.

5. **Improve grazing and fodder management.** Introduce controlled grazing and cut-and-carry fodder systems, and develop fodder on rehabilitated land.
6. **Strengthen community-based management.** Give wetland and forest user groups clear rights, responsibilities and benefits, and involve women and youth.
7. **Expand and protect tree planting.** Use indigenous and multipurpose species, ensure follow-up care and survival monitoring, and avoid planting on wetland areas.
8. **Strengthen monitoring and enforcement.** Build the capacity of environment offices to monitor LULC change with remote sensing and field checks, and carry out a 2016–2026 transition matrix, accuracy assessment and wetland field validation.
9. **Address underlying drivers.** Invest in family planning, rural education, non-farm employment and secure land tenure to reduce pressure on land.

Ethiopia Regional 2.2 Forest

2.2.1 State and trend of Forest in the Buge Wetland Ecosystem

A forest is a complex ecological system and natural resource dominated by trees. While hundreds of definitions exist globally based on factors like tree density, height, and land use, the most widely accepted institutional definition comes from the United Nations. According to the UN Food and Agriculture Organization (FAO), a forest is officially defined as land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent. This criteria specifically excludes land that is predominantly under agricultural or urban use.

Buge (often spelled Bugie or Buge Wanche) is a locality and kebele located in the Wolaita Zone of the South State, situated in the neighborhood of Wolaita Sodo. While often grouped under the broader Bilate River catchment and Sodo Zuria/Damot Gale ecosystem complex, the area has become highly recognized in environmental circles due to intensive, long-term participatory ecological restoration projects.

The Buge Wetland, located in the Wolayita Zone (Sodo Zuria) Buge wancho kelebele in Southern part of Ethiopia. The distance between Wolaita Sodo to Addis Ababa is 328 Km by road. It is an ecologically significant ecosystem within the Bilate River catchment / Lake Abaya basin in the Wolayita Zone of Southern Ethiopia, and the wetland acts as a key hydrological sponge. Like many wetlands in the Ethiopian Rift Valley region, it provides indispensable ecosystem services, including flood regulation, local climate mitigation, ground water recharge, and sediment retention. Buge also serves as a vital natural sponge filtering water, sequestering carbon, and sustaining local rural livelihoods. It provides critical habitat for flora and fauna.

Vegetation & Forest Types in the Buge Wetland Zuria of Wolayta Zone

The Buge Wetland and its surrounding "Zuria" forest edge located in the structurally diverse highlands and rift peripheral zone. This forest ecosystem consists of moist Afromontane flora, wetland macrophytes, specialized bird families, and small to medium mammals. According to the FGD report, the Buges wetland includes 335 hectares of forest land, 285.3 hectares of which were planted by the community. According to the report, the area contains 338 hectares of man-made forest coverage, which was planted by the community. But the forest coverage of the buge's wetland buffer zone the amount of forest coverage declined time to time due to a number of driving forces and pressures.

Forest and woody vegetation patches in the surrounding zuria feature indigenous tree species such as እንደ ግራር (*Vachellia tortilis Acacia tortilis*) እና ዋንዛ (*Cordia africana*), alongside introduced species like ከውጭ ከገቡ እንደ ባሕር ዛፍ (*Eucalyptus globulus*). Based on ecological surveys from the Ethiopian Biodiversity Institute (EBI) and regional university field assessments, the species inhabiting this specific wetland-forest matrix are categorized below:

Table 9: List of flora species found in Buge wetland forest ecosystem

No	Scientific name	Amharic name	Re-mark
1	Acacia species	ግራር	
2	Ficus sure	ሾላ	
3	*Cordia Africana,*	ዋንዛ	
4	Croton macrostachyus	ብሳና	
5	Eucalyptuses	ባህር ዛፍ	

Peripheral Forest Vegetation (The "Zuria" Buffer)

According to the FGD and key informant reports, the peripheral ("zuria") woody vegetation is transitions from indigenous moist Afromontane tree pockets into intensive agro-forestry zones. Native Trees: Historically dominant riverine and woodland species include the ታላቁ ዋርካ (Giant Sycamore) (*Ficus sycomorus*), Water berry (ዶቅማ) (Syzygium guineense), African elm (ሻሸሬ) (Celtis africana), and various native Acacia species. Acacia-Commiphora Woodland (የግራርና የከሚፎራ ደን) are common in lower or drier transitional slopes adjacent to valley bottoms and local drainage networks. Dry & Moist Afromontane Mosaic are scattered remnant woody species, shrubs, and secondary tree growth on elevated terrain surrounding local water points. Riparian and Wetland Vegetation (የወንዝ ዳርቻ እና ረግረጋማ እፅዋት) are dominated heavily by herbaceous and non-woody aquatic flora such as papyrus, sedges (Cyperus species), reeds, and marsh grasses rather than extensive tree-based forest coverage. Enset (False Banana): Culturally and ecologically vital Enset ventricosum (locally Uuttaa) is planted densely along the forest

boundaries and adjacent smallholder farms. There are also Exotic/Encroaching Trees around the Buge wet land. They are fast-growing (የባህር ዛፍ) *Eucalyptus* and (የጥድ) *pine* species have aggressively expanded across the peripheral buffer zones. Human-planted woodlots featuring Eucalyptus trees are frequently found along the edges of local wetlands and farm boundaries. Invasive alien plant species have aggressively established themselves in the Wolayta Zone, severely disrupting native habitats and outcompeting local flora. According to botanical surveys by the Ethiopian Biodiversity Institute (EBI) and FGD reports, the most damaging weeds include:

- ✓ Parthenium Weed (Parthenium hysterophorus): Locally known as "Faramsissa". This aggressive annual herb releases toxic chemicals into the soil (allelopathy) that stop native grasses and crops from growing. It takes over the drier peripheral buffer zones, turning diverse meadows into single-species weed patches.

Table 10: Invasive Allen Species in Buge Wetland Ecosystem

No	Scientific Name	Locale name	English name	Area coverage
1	*Parthenium hysterophorus*	ቅንጬ	Parthenium weed / Whitetop / Congress grass	16.25 hectare
2	*Eucalyptus globulus*	ባሕር ዛፍ	Tasmanian Blue Gum / Blue Gum	
3	*Pontederia crassipes*	እምቦጭ	Water Hyacinth	2.75 hectare
4	*Lantana camara*	የወፍ ቆሎ	Lantana / Wild Sage / Tickberry	18.5 hectare

Source: From woreda office of Natural resource department and FGD report in 2026

Wetland Flora & Macrophytes (Aquatic Plants)

The inner, waterlogged sections of the Buge wetland feature dense communities of emergent, submerged, and floating plants that form the primary shelter for aquatic wildlife:
Sedges and Rushes (Cyperaceae): Dominated locally by plants known as 'Qetema' (Cyperus species) and 'Fila' (Typha species/cattails), which act as filtering systems and nesting grounds.

Grasses and Reeds: Hydrophytic grasses like Paspalidium germinatum, Panicum, and Phragmites line the marshy shorelines.

Floating Vegetation: Aquatic species such as the Blue water lily (Nymphaea coerulea) and floating smartweeds (Polygonum).

Table 11: List of flora and fruit species found in Buge wetland zuria forest ecosystem

No	Scientific name	Amharic name	Re-mark
2	Acacia species	ግራር	
3	Ficus sure	ሾላ	
5	*Cordia Africana,*	ዋንዛ	
6	Croton macrostachyus	ብሳና	
7	Eucalyptuses	ባህር ዛፍ	

Table 12: list of fruits

No	Scientific name	Amharic name
2	Rhamnus prinoides	ጌሾ/Gasho/
3	Banana	ሙዝ
4	Mangifera indica	ማንጎ
5	Sweet orange	ብረቱካን
6	Coffee	ቡና
7	Lemon	ሎሚ
8	Psidium guava	ዘይቱና
9	Avocado	አቮካዶ

Source; Worde Environmental protection and Forest conservation reports Jan 2026.



Figure 17: protected forest areas in Buge wetland forest ecosystem

Source: (from field survey in 2026).



Figure 18: protected forest area source (from field survey in 2026)



Figure 19: plantation forest in the ecosystem Source: (filed survey 2026)



Figure 20: Forest ecosystem changed to grazing & farmland (Source; Field photo in 2026).

2.2.2 Driver and pressure for Forest in Buge wetland Ecosystem

A driving force‟ is a need of primary and secondary activates. Driving forces for an individual are the need for shelter, food, water, profit and entertainment. The primary driving forces causing environmental forest degradations on the Buge Wetland include:

Demographic Growth: High population density and rapid growth in Sodo Zuria and nearby rural kebeles create severe land scarcity.

Economic Needs & Poverty: Dependence on rainfed agriculture forces smallholder farmers to seek fertile, moist soils in low-lying wetland zones for dry-season cropping.

Institutional & Policy Gaps: Lack of a clear legal framework designating wetland boundaries, open-access tenure systems, and inadequate inter-sectorial coordination between agriculture, water, and environmental offices.

Urban Expansion: Proximity to Sodo town accelerates demand for construction materials (clay, sand, thatch) and expanded agricultural supply.

Pressures

These driving forces translate into direct physical pressures on the wetland ecosystem: according to the key informant and FGD report the major pressures in Buge's wetland are listed as follows: **Drainage and Agricultural Conversion:** Construction of drainage canals to reclaim wetland margins for teff, maize, and vegetable cultivation.

Overgrazing: Large herds of cattle and sheep graze directly on the wetland bed during dry spells, leading to severe trampling and soil compaction.

Siltation & Sedimentation: Deforestation and poor farming practices in the surrounding upper catchments lead to topsoil erosion that washes directly into the Buge basin.

Resource Over-extraction: Unregulated harvesting of macrophytes (papyrus, reeds) for roofing, mats, and fodder beyond natural regeneration rates.

Water Abstraction: Uncontrolled pumping for small-scale irrigation schemes upstream and along the wetland edges

2.2.3 Impact of loss of Forest losses in Buge wetland Ecosystem

A. Ecological Impacts

- Habitat Destruction & Fragmentation: Loss of critical breeding, nesting, and feeding grounds for water birds, amphibians, native fish species, and wetland invertebrates.
- Loss of Biodiversity: Decline in local endemic plant species and displacement of wildlife reliant on the wetland microenvironment. Decline in Flora Species Over-harvesting for thatch/crafts and clearance for farming cause a loss of native macrophyte communities.
- Disruption of Ecosystem Services: Loss of natural water purification capabilities, leading to silt-heavy downstream runoff and weakened flood control capacity. : Reduced water filtering capacity leads to poorer water quality downstream, increased silt loads, and diminished flood retention.

B. Socio-Economic Impacts

- Water and Resource Scarcity: Decreased availability of clean water for domestic use and livestock during the dry season. As the wetland degrades, dry-season water supplies for domestic use and livestock decrease.
- Livelihood Vulnerability: Reduced supply of natural raw materials (thatch, grass, Medicinal plants) harms vulnerable community members who depend on them for supplementary income. Local communities, especially marginalized households and women who harvest wetland plants for weaving, fuel, or medicinal uses, face reduced resource availability.
- Resource Conflicts: Heightened competition and disputes between agriculturalists and Livestock herders over shrinking wetland space. Competition over shrinking fertile wetland soils and grazing areas triggers localized tension among farmers and pastoralists.

C. Invasive Weeds and Their Ecological Impacts in the Buge's wet land

When invasive weeds like Parthenium and Lantana replace native vegetation, the environmental impact cascades through the food chain:

- Loss of Nesting Material: The loss of native sedges like 'Qetema' (Cyperus) deprives birds like Rouget's Rail of the specific building materials they need to nest.
- Food Supply Shortages: Monoculture weed infestations reduce the abundance of native insects, seeds, and amphibians, leaving wading birds without reliable food sources.



Figure 21: **Buge wetland Habitat Destruction & Fragmentation. (sources: from filed survey, 2026)**



Figure 22: **Buge wetland Habitat Destruction & Fragmentation erroded land. (sources: from filed survey, 2026)**

2.2.4 Response for mitigating forest and wood land degradation in Buge wetland Responses by Government and Society

- ✓ Institutional Interventions: Local agricultural and environmental protection offices (Wolayita Zone / Sodo Zuria Woreda Agricultural and Natural Resource Development Offices) attempt to map and monitor wetland boundaries.
- ✓ Watershed Management Programs: Inclusion of upper catchment areas in green legacy Initiatives, terracing, and afforestation programs to reduce siltation entering the wetland system. Inclusion of the surrounding upper catchments in regional soil and water conservation (SWC) schemes, such as community physical terracing and the Green Legacy reforestation campaign.
- ✓ Research and Policy Guidance: Collaborations with local institutions (such as Wolaita Sodo University) and the Ethiopian Biodiversity Institute (EBI) to assess biodiversity, land-use changes, and ecological health. Collaborative studies conducted by Wolaita Sodo University and regional research centers to quantify land-use/land-cover (LULC) changes and recommend sustainable management strategies.

- ✓ Local Monitoring & Mapping: Efforts by the Wolaita Zone Agricultural and Environmental Protection Offices to map degraded wetland zones and raise environmental compliance requirements.

Community and Society Responses

- ✓ Community Watershed Committees: Local kebele-level natural resource management committees advocate for rotational grazing and restricted seasonal access to sensitive wetland zones.
- ✓ Awareness Campaigns: NGO and academic partnerships conduct community dialogues regarding the long-term dangers of wetland draining versus the economic benefits of sustainable utilization.

✓ Traditional Wise-Use Practices: Some local communities maintain traditional seasonal rules regarding grass harvesting to allow plant regeneration.

To reverse biodiversity loss at the Buge Wetland, key next steps include:

1. Enforcing clear legal boundaries and buffer zones around the wetland.
2. Developing a dedicated, participatory Wetland Management Plan that involves local farmers.
3. Promoting eco-friendly alternative livelihoods (e.g., sustainable aquaculture, controlled forage harvesting, and apiculture).
4. Expanding soil and water conservation in the upper catchments to stop siltation.
5. Delineation & Protection: Enforce legally recognized buffer zones around the Buge Wetland to stop direct agricultural encroachment.
6. Integrated Wetland Management Plan (IWMP): Formulate a participatory plan involving local farmers, pastoralists, and district experts.
7. Alternative Livelihoods: Promote eco-friendly income streams such as managed apiculture (beekeeping), zero-grazing fodder production, and sustainable aquaculture.




Lat: 6.8207553° Long: 37.8370906°
UTM: 371498.442E 754088.953N 37N
MGRS: 37NCH 71498 54089
EPSG:4326: 37.8370906 6.8207553







Figure 23: **Buge wetland buffer protected land. (sources: from filed survey, 2026)**

2.2.5 Outlook

If grassland coverage decreases from 483 hectares to 20.5 hectares over a ten-year period (2016–2026), the wetland may be lost completely within the next decade. Consequently, the community will face a severe shortage of grazing land for cattle, reduced fodder production, and a decline in sustainable aquaculture. Furthermore, due to the scarcity of grazing land in the Buge wetland, livestock herd sizes have been steadily decreasing over time.

Additionally, if the population growth rate increases by 2.8% every ten years—rising from 79,188 to 88,516 in rural areas and from 15,602 to 17,658 in urban centers—the wetland will likely shrink further. This degradation will prevent it from providing vital ecosystem services and adequate water resources to the community.

2.3 Biodiversity

2.3.1 State and trend of Biodiversity in the Buge Wetland Ecosystem

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

Ethiopia is one of the world countries, which is rich in faunal, floral and microbial diversity. Ethiopia is considered as the fifth largest floral country in tropical Africa. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, of which about 15 percent or more are probably endemic. Ethiopia is also rich in faunal diversity with mammals (277 spp.), birds (861 spp.), reptiles (78 spp.), amphibians (54 spp.), and fishes (101 spp.) (Mishra et al,2012).

The biodiversity composition of the Buge Wetland and its immediate surrounding sub-catchment (Buge Zuria in the Sodo Zuria district of the Wolaita Zone) includes a variety of flora and fauna typical of the Rift Valley basin wetlands in Southern Ethiopia. Due to the wetland's position, it supports species adapted to deep aquatic, marshy, moist-meadow, and surrounding savanna/woodland conditions.

2.3.1.1Flora Biodiversity of bugys wetland ecosystem

The Buge (Bugys) wetland and its *zuria* (surrounding buffer zone/periphery) inside the Damot Gale area of the Wolayita Zone feature a diverse mix of Afro-tropical Rift Valley biodiversity. The species are highly adapted to changing water tables, riverine woodlands, and heavily populated agricultural borders. The lists below detail the typical Flora (Plants) and Fauna (Animals) found within the core marsh and its surrounding periphery (*zuria*): The vegetation divided into aquatic species (living in the core water and mud) and terrestrial/buffer species occupying the surrounding drier margins (*zuria*).

Table 13: Types of plant found in the Buge wetland

Plant type Category	Common/ local Name	Scientific Name	Habitat / Use
Emergent Macrophyte	Papyrus Sedge / Reed	*Cyperus papyrus* / *Cyperus* spp.	Core wetland mud and shallow water
Emergent Macrophyte	Common Cattail	*Typha latifolia*	Stagnant, waterlogged marsh edges
Grass / Fodder	Vetiver Grass	*Chrysopogon zizanioides*	Planted on canal banks for soil stabilization
Grass / Fodder	Bermuda Grass	*Cynodon dactylon*	Wetland margins (*zuria*) used for grazing
Indigenous Tree	Umbrella Thorn Acacia	*Vachellia (Acacia) tortilis*	Drier riverine woodland buffer zone
Indigenous Tree	Sycamore Fig	*Ficus sycomorus*	Wetland banks and stream margins
Exotic Tree (Cultivated)	River Red Gum	*Eucalyptus camaldulensis*	Upland *zuria* woodlots (encroaching)

Invasive Alien Weed	Congress Grass (*Erem-Siss*)	*Parthenium hysterophorus*	Disturbed dry margins and roadsides

2.1. Fauna (Animal Life) of Buge Wetland & Zuria

The animal population comprises specialized wetland birds, small mammals adapting to the agricultural landscape, amphibians, and domestic livestock that heavily depend on the ecosystem for survival.

Table 14: Animal Category in the Buge wetland

Animal Category	Common Name	Scientific Name	Ecological Status / Role
Bird (Avifauna)	Abyssinian Longclaw	*Macronyx flavicollis*	Near-endemic; uses moist tussocky grass
Bird (Avifauna)	Wattled Crane	*Bugeranus carunculatus*	Threatened; visits seasonal mudflats
Bird (Avifauna)	Sacred Ibis	*Threskiornis aethiopicus*	Common shallow-water mud forager
Bird (Avifauna)	Hadada Ibis	*Bostrychia hagedash*	Riverine tree nester and wetland feeder
Mammal (Wild)	Common Duiker	*Sylvicapra grimmia*	Hides in dense peripheral reed thickets
Mammal (Wild)	Crested Porcupine	*Hystrix cristata*	Nocturnal burrower in the dry suzia

2.2. Medicinal Plants of Buge Wetland and Zuria

Table 15: Traditional Medicinal Plants Data Table Herbal Medicinal Plants

No.	Local Name (Amharic / Wolaita)	Biological / Scientific Name	Primary Plant Part Used	Documented Traditional Medicinal Value & Application
1	ዳማከሴ (Damakese)	*Ocimum lamiifolium*	Fresh Leaves	Crushed or squeezed fresh to inhale or drink juice to treat "Mich" (acute fevers), headaches, influenza, and the common cold.
2	ፌሶ (Fe) / ፌሶ (Feso)	*Ferula communis* (or related *APIACEAE*)	Roots / Stems	Used traditionally to treat respiratory conditions, chest congestion, stomach cramps, and dynamic anti-parasitic needs.
3	ጤናዳም (T'enadam)	*Ruta chalepensis*	Leaves / Fruits	Expressed juices treat infantile stomach aches, intestinal gas, and earaches. Dried fruits flavor coffee and tea to relieve nausea.
4	ዕሬት (Ret)	*Aloe macrocarpa / Aloe vera*	Clear Leaf Gel (Latex)	Applied topically to soothe open wounds, burns, and skin infections.

				Bitter sap is diluted orally as a strong laxative or malaria remedy.
5	በሶብላ (Besobla)	*Ocimum basilicum* var. *thyrsiflorum*	Leaves / Seeds	Highly valued culinary herb used to treat stomach cramps, poor digestion, and mild gastrointestinal bloating.
6	ነጭ ሽንኩርት (Nech Shinkurt)	*Allium sativum*	Raw Bulbs (Cloves)	Broad-spectrum antimicrobial used for malaria symptoms, severe coughs, hypertension, and localized skin infections.
7	ቀይ ሽንኩርት (Key Shinkurt)	*Allium cepa*	Fleshy Bulbs	Used as an anti-inflammatory, general immune tonic, and digestive aid; juice treats minor skin irritations.
8	ዝንጅብል (Zinjibil)	*Zingiber officinale*	Fresh/Dried Rhizomes	Carminative and warming remedy taken orally to treat nausea, morning sickness, common cold, throat irritation, and intestinal spasms.
9	ቦሬሳ (Boresa)*	*Croton macrostachyus* (Zonal Variant)	Bark / Leaves	High-priority remedy used topically for fungal ringworm (*Tinea capitis*), skin rashes, and internally for treating livestock stomach complaints.
10	ሹሙሉዋ (Shumuluwa)	*Kalanchoe densiflora* / *Kalanchoe spp.*	Fleshy Leaves	Succulent leaves are warmed or crushed into a paste applied as a poultice on swelled wounds, abscesses, and deep boils to draw out infection.
11	ጦስኝ (Teyemusha) / (Teyem)	*Thymus schimperi*	Dried Leaves	Endemic Ethiopian wild thyme used to treat chronic coughs, chest pain, and bronchitis when brewed as a hot herbal tea.

Note on Variants: Boresa, Shumuluwa, and Teyemusha are regional phonetic spellings reflecting local Wolayttattuwa classification systems used by community elders and traditional healers in the mid-basin areas.

2.3. Traditional Preparation and Administration Trends

Predominant Habitats: Wild-growing herbs along the moist, swampy margins make up the largest percentage of the region's medicinal plant profile, followed closely by shrubs and riverine trees.

Preparation Method: The community mostly uses fresh leaves. These are commonly crushed, ground, or juiced and frequently mixed with pure water.

Primary Route: The majority of internal remedies are administered orally, while dermal and topical paste applications are used for wounds and skin conditions.

2.4. Endangered Plant Species

Around the Buge Wetland in Damot Gale Woreda, Wolaita Zone (Buge Wetland Zuria), due to high population growth, agricultural expansion, livestock grazing, and water scarcity (excessive drying), numerous native tree species have become endangered. In particular, hard-wood trees such as Zigba (African Pencil Cedar) and Tsid (African Juniper), as well as moisture-loving large trees like Wanza (Cordia africana), Shola (Wild Fig), and Warka (Sycamore Fig), are facing the threat of extinction in the area. Below is a table showing the list of these endangered/threatened tree species mentioned, their biological names, their ecological roles in the area, and why they are endangered:-

Table 16: : Endangered plant species

No.	Local Name (Amharic)	Biological / Scientific Name	Zone / Habitat in the Ecosystem	Threat Factors (Reasons for Decline)	Primary Use & Ecological Value
1	**Zigba** (ዝግባ)	*Podocarpus falcatus*	Peripheral dry forests and riverine edges	Heavily logged for house construction and timber production; compounded by a very low natural regeneration rate.	Preserves groundwater levels and provides critical shelter and habitat for local wildlife.
2	**Tsid** (ፅድ)	*Juniperus procera*	Surrounding hilly terrain and drier transitional slopes	Extensively and illegally deforested for structural poles, house pillars, and livestock fencing.	Prevents soil erosion and assists in the reclamation and rehabilitation of degraded lands.
3	**Wanza** (ዋንዛ)	*Cordia africana*	Fertile agricultural farm boundaries surrounding the wetland	Heavily cut down due to high commercial demand for furniture production and ongoing farmland expansion.	Vital for honey production (high floral value), provides canopy shade, and enhances soil fertility.
4	**Bisana** (ቢሳና)	*Croton macrostachyus*	Intermediate moisture zones surrounding the wetland	Over-exploited for traditional medicine extraction (bark and leaves) and highly sought-after for domestic firewood.	Improves soil quality through nitrogen fixation and serves as a highly utilized resource for traditional healthcare.
5	**Shola** (ሾላ)	*Ficus sur*	Highly waterlogged swamp interiors	Faces severe drying risks due to hydrological shifts caused by converting	Provides an essential food source (fruits) for birds and primates, and

			and immediate riverbanks	wetlands into dry agricultural plots.	protects local water springs.
6	**Warka** (ዋርካ)	*Ficus vasta*	Grassland plains along the wetland boundaries	High livestock trampling causes soil compaction, preventing new seed germination, while older mature trees are cleared for farming.	Provides expansive shade for community gatherings and possesses a high capacity for water retention.
7	**Bahir Zaf** (ባህር ዛፍ)	*Eucalyptus camaldulensis*	Designated peripheral hilltops (Upland Woodlots)	**Special Note:** Not endangered; it is an exotic, aggressively expanding tree. It is listed because its high water intake dries the wetland, threatening native trees.	Delivers fast-growing timber for traditional construction and provides rapid cash income for smallholder farmers.

2.5. Faunal Biodiversity of Buge wetland ecosystem

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

Mammal species: - The identified mammal species in the Buge wetland ecosystem are listed in table 3 by their Local name, common name, Family name, and Scientific name.

Table 17: **Identified mammal species in Buge wetland ecosystem.**

Local name	Common name	Family name	Scientific name
Jib/ጅብ/	Hyena	*Hyaenidae*	*Hyaenidaecarnivora*
Tota/ጦጣ	Ape	*Hominidea*	*Hylobates lar*
Dikula/ድኩላ	Impala	*Bovidae*	*Aepyceros melampus*
Zinjaro/ዝንጀሮ/	Baboon	*cercopithecinae*	*Papio hamadryas*
Midaqo/ሚዳቆ	Duiker	*cephalophinae*	*Cephalophus harveyi*
Tenchele/ጥንቸል	Rabbite	*Leporidae*	*Brachylagus idahoensis*
Gureza/ጉሬዛ	Mantled guereza / Abyssinian black-and-white colobus	Cercopithecidae	Colobus guereza
Jart/ጃርት	Crested porcupine	Hystricidae	Hystrix cristata
እባብ	Snake		Serpentes
ቀበሮ	Ethiopian wolf / Abyssinian fox	Canidae	*Canis simensis*

Source:- from FGD discussion.

Bird species: - The identified bird species in the buge wetland ecosystem are listed in table 4 by their Local name, common name, Family name, and Scientific name.

Table 18: **Identified bird species in Buge wetland ecosystem.**

Local name	Common name	Family name	Scientific name

Amora/Qura	Crow	*Corvidae*	*Corvus corone*
Dakiye	Duck	*Anatidae*	*Anas robripes*
Jigra	Goose	*Anatidae*	*Alopochen aegyptiacus*
Regbe	Dove	*Columbidae*	*Columba livia*
Qoq			

Source:- from FGD and key informant

Fauna (Animal Life) of Buge Wetland & Zuria

The animal population comprises specialized wetland birds, small mammals adapting to the agricultural landscape, amphibians, and domestic livestock that heavily depend on the ecosystem for survival.

Table 8: Fauna (Animal Life) of Buge Wetland & Zuria

Animal Category	Common Name	Scientific Name	Ecological Status / Role
Bird (Avifauna)	Abyssinian Longclaw	*Macronyx flavicollis*	Near-endemic; uses moist tussocky grass
Bird (Avifauna)	Wattled Crane	*Bugeranus carunculatus*	Threatened; visits seasonal mudflats
Bird (Avifauna)	Sacred Ibis	*Threskiornis aethiopicus*	Common shallow-water mud forager
Bird (Avifauna)	Hadada Ibis	*Bostrychia hagedash*	Riverine tree nester and wetland feeder
Mammal (Wild)	Common Duiker	*Sylvicapra grimmia*	Hides in dense peripheral reed thickets
Mammal (Wild)	Crested Porcupine	*Hystrix cristata*	Nocturnal burrower in the dry suzia

Sources :from KI and FGD 2026

2.3.2 Driver and Pressure of Biodiversity Degradation in the Buge Wetland Ecosystem

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

The biodiversity of the Buge Wetland is under severe stress from both human activities and environmental changes: The drivers of biodiversity degradation in Buge wetland ecosystems are population growth, investment activities, agricultural land expansion, and illegal settlement.

- Agricultural Expansion & Drainage: High population density and land scarcity in the Wolayita Zone drive farmers to drain parts of the wetland for crop production (e.g., maize, vegetables, and teff) during dry and wet seasons alike.
- Overgrazing and Soil Compaction: Large livestock herds graze directly within the wetland boundaries, leading to trampling, destruction of nesting sites, soil compaction, and loss of native vegetation.
- Deforestation & Catchment Degradation: Clearing trees in the surrounding upper catchments leads to severe topsoil erosion. Heavy rain washes sediment into the Buge Wetland, causing rapid siltation and alteration of water depths.
- Over-extraction of Water: Unregulated pumping and diversion of water for small-scale irrigation lower the wetland's water table.
- Encroachment & Urbanization: Settlement expansion near Sodo town continuously reduces the physical buffer zone around the wetland.
- Climate Variability: Prolonged dry spells and fluctuating rainfall patterns exacerbate the drying out of fragile wetland margins.

2.3.3 Impact of Biodiversity in the Buge Wetland Ecosystem

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

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

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

Impact of Eucalyptus: Because Eucalyptus has a very high water consumption rate, if planted inside the Buge Wetland core, it dries up the water table and starves native trees such as Shola, Warka, and Zigba of moisture, leading to their extinction. Therefore, agricultural experts in the area recommend planting Eucalyptus only on degraded hillsides, well away from the wetland water sources.

Conservation Efforts: Currently, to save these endangered trees, area exclosures (protected land closures) and watershed management initiatives are actively being undertaken in the area.

Impact on local community: - The local community affected by scarcity of different forest product, (like; spices and honeybee, durable tree species for construction and other uses, etc.) which use for their daily and continues household consumption and also affected by shortage of traditional medicinal plant species. These exposed the community to incur additional costs. Due to the high degree of forest degradation, water quality and quantity is decreased, this makes the local community vulnerable to the disease like malaria. Invasive weeds also affect the community by decreasing crop productivity, these leads to food insecurity.

Impact on the flora species: -the floral species are also highly degraded because it imposed to forest fire destruction and over utilization of different tree species. Due to this reasons, different tree species are degraded and tends to extinct.

Impact on wild life: - Due to their habitat destruction by forest fire and illegal hunting activities the wild life species are disturbed and compelled to migrate to other area. Especially bird's species are imposed to migration.

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

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

2.3.4 Response to Biodiversity Degradation in the Buge Wetland Ecosystem

There is a forest conservation team and forest fire controlling teams, which are organized by the Woreda and the local community to conserve the forest and its biodiversity, but it's not yet effective.

To address the degradation and loss of endangered indigenous forest coverage (such as *Podocarpus falcatus*, *Juniperus procera*, *Cordia africana*, and *Ficus* species) in the Buge wetland zuria (periphery) within the Wolayita Zone, a multi-layered approach combining community actions, environmental strategies, and regional policies has been deployed.

Because the Wolayita Zone is one of the most densely populated agricultural regions in Ethiopia, these interventions are designed to balance local community survival with ecological restoration:

1. Land-Use Policy and Institutional Bylaws (Community-Led Regulation)

Regional agricultural offices and local administrative units (*kebeles*) have implemented binding community regulations to govern the buffer zones:

- ✓ Eucalyptus Exclusion Policies: Strict agricultural directives discourage or ban the planting of water-depleting Eucalyptus trees directly inside the high-moisture sponge soils of the wetland core and its direct borders. Smallholders are legally guided to plant these woodlots exclusively on degraded upland hillsides where they cannot sap the wetland's water table.
- ✓ Community Bylaws (*Deera* / Local Agreements): Traditional elders and local water-user associations have established penalties and fines for unauthorized wood cutting, clearing riverine vegetation for expanding farmlands, or setting uncontrolled agricultural fires in the *zuria*.

2. Physical and Engineering Catchment Rehabilitation Strategies

To protect remaining indigenous trees from losing their soil anchor and suffering from drying water tables, systematic watershed management has been enforced:

- Gully and Stream Bank Stabilization: Constructing check-dams (using dry stones, wood, and gabions) along the slopes feeding into the Buge wetland. This slows down the velocity of rushing water, prevents deep soil gullies from tearing up forest roots, and traps topsoil.

- Moisture Retention Engineering: Excavating deep trenches, hillside terraces, and micro-basins across the surrounding slopes. These physical modifications force rainwater to infiltrate the ground, replenishing the local water table required to keep moisture-loving trees like *Ficus sur* (Shoala) and *Ficus vasta* (Warka) alive.

3. Biological and Forestry Management Actions

Direct interventions targeting the flora and forest cover include:

- Seasonal Area Exclosures (Restricted Zones): Designating severely degraded forest patches and riverine borders as enclosures. Livestock entry is entirely banned in these zones for specific multi-year cycles. This prevents cattle from trampling seedlings and compacting the soil, allowing endangered indigenous trees to regenerate naturally from the seed bank.
- Targeted Indigenous Nursery Production: Local government-run and NGO-supported botanical nurseries in Damot Gale Woreda actively cultivate seeds of endangered trees like *Cordia africana* (Wanza) and *Croton macrostachyus* (Bisana). These are distributed to farmers for agroforestry practices or planted during national green legacy campaigns.
- Living Buffer Strips: Planting deep-rooted Vetiver grass and native shrubs along the transitional boundary between active crop fields and the forest edge to act as a physical shield against continuous agricultural encroachment.

4. Socio-Economic and Participatory Actions

- Integrated Agroforestry Systems: Farmers are trained to incorporate endangered trees like *Cordia africana* directly into their farming plots (e.g., surrounding homesteads or within enset and coffee fields) rather than clearing them. This provides fields with natural nitrogen-fixation and shade while keeping the species safe from local extinction.
- Participatory Forest & Watershed Committees: Forming community-led committees that assume ownership of specific hillsides. These committees coordinate seasonal maintenance labor and ensure that upstream activities do not wash destructive silt onto downstream forest floors.

2.3.5 Outlook

The future biodiversity outlook for the Buge Wetland Ecosystem depends heavily on transitioning from a purely preservationist model to a participatory, policy-driven, and community-based management framework. The baseline text emphasizes that long-term ecological sustainability can only be achieved if scientific research, strict law enforcement, and local socio-economic incentives are integrated. By aligning regional investments with national biodiversity policies, the Buge ecosystem can reverse its current degradation trajectory and achieve balanced, sustainable utilization.

The Buge Wetland Ecosystem is undergoing severe socio-economic and ecological degradation driven by land-use changes, agricultural expansion, and illegal settlement.
This degradation directly threatens human well-being, destabilizes regional microclimates, and exposes local communities to severe health, economic, and food security risks. Immediate, policy-driven intervention is required to halt irreversible environmental collapse.

This document provides a strategic brief on the severe ecological and socio-economic degradation within the Buge Wetland Ecosystem. Driven by unregulated agricultural expansion, illegal settlements, and inappropriate forestry practices (such as core-zone Eucalyptus planting), the ecosystem is nearing a point of irreversible collapse. This document outlines immediate legislative mandates and incentive-based policy options required to stabilize the region, safeguard public health (Malaria control), and secure local livelihoods.

2.4 Climate

2.4.1 State and Trend of climate change/Variability for Buge Wetland

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

The Buge Wetland Ecosystem is located in Sodo Zuria District, Wolaita Zone, Southern Ethiopia. To assess climate change and climate variability in the study area, data was collected from the Bodity meteorological station, field observations, and focus group discussions (FGDs). Meteorological data on rainfall and maximum and minimum temperatures analyzed to identify historical climate trends and variability in the Buge Wetland Ecosystem. Field observations and information obtained through FGDs used to complement the meteorological data and provide further insights into local climate conditions and their potential implications for the wetland ecosystem.

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 Buge wetland

According to the discussions held with the local community, there is a perception that temperatures have increased by approximately 50% compared with previous years. Similarly, changes have been observed in the amount, distribution, and seasonal patterns of rainfall.

Community members reported that, in the past, the main rainy season (Kiremt) generally began in July, while the Belg rainy season extended from March to May. However, since 2017 E.C. (2024/2025 G.C.), the community has experienced rainfall shortages, delays in the onset of rainfall, and rainfall occurring outside the usual seasons.

These observations indicate perceived changes in local climatic conditions, particularly increasing temperatures and the irregular distribution of rainfall.

Analysis of Bodity Monthly Average Rainfall

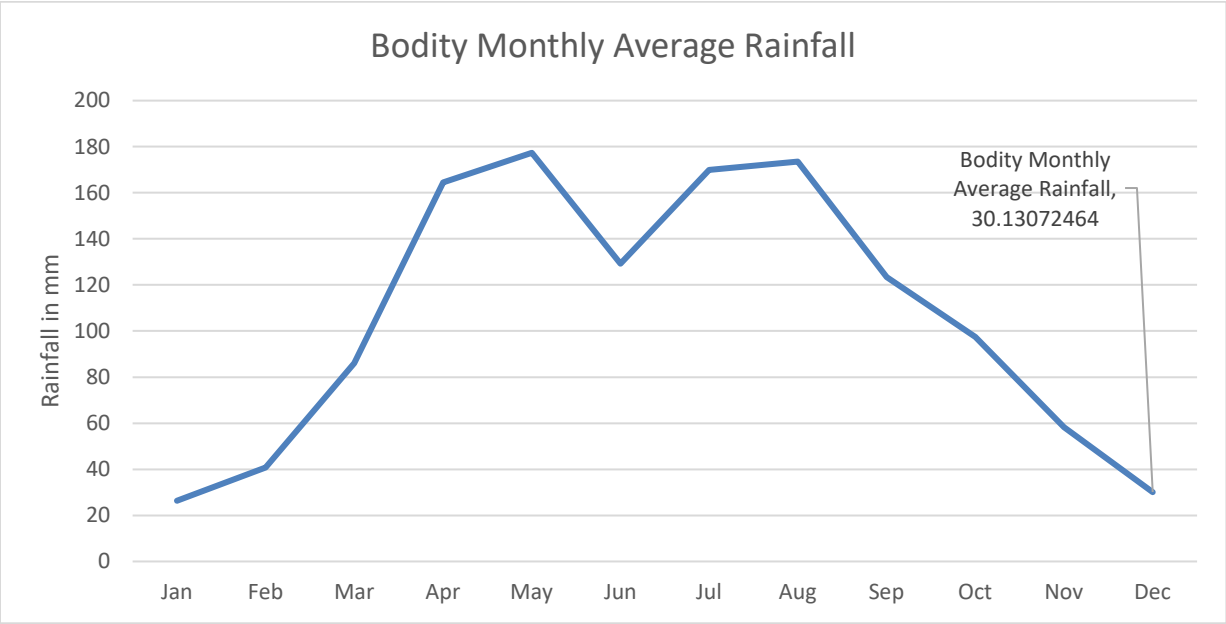


Figure 24: Bodity average rainfall

The line graph shows the average monthly rainfall in Bodity, measured in millimeters (mm), from January to December.

From the above figure we can see that Bodity's rainfall pattern is bimodal because have two rainfall peaks. The first peak is during May, about 177.3 mm and the Second peak is in August, approximately 173.4 mm. so this indicate that the study area have two rainfall seasons. Overall trend: Rainfall increases from January to May, decreases in June, rises again in July and August, and then declines steadily from September to December. Rainfall is high during April to August in wettest period and it has become low during November to February in driest period. The graph demonstrates that Bodity experiences considerable monthly variation in rainfall. The highest rainfall occurs in May, while the lowest occurs in December. The general pattern suggests a pronounced rainy season in the middle of the year and a relatively dry period toward the end and beginning of the year.

Analysis of Bodity Annual Rainfall (1990–2025)

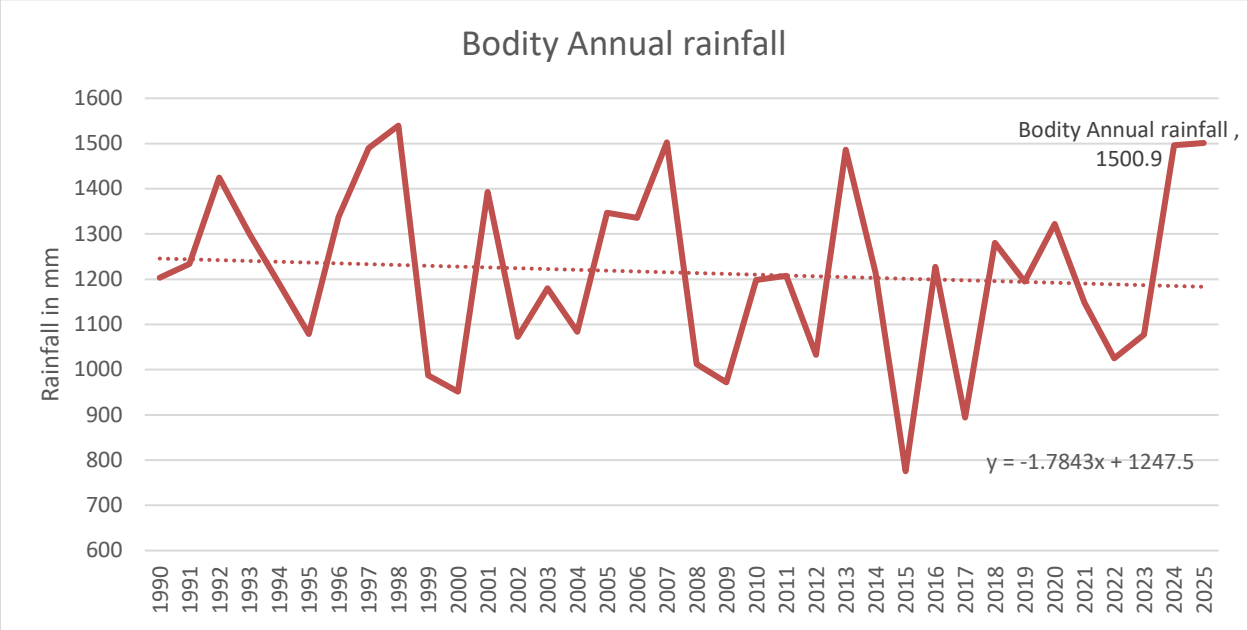


Figure 25: Bodity annual rainfall

The line graph illustrates the annual rainfall distribution in Bodity from 1990 to 2025, measured in millimeters (mm). It shows fluctuations in annual rainfall and the overall long-term trend.

The graph shows considerable year-to-year variation in rainfall. The linear trend line has the equation:

y=-1.7843x+1247.5

The negative slope -1.7843 indicates a slightly decreasing trend in annual rainfall over the study period. According to this trend line, rainfall decreases by approximately 1.78 mm per year on average. However, the actual rainfall varies substantially from year to year. Maximum rainfall and Minimum rainfall occurred Approximately 1,540 mm in 1998 and 756 mm in 2015 respectively. The average annual rainfall is approximately 1214 accordingly wettest years were 1992,1997,1996, 1997, 1998, 2001, 2005-2007, 2013, 2018, 2020, 2024, and 2025. The driest years included 1990, 1993, 1994, 1995, 1999, 2000- 2004, 2012, and 2014, 2015-2017, 2019, 2021, 2022 and 2023. These fluctuations suggest that rainfall distribution is irregular, with alternating wetter and drier years. Bodity's annual rainfall from 1990 to 2025 characterized as high interannual variability and a slight overall decreasing trend. Although the trend line suggests a gradual decline, several years experienced high rainfall, including the final two years shown. The pronounced fluctuations indicate that rainfall is not consistent from one year to another.

Analysis of Bodity Annual Average Maximum Temperature (1990–2025)

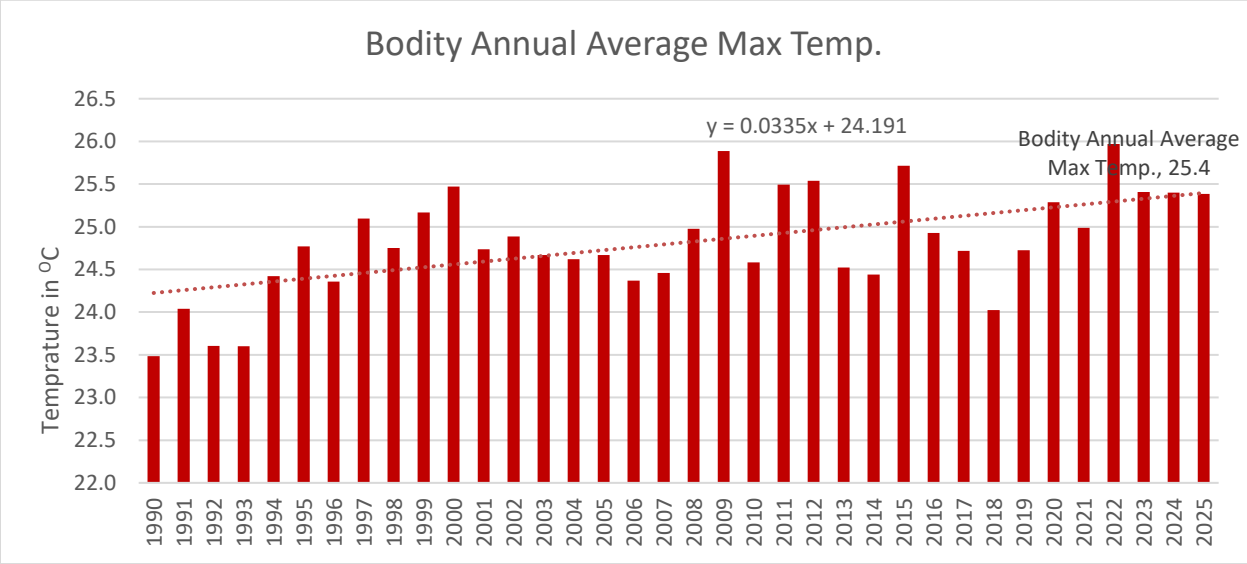


Figure 26: Bodity annual average maximum temperature

The above figure shows the annual average maximum temperature in Bodity from 1990 to 2025, measured in degrees Celsius (°C). It shows annual temperature fluctuations and an overall increasing trend over the 36-year period.

The graph indicates that the annual average maximum temperature has generally increased over time. The dotted trend line has the equation:

y=0.0335x+24.191y=0.0335x+24.191

The positive slope of 0.0335 indicates an estimated increase of approximately 0.034°C per year, equivalent to about 0.34°C per decade. This suggests a gradual warming trend in Bodity's annual average maximum temperature. Highest and lowest annual temperature were approximately 26.0°C in 2022 and 23.5°C in 1990 respectively.

Bodity's annual average maximum temperature from 1990 to 2025 shows a clear overall warming trend, despite fluctuations between individual years. The trend-line equation indicates an increase of approximately 0.34°C per decade. This pattern is consistent with increasing heat exposure and highlights the importance of climate adaptation in agriculture and water management.

Implications of the temperature trend

The increasing temperature trend may have several implications:

- Agriculture: Higher maximum temperatures may increase crop water requirements and heat stress.
- Water resources: Increased evaporation may contribute to soil moisture loss and greater pressure on water supplies.
- Livestock: Higher temperatures may cause heat stress and affect animal productivity.
- Human health: Hotter conditions may increase heat-related discomfort and health risks, particularly during periods of extreme heat.

The actual effects depend on rainfall patterns, humidity, crop types, land management, and local adaptation measures.

Analysis of Bodity Monthly Average Maximum Temperature

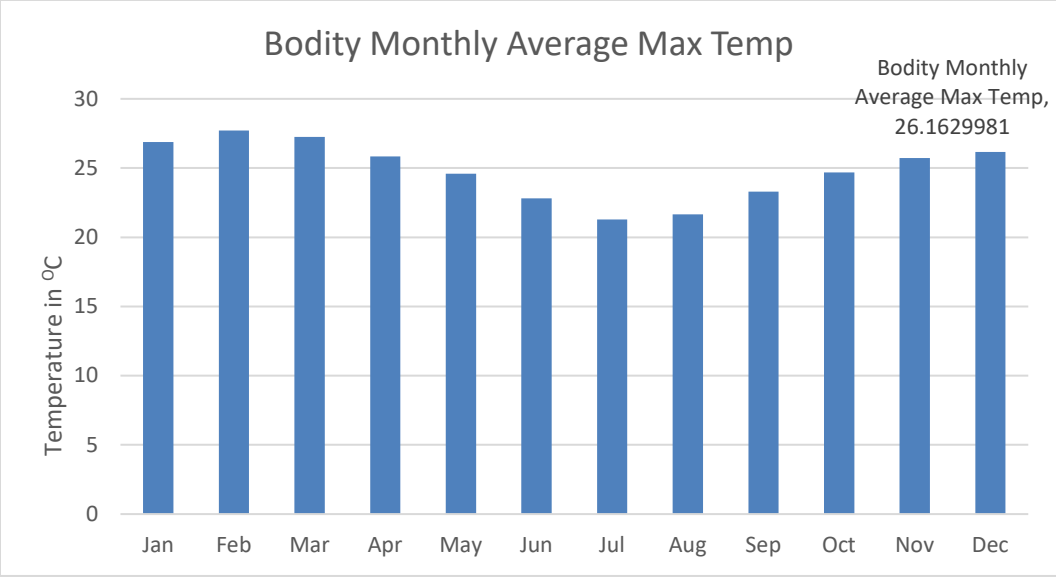


Figure 27: Bodity monthly average maximum temperature

The above figure illustrates the monthly average maximum temperature in Bodity throughout the year, measured in degrees Celsius (°C).

From January to February, the temperature increases slightly from approximately 26.8°C to 27.7°C, reaching its highest level in February. The temperature gradually decreases from March to July around 27.2°C to 21.2°C, indicating a cooling trend. The temperature begins to rise slightly, increasing from approximately 21.7°C to 23.2°C during August to September. In addition, starting from October to December the temperature continues to increase, reaching approximately 26.2°C in December.

The Highest and lowest temperature were observed in February, at approximately 27.7°C and July, at approximately 21.2°C respectively.

The above figure shows a clear seasonal pattern, with relatively high temperatures at the beginning and end of the year and lower temperatures during the middle of the year. The temperature declines from February to July before recovering steadily from August through December.

In conclusion, Bodity experiences relatively warm conditions throughout the year, with moderate seasonal variation in average maximum temperature. February is the warmest month, while July is the coolest. The overall pattern suggests a single broad annual temperature cycle, characterized by a cooling period followed by gradual warming.

Analysis of Bodity Monthly Average Minimum Temperature

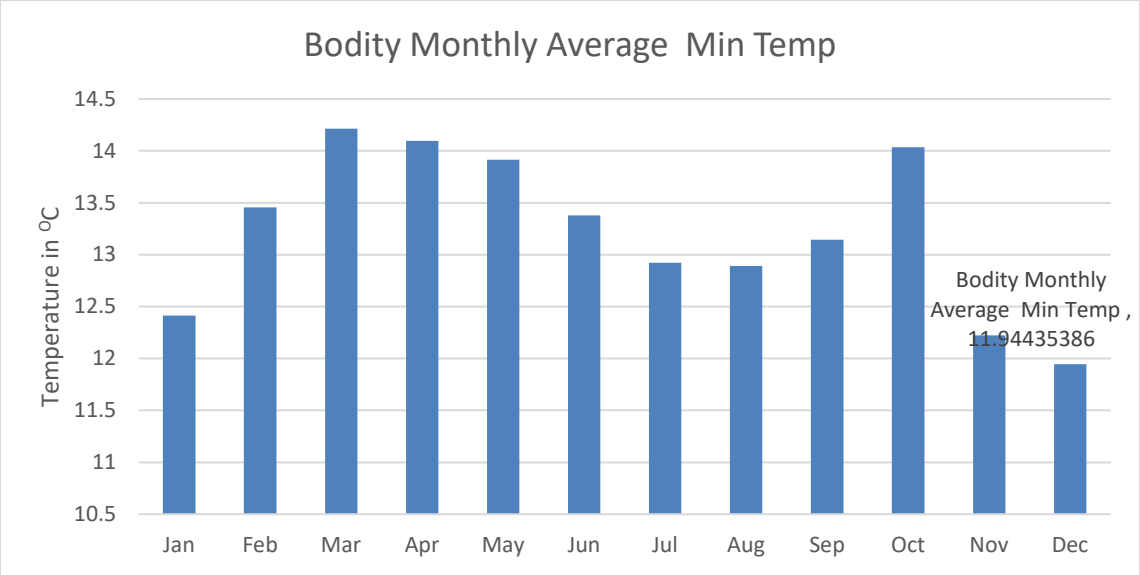


Figure 28: Bodity monthly average minimum temperature

The above figure shows that the monthly average minimum temperature in Bodity throughout the year, measured in degrees Celsius (°C).

From January to March the average minimum temperature rises from approximately 12.4°C in January to 14.2°C in March, indicating a warming trend. The temperature gradually decreases from approximately 14.1°C in April to 12.9°C in August. From September to October, the temperature increases from about 13.1°C to 14.0°C, showing a brief warming period. The temperature drops sharply, from approximately 12.2°C in November to 11.9°C in December.

The Highest and the lowest minimum temperature observed in March, at approximately 14.2°C and in December, at approximately 11.9°C respectively.

The graph shows noticeable seasonal variation in Bodity's average minimum temperatures. The temperature increases during the first three months, decreases gradually toward August, rises again in October, and then declines toward December. This pattern indicates that nighttime and early-

morning temperatures remain relatively mild throughout the year, with cooler conditions toward the end of the year.

In conclusion, Bodity experiences relatively moderate minimum temperatures throughout the year. March is the warmest month in terms of average minimum temperature, while December is the coolest. The relatively small temperature range of about 2.3°C suggests limited annual variation in average minimum temperatures.

Analysis of Bodity Annual Average Minimum Temperature (1990–2025)

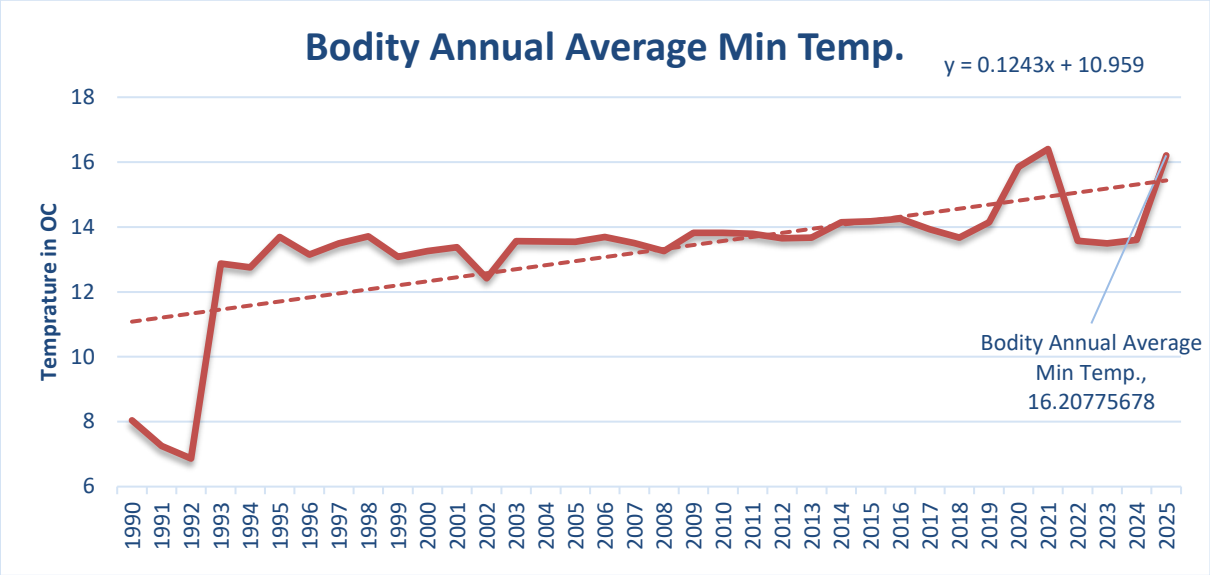


Figure 29: Bodity annual average minimum temperature

The graph illustrates the annual average minimum temperature in Bodity from 1990 to 2025, measured in degrees Celsius (°C). It shows fluctuations in minimum temperature over time and an overall increasing trend.

The graph indicates an overall increase in annual average minimum temperature. The dotted trend line has the equation:

$y = 0.1243x + 10.959$

The positive slope of 0.1243 indicates an estimated increase of approximately 0.124°C per year, equivalent to about 1.24°C per decade, based on the displayed trend line. This suggests that minimum temperatures have risen over the study period.

Highest and lowest temperature were approximately 16.4 C in 2021 and 6.8°C in 1992 respectively.

Bodity's annual average minimum temperature from 1990 to 2025 shows a clear overall increasing trend, despite substantial year-to-year fluctuations. The displayed trend line suggests warming of approximately 1.24°C per decade. This increase in minimum temperature highlights the importance of monitoring local climate conditions and considering temperature changes in agricultural planning and climate adaptation.

The increase in minimum temperature may have several implications:

- Agriculture: Warmer nights may affect crop development, flowering, and grain filling, depending on crop type and growth stage.
- Water resources: Higher nighttime temperatures can contribute to increased plant respiration and may influence overall water demand.
- Livestock: Warmer nights may reduce opportunities for animals to recover from daytime heat stress.
- Climate change: The sustained upward trend is consistent with a warming climate, although the graph alone cannot establish the cause.

Analysis of Bodity Mean Temperature (1990–2025)

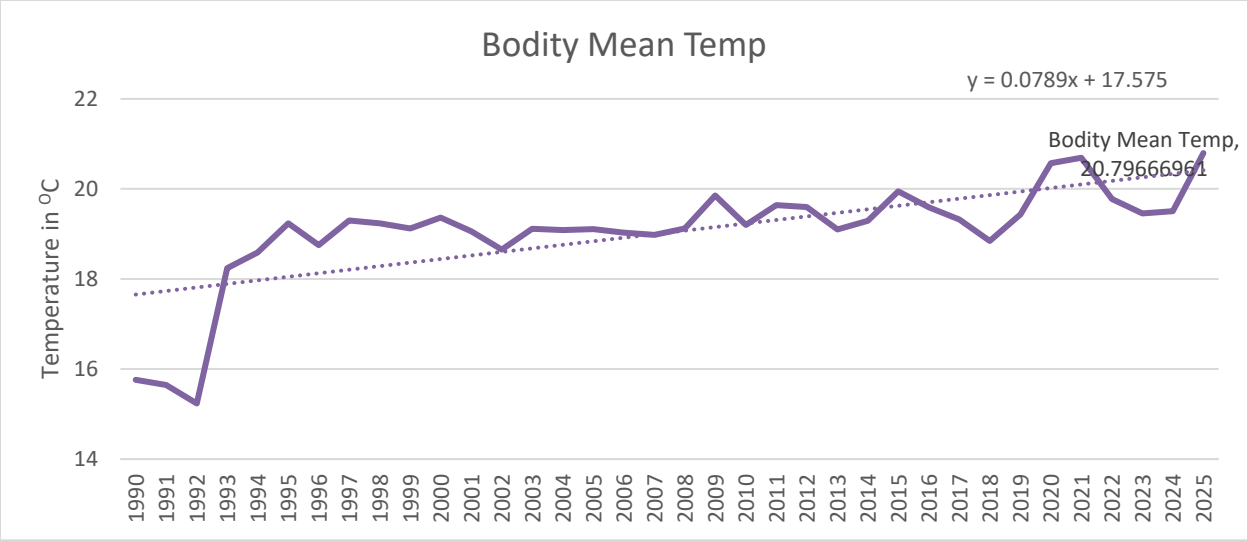


Figure 30: Bodity mean temperature

The line graph illustrates the annual mean temperature in Bodity from 1990 to 2025, measured in degrees Celsius (°C). It shows the variation in annual mean temperature and the overall trend over the 36-year period.

The graph shows an overall increasing trend in mean temperature. The dotted trend line has the equation:

$y = 0.0789x + 17.575$

The positive slope of 0.0789 indicates an estimated increase of approximately 0.079°C per year, equivalent to about 0.79°C per decade. This suggests that Bodity has experienced a gradual warming trend during the study period.

Highest and lowest mean temperature were approximately 20.8°C in 2025 and 15.2°C in 1992 respectively. From 2020–2025 mean temperatures remained relatively high, exceeding 20°C in several years and reaching approximately 20.8°C in 2025.

Bodity's annual mean temperature from 1990 to 2025 shows a clear overall warming trend, despite fluctuations between individual years. The displayed trend line indicates an increase of approximately 0.79°C per decade. The rise in mean temperature highlights the importance of climate monitoring and adaptation measures, particularly in agriculture and water management.

The increasing mean temperature may have several implications:

- Agriculture: Higher temperatures may increase crop water requirements and heat stress, potentially affecting crop growth and productivity.
- Water resources: Increased evaporation and evapotranspiration may contribute to soil moisture loss.
- Livestock: Warmer conditions may increase heat stress and affect animal productivity.
- Human health: Rising temperatures may increase heat-related discomfort, particularly during periods of unusually high temperatures.
- Climate change: The long-term upward trend is consistent with a warming climate, although this graph alone cannot establish the cause of the observed changes.

2.4.2. Driver and pressure for climate change/ Variability on the Buge Wetland Ecosystem

Population Growth

Population growth is an important socioeconomic factor that can contribute to climate change through increased demand for land, food, energy, water, and other natural resources. As the population increases, agricultural expansion, deforestation, fuelwood collection, livestock production, and settlement development may intensify, resulting in increased greenhouse gas emissions and reduced carbon storage. In the Buge wetland ecosystem of Sodo Zuria District, Wolaita Zone, southern Ethiopia, population pressure may contribute to wetland encroachment, vegetation degradation, and changes in ecosystem functions. These activities may also increase the vulnerability of the wetland to climate variability and change. However, population growth alone does not determine climate change; consumption patterns, energy sources, land-use practices, and economic activities also influence greenhouse gas emissions.

From FGD we understood that deforestation and over grazing, is one of the main driver and pressure for the climate change/variability in the study area.

Deforestation and Over grazing

Deforestation and excessive grazing Reduce wetland vegetation and biodiversity, Increase soil erosion and land degradation, Reduce soil moisture retention in surrounding areas, Increase the

vulnerability of the ecosystem to drought and changing rainfall patterns and reduce the wetland's capacity to store carbon. From field observation we sew there is soil erosion and land degradation



Figure 31: Degraded parts of Buge wetland ecosystem

2.4.3. Impact of climate change/variability on the Buge Wetland ecosystem

According to community members, climate-related changes have been associated with the occurrence of malaria among humans. In livestock, diseases locally known as *Aba Senga* and *Aba Gurba* have also been reported.

Furthermore, pest infestations have been observed affecting Enset, coffee, and banana crops. These problems have placed additional pressure on human health, agricultural productivity, and livestock health, thereby threatening local livelihoods and food security.

Community members reported that changes in rainfall patterns have significantly affected agricultural activities in the area. Traditionally, maize was planted in March and harvested in October, while teff was planted in July and harvested between October and November.

However, these agricultural calendars have become increasingly disrupted due to delayed, irregular, and insufficient rainfall. Such changes have affected planting and harvesting schedules, creating challenges for farmers in planning and carrying out agricultural activities.

According to the community, recurrent drought conditions have occurred since 2017 E.C. (2024/2025 G.C.). The resulting decline in grazing resources and maize production has adversely affected livestock rearing and household livelihoods.

Due to shortages of pasture and animal feed, some pastoralists have been forced to sell their livestock. Community members also reported that between five and ten animals die during drought episodes, although the period and geographical scope of this estimate require further verification.

Water scarcity identified as one of the major challenges facing the community. According to local accounts, recurrent droughts have occurred since 2017 E.C., contributing to livestock mortality, reduced crop production, and the deterioration of grazing resources.

Community members reported that more than 20 people died in 2018 E.C. (2025/2026 G.C.). They also expressed serious concern about the situation in 2019 E.C. (2026/2027 G.C.), reporting that maize production had failed and grazing resources had disappeared.

These conditions have increased the vulnerability of local households, particularly those dependent on rain-fed agriculture and livestock production. The resulting shortages of food, water, and animal feed have further undermined livelihood security.

In addition to drought, the community reported experiencing flood-related hazards. According to the information provided, a flood event in 2002 E.C. (2009/2010 G.C.) resulted in the displacement of one person.

The reported livestock losses included 12 oxen, five calves, 20 animals described in the original account as *lem*, more than 50 sheep, 10 goats, and between 20 and 40 chickens.

Furthermore, two household heads were reportedly displaced, four people relocated to other areas, and five people died as a result of the flood. Approximately 15 hectares of land were also reportedly abandoned or rendered unusable following the event.

Over all the findings from the community discussions indicate that rising temperatures, changing rainfall patterns, recurrent droughts, water scarcity, declining grazing resources, and flood events are adversely affecting human health, agricultural production, livestock, and environmental resources.

Irregular rainfall patterns have disrupted traditional agricultural calendars, reduced crop production, and contributed to shortages of livestock feed. These challenges have increased pressure on household livelihoods and food security. Reported livestock deaths, human fatalities, displacement, and damage to agricultural land further demonstrate the community's vulnerability to climate-related hazards. As reported during the community discussion, farmers previously harvested 10 quintals of maize, 8 quintals of beans, and 16 quintals of teff per hectare. However, agricultural productivity has declined significantly, and they currently obtain only 1 quintal of maize, 2 quintals of beans, and 2 quintals of teff per hectar in addition coffee product reduce by 50%.

2.4.4 Response Response taken for Climate Change/Variablity in the Buge Wetland Ecosystem

One of the adaptation measures reported by the community is annual tree seedling planting. This activity is important for environmental protection, increasing vegetation cover, restoring degraded land, and strengthening the resilience of local ecosystems to climate-related risks.

The findings highlight the importance of strengthening climate change adaptation and disaster risk reduction measures. Priority interventions include improving water resource management, strengthening drought and flood early warning systems, promoting climate-resilient agricultural practices, improving grazing land management, enhancing veterinary services, and expanding tree planting and ecosystem restoration initiatives.

According to the community discussion, 80 community members participate in soil and water conservation activities and sustainable development initiatives every week. In addition, the Buge Wancha Environmental and Forest Association was established to protect the Buge wetland. The association has 464 members and undertakes seedling-planting activities. Once a year, the association also provides grass harvested from the Buge wetland to its members at an affordable price. Furthermore, the association carries out wetland protection activities to prevent disturbance and damage caused by human and livestock activities.

2.4.5 Outlook for climate change /variability on the Buge wetland

Based on the annual rainfall graph for 1990–2025, the outlook for rainfall in Bodity suggests continued year-to-year variability, with a slight long-term decreasing trend. The trend-line equation indicates a gradual decline of approximately 1.78 mm per year. Annual rainfall is likely to remain variable, with alternating wet and dry years. The historical record shows substantial fluctuations, including very low rainfall in 2015 and high rainfall in 2024–2025.Years with substantially below-average rainfall may increase the risk of water shortages, crop stress, and reduced agricultural productivity. Years with high rainfall may increase the risk of soil erosion, waterlogging, and localized flooding, depending on rainfall intensity and local drainage conditions. Farmers should consider rainfall variability when selecting crops, planning planting dates, and managing soil moisture. Rainwater harvesting, soil, and water conservation measures could help reduce climate-related risks.

Based on the annual average minimum temperature data from 1990 to 2025, the outlook for Bodity suggests a continuation of the warming trend, with some year-to-year fluctuations.

The trend line ($y = 0.1243x + 10.959$) indicates an increasing trend in minimum temperature. If this historical trend continues, Bodity may experience warmer nighttime and early-morning

conditions in the coming decades. Increasing minimum temperatures may reduce nighttime cooling, potentially increasing heat stress for crops, livestock, and people, particularly when daytime temperatures are also high. Warmer nights may increase crop respiration and affect crop development, flowering, and grain filling. The impacts will depend on the crop species, growth stage, and availability of water. Higher temperatures may increase evapotranspiration and crop water demand, especially when combined with declining rainfall or prolonged dry spells. Warmer nights may limit recovery from daytime heat stress and affect livestock productivity and human comfort. Farmers and local planners should consider heat-tolerant crop varieties, improved soil moisture conservation, agroforestry, and appropriate planting dates to reduce potential climate risks.

The outlook indicates that Bodity is likely to experience warmer minimum temperatures if the historical warming trend continues. This may have important implications for agriculture, water management, and local climate resilience. Monitoring both minimum and maximum temperatures will help identify changes in heat exposure and support adaptation planning.

Based on the annual average maximum temperature data from 1990 to 2025, the outlook for Bodity suggests a continuation of the warming trend, with some year-to-year fluctuations.

The trend-line equation ($y = 0.0335x + 24.191$) indicates an increase of approximately 0.034°C per year, or 0.34°C per decade. If this historical trend continues, Bodity may experience progressively higher annual average maximum temperatures in the coming decades. Continued warming may increase the frequency or intensity of hot conditions, potentially affecting agricultural production, livestock, and human comfort. Higher temperatures may increase crop evapotranspiration and soil moisture loss, particularly during periods of low rainfall. Heat-sensitive crops may experience reduced growth and productivity. Rising temperatures may increase evaporation and crop water requirements, placing additional pressure on water resources during dry periods. Continued warming may increase livestock heat stress and the risk of heat-related health problems, particularly during unusually hot periods. Therefore, Climate-smart agriculture, soil moisture conservation, agroforestry, appropriate crop varieties, and improved water management may help reduce the potential impacts of increasing temperatures.

2.5 Water

2.4.1 State and Trend of Water Availability in the Buge wetland ecosystem

Water is considered 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 distributed 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, the provision of water for energy production is ignored by water professionals and development experts. Sustainable development and advanced economic growth, sanitation, wastewater treatment, and water supply cannot be achieved 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 voiced nowadays, focuses on the necessary integration of water management between sectors, policies, and institutions. These can be 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 man-made 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).

The Ethiopian Rift is characterized by a chain of lakes varying in size, hydrological and hydrogeological setting. Some of the lakes and tributary rivers are used 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 specified chemical contamination (WHO and UNICEF, 2019).

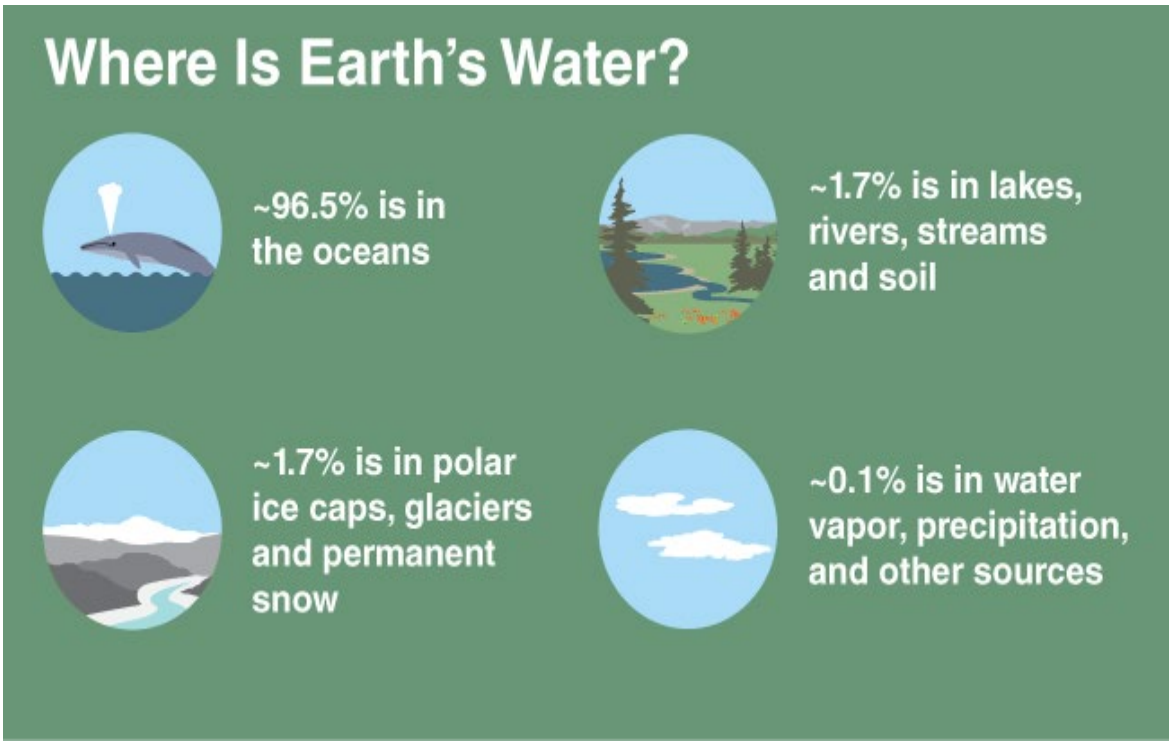
According to report by the Central Statistical Agency of Ethiopia (2017), nationally 13 percent of the population is considered using safely managed services (CSA, 2017).Limited access to drinking water services continues to be a major public health problem in Ethiopia.

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.

What Is the Water Cycle?

The water cycle is the path that all water follows as it moves around Earth. Water changes between three states of matter solid, liquid, and gas in the water cycle. Liquid water is found in oceans, rivers, lakes, and even underground. Solid ice is found in glaciers, snow, and at the North and South Poles. Water vapor a gas is found in Earth's atmosphere.

Water can be found all over Earth in the ocean, on land, and in the atmosphere. The **water cycle** is the path that all water follows as it moves around our planet.



Earth's water is found in all three states of matter: solid, liquid, and gas. Most of it is found in the ocean, and the rest is fresh water.
NASA/JPL-Caltech

On Earth, you can find water in all three states of matter: **solid**, **liquid,** and **gas**. Liquid water is found in Earth's oceans, rivers, lakes, streams, and even in the soil and underground. Solid ice is found in glaciers, snow, and at the North and South Poles. Water vapor — a gas — is found in Earth's atmosphere.

How does water travel from a glacier to the ocean to a cloud? That's where the water cycle comes in.

The Water Cycle

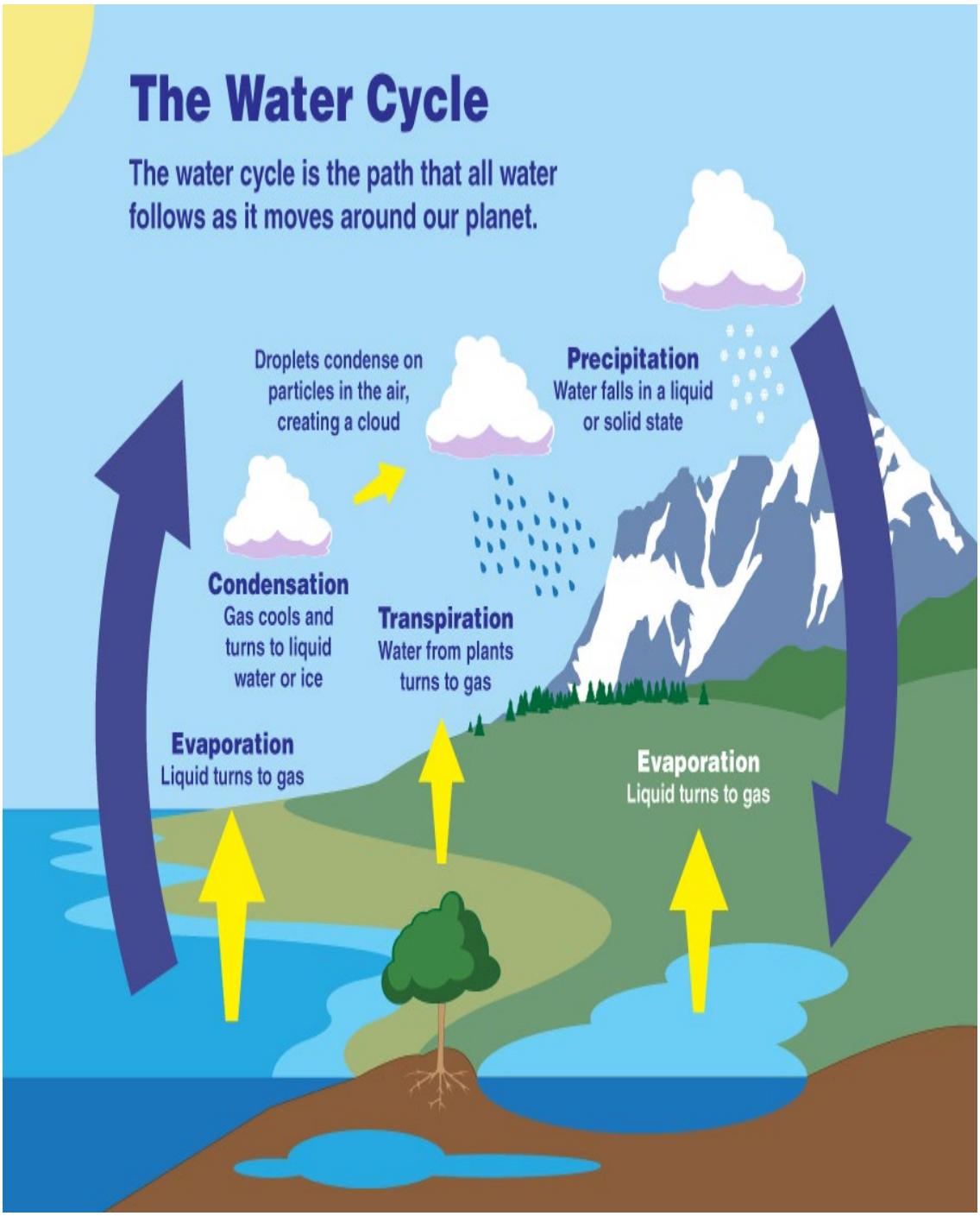


Figure 32: Water Cycle

Earth's water cycle is the path that water takes as it moves around Earth. This includes times when it flows, like when it rains, and places where it's stored, like in ice, groundwater, lakes, rivers, and the ocean.

Household water data and treatment practices for Sodo Zuria District (Wolaita Zone, Southern Ethiopia) from community-based studies show the following key metrics and facts:

District Overview

- **Location:** Wolaita Zone, Southern Ethiopia (approx. 329 km south of Addis Ababa)
- **Administrative Units:** 36 Kebeles
- **Population & Households:** ~172,632 people across roughly 35,231 households
- **Primary Water Sources:** Mostly unimproved sources, including rivers, unprotected wells, and natural springs.

Household Water Treatment (HWT) Practices

- **Overall Treatment Rate:** Only **44.1%** of rural households practice any form of household water treatment; **55.9%** never treat their water.
- **Primary Methods Used:**
  - **Boiling:** 29.5%
  - **Filtration:** 43.3% *(among those aware/practicing treatment)*
  - **Chlorine Bleach / Watermaker:** 10.1%
  - **Solar Disinfection (SODIS):** 21.3%
  - **Settling / Decanting:** 4.5%
- **Consistency:** While 67.4% claim to know or practice treatment methods, only **39.9%** perform water treatment consistently.

Key Barriers & Influencing Factors

- **Awareness vs. Action:** 84.3% of residents have heard of water treatment and know the health risks of untreated water, yet only 47.2% rate their own knowledge as "fair" and 10.1% as "very good".

- **Main Constraints:** Affordability (84.3%), time constraints (78.7%), seasonal water availability variations (68.0%), perception that treatment is ineffective (28.7%), and method complexity (28.1%).
- **Positive Predictors:** Household water treatment practice increases with higher monthly income (AOR = 1.5), older age above 45 (AOR = 1.69), and frequency of fetching water twice a day (AOR = 2.8)

Challenges, practices, Wolaita Sodo town, water demand and supply. Access to water supply in Ethiopia is amongst the lowest in Sub-Saharan African countries. For instance in both urban and rural parts of the country, the existing service level is lesser than the required levels. Therefore, the study was intended to assess the practices and challenges of water service delivery in Wolaita Sodo town. To attain the objectives of the study descriptive research design was implemented. Both primary and secondary sources were used to obtain all necessary data for the study. Specifically the study conducted on 199 households that selected from Wolaita Sodo town residents using stratified sampling technique. Questionnaires, interview and document analysis were used to collect data concerning the practices, accessibility and challenges of water supply in the town. The result of the study illustrates that water supply is very poor and below the standard that set by World Health Organization in Wolaita Sodo town. It is quite evident that rapid population growth, frequent interruption of water supply, poor management, lack of budget, and low participation of community and other stakeholders were mainly restrains water services delivery in the town. Because of this the gap between demand for water service and its supply is increasing. Therefore, Water supply and sanitation department, NGOs, communities, and private sectors should be actively engaged in crafting and applying various projects to provide safe water service delivery in the town.

Key takeaways

1. Access to clean water in Wolaita Sodo is critically low, with only 24% coverage.
2. Rapid population growth at 2.5% exacerbates water supply challenges amid stagnation in service delivery.
3. Water supply interruptions occur frequently, with 89% of households lacking daily access to water.
4. Ineffective governance, poor management, and inadequate funding impede water service improvements.

5. Community engagement and infrastructure investment are essential for sustainable water delivery solutions.

2.4.2. Driver and pressure for Water of Water Resource Degradation in the Buge wetland ecosystem

Population Growth

According to Sodo zuiriya 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 Buge 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.

1. 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.

2. 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

3.4.3 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, impacting 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, impacting 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, impacting 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 due to the fact that 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,. Sodo zuriya 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 Buge 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 exposed 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 Buge wetland 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 introduced to inform residents about the importance of water conservation and the consequences of degradation.

The outlook for water degradation in sodo zuriya 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, impacting 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

If conditions continues business us usual the Sodo zuriya woreda water problem will aggravate time to time, so that not only the community but also animal will be suffered with water problem.

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. Implementing conservation strategies, improving resource efficiency, and restoring degraded areas can 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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