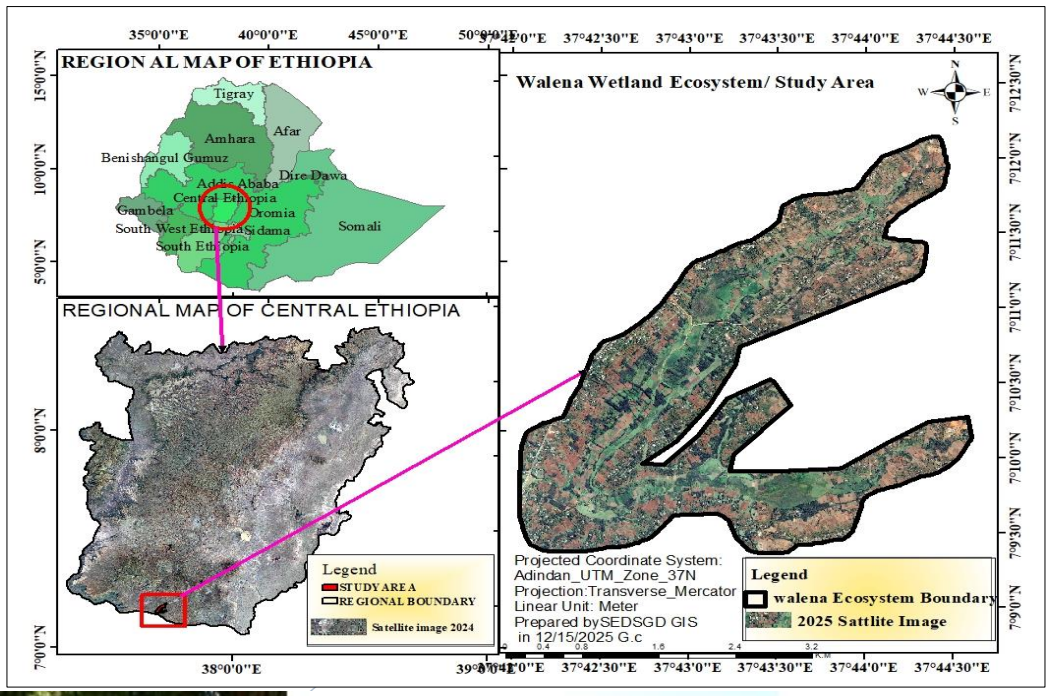
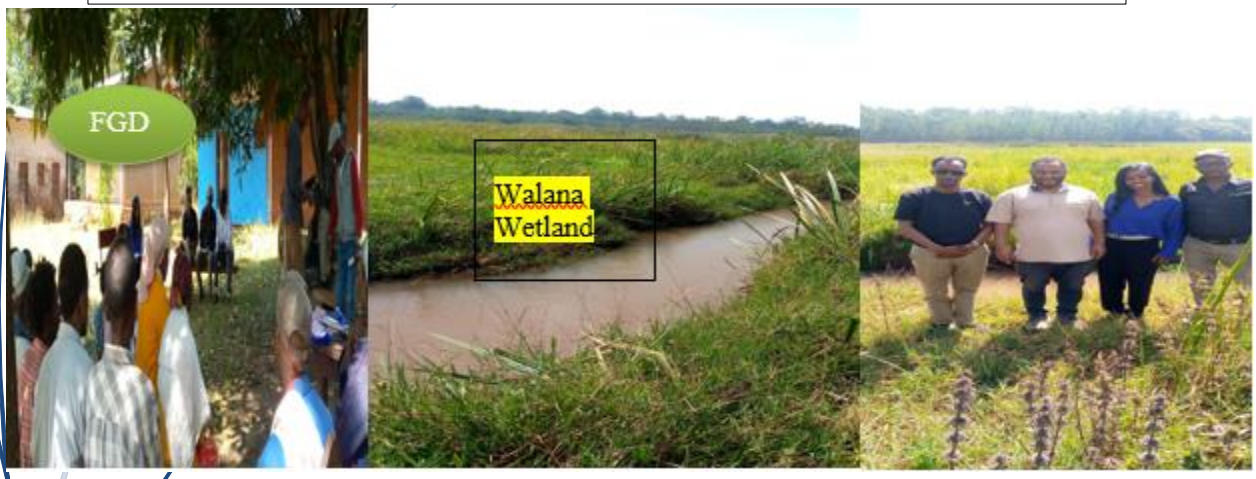
FACT-SHEET OF WALANAWETLAND ECOSYSTEM
In the Central Ethiopia

[Date]





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Abbreviations

FGD=Focus Group Discussion

FAO = Food and Agriculture Organization (of the United Nations)

NASA = National Aeronautics and Space Administration

EMI= Ethiopia Meteorological Institute

UN= United Nation

FGD -Focal Person Dissection

GIS –Geographical Information system

IUCN –International Union Conservations to Nature

MEA- Millennium Ecosystem Assessment

1. General Back ground

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 found to be unsatisfactory and criticized for two reasons. First, the benefits of development have been 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. They are promoting development and achieving their national aspirations by 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 is implementing its five-year Growth and Transformation Plan (GTP), which aims to improve the livelihoods of its people. The GTP seeks to sustain rapid and broad-based economic growth and is built on seven pillars, four of which are: sustaining fast and equitable economic growth; maintaining agriculture as a major source of economic growth; creating favorable conditions for industry to play a key role in the economy; and expanding and improving the quality of infrastructure development. Furthermore, the environmental sector plan is an integral component of the country's GTP.

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).

GTP-II argues that reaching its goals require significant investments to boost agricultural productivity, strengthen the industrial base and foster export-oriented growth NAP-ETH (2017). NAP-ETH aims to strengthen holistic integration of climate change adaptation in Ethiopia's long-term development pathway; its vision is to create climate change impact resilient development for Ethiopia and its people NAP-ETH (2017).

Frame works/Approaches

The Driver-pressure-state-impact-response framework the current study tried to use DPSIR approaches.

The DPSIR framework is a variant of the Pressure – State – Response (PSR) framework originally developed by Rapport and Friend (1979) for Statistics Canada and adopted by other bodies such as UNEP in the GEO and AEO processes.

The "DPSIR" framework is multi-scalable and indicates generic cause and effect relations within and among the following:

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

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

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

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

- RESPONSES: Responses consist of elements among the drivers, pressures and impacts which may be

Used for managing society in order to alter the human environment interactions. Drivers, pressures and impacts that can be altered by a decision-maker at a given scale are referred to as endogenous factors, while those that cannot are referred to as exogenous factors

2. Social and Economic Environment

2.1 Social Environment

2.1.1. State and trend of 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

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 social circle (http://www.definitions.net/definition/social environment)

A **wetland** is a distinct semi-aquatic ecosystem whose groundcovers are flooded or saturated in water, either permanently, for years or decades, or only seasonally. Flooding results in oxygen-poor (anoxic) processes taking place, especially in the soils. Wetlands form a transitional zone between waterbodies and dry lands, and are different from other terrestrial or aquatic ecosystems due to their vegetation's roots having adapted to oxygen-poor waterlogged soils. They are considered among the most biologically diverse of all ecosystems, serving as habitats to a wide range of aquatic and semi-aquatic plants and animals, with often improved water quality due to plant removal of excess nutrients such as nitrates and phosphorus.

Wetlands exist on every continent, except Antarctica. The water in wetlands is either freshwater, brackish or saltwater. The main types of wetland are define based on the dominant plants and the source of the water. For example, *marshes* are wetlands dominated by emergent herbaceous vegetation such as reeds, cattails and sedges. *Swamps* are dominated by woody vegetation such as trees and shrubs (although reed swamps in Europe are dominated by reeds, not trees). Mangrove forest are wetlands with mangroves and halophytic woody plants that have evolved to tolerate salty water.

Examples of wetlands classified by the sources of water include *tidal wetlands*, where the water source is ocean tides; *estuaries*, water source is mixed tidal and river waters; *floodplains*, water source is excess water from overflowed rivers or lakes; and *bogs* and *vernal ponds*, water source is rainfall or meltwater, sometimes mediated through groundwater springs. The world's largest wetlands include the Amazon River basin, the West Siberian Plain, the Pantanal in South America, and the Sundarbans in the Ganges-Brahmaputra delta.

Wetlands contribute many ecosystem services that benefit people. These include for example water purification, stabilization of shorelines, storm protection and flood control. In addition, wetlands also process and condense carbon (in processes called carbon fixation and sequestration), and other nutrients and water pollutants. Wetlands can act as a sink or a source of carbon, depending on the specific wetland. If they function as a carbon sink, they can help with climate change mitigation. However, wetlands can also be a significant source of methane emissions due to anaerobic decomposition of soaked detritus, and some are also emitters of nitrous oxide.

Humans are disturbing and damaging wetlands in many ways, including oil and gas extraction, building infrastructure, overgrazing of livestock, overfishing, alteration of wetlands including dredging and draining, nutrient pollution, and water pollution. Wetlands are more threatened by environmental degradation than any other ecosystem on Earth, according to the Millennium Ecosystem Assessment from 2005. Methods exist for assessing wetland ecological health. These methods have contributed to wetland conservation by raising public awareness of the functions that wetlands can provide. Since 1971, work under an international treaty seeks to identify and protect "wetlands of international importance."

Durame is a town in southeastern Ethiopia. The administrative center of the Kembata Tembaro Zone of the Southern Nations, Nationalities and Peoples Region (SNNPR), this town has a latitude and longitude of 7°14′N 37°53′E with an elevation of 2101 meters above sea level. Damboya Woreda surrounded by Materials on the Nordic Africa Institute website, describe Durame as the main town for the Kambaata-speaking people.

According to the SNNPR's Bureau of Finance and Economic Development, as of 2003 Durame's amenities include digital telephone access, postal service, 24-hour electrical service, two bank branches (Global bank and Commercial Bank of Ethiopia), and a hospital.

Following the Italian invasion, on 8 May 1936 a civil war erupted between the local population and the remaining Amhara, forcing local missionaries to evacuate the area. In 1962 a road linking Durame with Hosaena was constructed; bridges over the Markos and Dembe rivers were built in 1968.

Demographics

Based on the 2007 Census conducted by the CSA, this Woreda has a total population of 24,472 of whom 12,173 are men and 12,299 women. The majority of the inhabitants were Protestants, with 86.51% of the population reporting that belief, 7.39% practiced Ethiopian Orthodox Christianity, and 4.93% were Catholic.

The 1994 census reported this town had a total population of 7,092 of whom 3,577 were men and 3,515 were women. It is the larger State and trend of social environment

Population

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.

Table 1: Population Trend Kacha Bira Woreda

Year (G. C) for the last 25 years	Rural population			Urban. population		populati on	Total in 25 years
	MALE	FEMAL	TOTA	MALE	FEMALE	TOTAL	
	84710	85362	170072	48370	49770	98140	

Source: - kacha Woreda (2025)

As the population increases, their economic interest, the demand on infrastructure, food security, energy source, health facilities and necessities as a whole is increased. The consequences that we saw in the nearby Walana wetland Ecosystem due to high population the demand for grazing land and agriculture courses the distraction of the ecosystem.as we have seen from the Table the number of women is greater than men.

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: Student of Kacha Bira Woreda

NO	**Level of School**	**Students in Kacha Bira Woreda**						
		Number of schools	**2023**			**2024**		
			Male	**Female**	**Total**	**Male**	**Female**	**Total**
1	Elementary school	38	8720	8240	16960	8940	8417	17357
2	Primary School (1-8)	38	1946	2080	4026	2011	2196	4207
3	SS/High School (9-12)	4	611	723	1334	624	754	1378
4	Number of teacher		380	274	654	385	285	669

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

According to Kacha Bira Education office report 38 elementary school 38 primary school,and 4 SS school, , School are Available .

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 Kacha Woreda gives various services to the area's population.

No		years					Total
		2020	2021	2022	2023	2024	
1	Governmental Health Center	4	4	4	4	4	4
1.1	Primary Hospital	o	0	0	0	0	
1.2	Health center						
1.3	Health post	22	22	22	22	22	80
2	Private Health Centers	0	0	0			0
2.1	Primary Health clinics	2				3	5
2.3	Private pharmacy	1	1	1	2	2	3
	Total						

Source: - Kacha Bira Woreda Health Report 2018

As indicated on the above tables, the numbers of Governmental Health Institutions in the Woreda is constant no increment. From the total population who has access to health service is 80% however there is no health center problem as compared with the Woreda population.

Road and 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 Kacha Bira *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).

The total existing road in the *Woreda* is 86 kilometers. Most of the rural roads are seasonal and deteriorated, thus their role to the *Woreda* socio economic development is limited.

The population who has access to Road infrastructure is around 55.3%, According to focal groups and key informant discussion in *Kacha Bira Woreda* there is a great problem of road infrastructure .

Table 4: ***Types and length of Roads, Kacha Bira in the year 2018***

No	**Road type**	**Length in km**	% of population who has access to Road
1	Asphalt	32.5	55.3%
2	All weather rood	29	
3	Dray weather rood	24.5	
	Total	86	55,3%

Source: Woreda Transport office

Water Resource and Supply

In the *Woreda*, water bodes like 1 pond 2 spring and 5 revers are available The above stated surface water resources and various springs were used to provide the *Woreda* with considerable amount of water that was sufficient for domestic water use and even for all year round human, animal water consumption and for irrigation purposes. However, elder in the *Woreda* under lined that currently due

to various environmental and social problems the wetland and springs were dried, while the volume of existing small streams and river as well as the discharge rate of springs has been decreasing from time to time. Because of this risen, the percentage of population who has access to cline water is 28.3%

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. Kacha Bira *Woreda*, has 24 hours telephone services, from total population 71% 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 kacha Bira Woreda 15, % of the population has access to electric service this shows that electricity is one of the major problem for the Woreda .

2.1.2. Drivers and pressure of social environment

Walana wetland Ecosystem is one of highly degraded ecosystem. The main drivers for the deterioration of the ecosystem are mainly population growth and that leads to overstocking Natural resource, 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.

2.1.3. 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 Boser up (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 agricultural land. This is usually happened in Walana wetland.

- Over grazing and demand of land for house constriction and land for agriculture, increasing animal population around Walana wetland ecosystem is one problem for ecosystem degradation.

2.1.4. 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 programme in accordance with national priorities as stated below

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

(ii) Provision of expanded family planning services;

(iii) Strengthening of training in population;

(iv) Promotion of the status of women.

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

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 Walana wetland ecosystem they were done conservation work like water shade management.

2.1.5. Outlook for Socio Environment of SMFE

If the completely 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 Walana ecosystem.

2.2. Economic Environment

2.2.1. State and trend of the economic Environment

Agriculture is the most important determinant of the Central Ethiopia Peoples' Region's economy and it will continue to play the leading role in the overall economy development of the region. The livelihood of the people is dependent on agriculture, however, agricultural system in the region is at subsistence level and food insecurity problem is increasing at alarming rate.

According to the current (FEDO) report in 2024, Contribution of Agriculture sector to kacha Bira *Woreda* gross domestic product (GDP) is very high, which is:-

- Agriculture Sector 73. %
- Industry Sector 2 %
- Service sectors 20%

- Investment Sector 5% (Percent) and it does not get information about service sector.

Livestock sector is a source of livelihoods and income, mainly for the rural and per-urban communities.

2.2.2. Drivers and pressures of the economy

The driving force behind economic policy-making lies in the macro-economic objectives. The macro-economic objectives should be environmentally and socially sustainable. Obviously, the macro-economic objectives are economic growth measured in terms of the percentage change in the Gross Domestic Product (GDP), employment, price stability, and equity. The very concept of studying population dynamics and economic environment is that its interlinked nature.

2.2.3. Impacts due to the Economic Condition

The nature of economic growth can be analyzed 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 considered to understand 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 Walana 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 charcoal, 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. The population density around Walana wetland ecosystem is increasing.

Response Measures

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

2.2.4. Outlook for Economy

If everything continues as business as usual, Walana wetland Ecosystem in Kacha Bira Woreda the natural environment could not be able to provide the environment service.

2.2.5. 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 including water shade management

- To improve Livestock production management of all farmers
- Awareness creation should be given about climate change,

3. Biophysical environment for Walana wetland ecosystem

3.1. Land

3.1.1. State and trend of Walan wetland ecosystem Detailed Land Use/Land Cover Dynamics (2015–2025)

Table 5: Land Use/Land Cover Change Matrix (2015–2025)

LULC Class	2015 Area (ha)	2015 %	2025 Area (ha)	2025 %	Change (ha)	Change (%)	Annual Rate (ha/yr)
Wetland	484.7	46.4 %	143.0	13.7 %	-341.7	-32.7%	-34.2
Perennial Crop	213.6	20.4 %	445.5	42.6 %	+231.9	+22.2 %	+23.2
Cropland	186.5	17.8 %	289.1	27.7 %	+102.6	+9.9 %	+10.3
Forest	93.6	8.9%	140.2	13.4 %	+46.6	+4.5 %	+4.7
Settlement	8.2	0.8%	16.4	1.6%	+8.2	+0.8 %	+0.8
Bare Land	51.2	4.9%	7.0	0.7%	-44.2	-4.2%	-4.4
Road	2.5	0.2%	2.5	0.2%	0.0	0.0%	0.0

LULC Class	2015 Area (ha)	2015 %	2025 Area (ha)	2025 %	Change (ha)	Change (%)	Annual Rate (ha/yr)
Water Body	3.4	0.3%	0.0	0.0%	-3.4	-0.3%	-0.3
TOTAL	1,043.7	100.0 %	1,043.7	100.0 %	0.0	0.0%	0.0

This table (table 5) serves as the foundational quantitative record of ecosystem transformation, documenting a radical shift from a wetland-dominated to an agriculture-dominated landscape over just ten years. The numbers reveal a catastrophic loss of wetland area 341.7 hectares vanished, representing nearly one-third of the total study area, with wetlands declining from nearly half the landscape (46.4%) to a mere remnant (13.7%). This disappearance occurred at an alarming rate of 34.2 hectares annually, indicating systematic, sustained conversion rather than incidental loss. Simultaneously, perennial crops more than doubled their footprint, expanding from 213.6 to 445.5 hectares to become the new dominant land use, while general cropland also grew substantially. The increase in forest cover from 8.9% to 13.4% initially appears positive but likely reflects plantation forestry particularly water-intensive eucalyptus rather than natural regeneration, representing ecological degradation disguised as improvement. Bare land diminished significantly as virtually all-convertible land was brought into production, suggesting maximum land pressure. This transformation represents a fundamental ecosystem regime shift, where hydrological and ecological functions have been sacrificed for agricultural production, with profound implications for water regulation, biodiversity, and long-term sustainability.

Soil Moisture Content (SMC) Dynamics

Table 6: Soil Moisture Content Change (2015–2025)

SMC Class	SMC Range	Ecological Interpretation	2015 Area (ha)	2015%	2025 Area (ha)	2025%	Change (ha)	Annual Rate (ha/yr)
Very Low	≤ 0.5739	Severely dry soil; degraded/bare land	300.9	28.80%	259	24.80%	-41.9	-4.19
Low	0.5740 – 0.7784	Dry soil; limited water availability	457.4	43.80%	426.4	40.90%	-31	-3.1
Moderate	0.7785 – 0.9829	Optimal for vegetation and biodiversity	197.8	19.00%	242.6	23.20%	44.8	4.48
High	> 0.9829	Wet soil; wetlands or riparian zones	87.6	8.40%	115.7	11.10%	28.1	2.81
TOTAL			**1,043.70**	**100.00%**	**1,043.70**	**100.00%**	**0**	**0**

This table (Table 6) presents a seemingly paradoxical finding: while wetlands physically disappeared, soil moisture conditions overall improved. The data show a 6.9% shift from dry to moist soil conditions, with the combined "Moderate" and "High" moisture classes growing from 27.4% to 34.3% of the area. This apparent improvement contradicts expectations, as wetland drainage typically reduces overall landscape moisture. The explanation lies in spatial redistribution and local intensification: drainage concentrates water in remaining wetland fragments and irrigation likely boosts moisture in agricultural zones, creating localized improvements that mask broader hydrological degradation. The Moderate moisture category optimal for vegetation growth showed the strongest positive trend, increasing by 4.48 hectares annually, while severely dry areas

diminished at nearly the same rate. This suggests that while the wetland ecosystem structurally collapsed, certain areas experienced functional changes that temporarily improved growing conditions. However, this improvement is likely unsustainable, depending on continued water redistribution that may ultimately fail as the hydrological system degrades further. The table thus reveals a complex, non-linear relationship between land cover and soil moisture, where immediate local gains may precede system-wide collapse.

Spatial Pattern Analysis

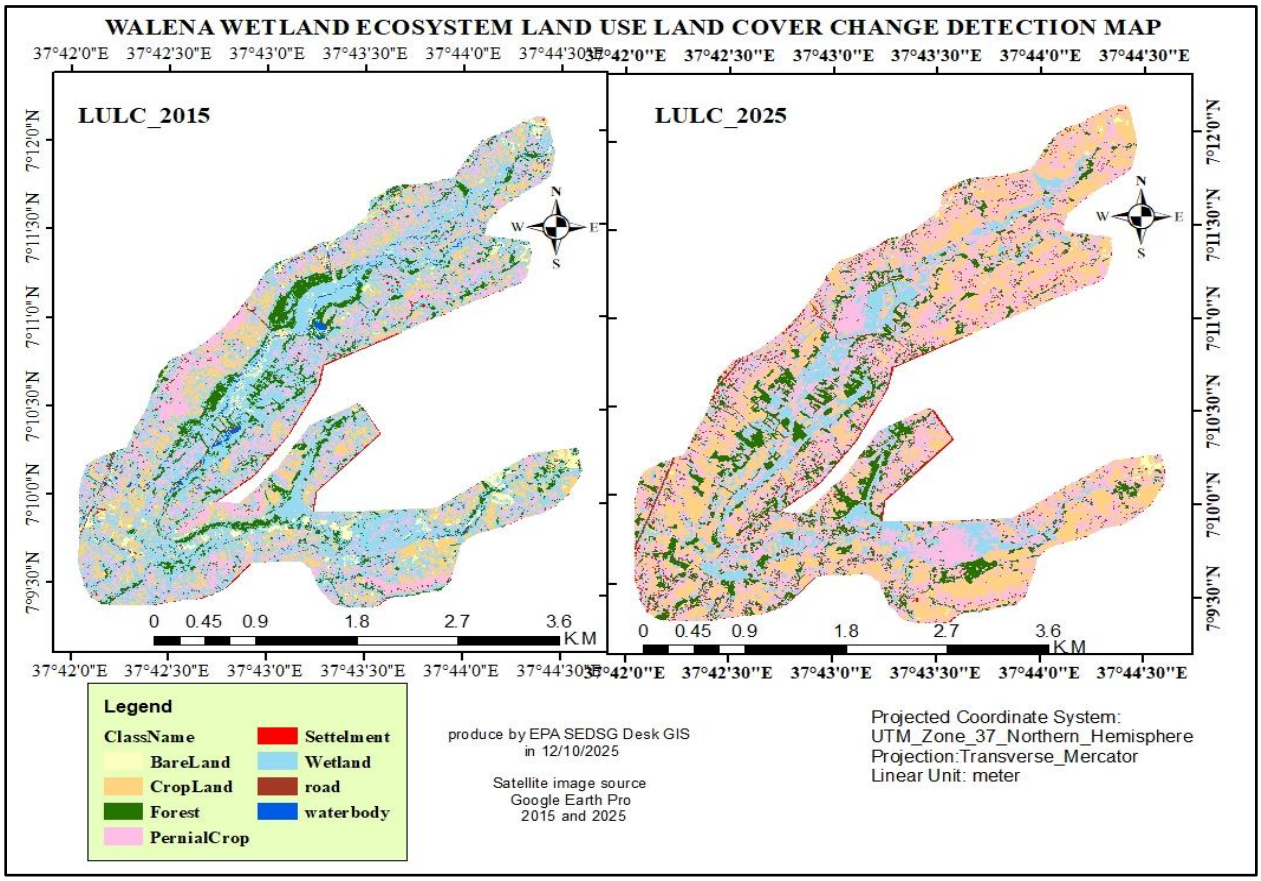


Figure 1: LULC Change Maps (2015 vs. 2025)

Key Spatial Observations:

1. **Wetland Fragmentation**: Continuous wetland areas in 2015 were fragmented into isolated patches by 2025
2. **Agricultural Encroachment**: Perennial crops expanding radially from wetland edges

3. **Central Corridor Persistence**: Linear wetland/riparian corridor remains but is narrowed

4. **Forest Patch Distribution**: New forest areas concentrated on steeper slopes

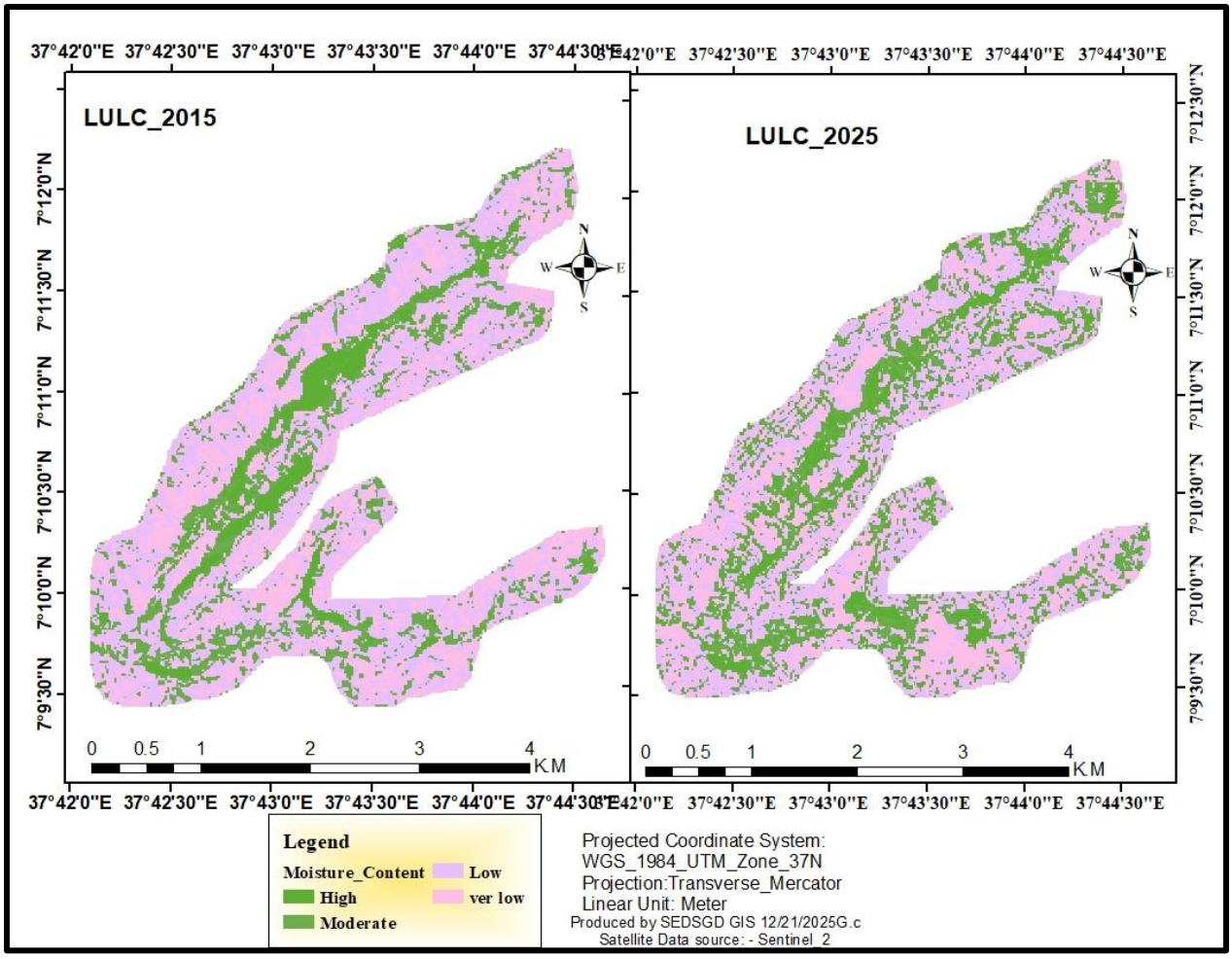


Figure 2: SMC Distribution Maps (2015 vs. 2025)

SMC Spatial Patterns:

1. High Moisture Concentration: The central corridor shows increased saturation

2. Dry Zone Expansion: Outer agricultural areas show decreased moisture

3. Moisture Redistribution: Not uniform improvement, but spatial redistribution

3.1.2. Driver and pressure for Walan wetland ecosystem degradation

Primary Drivers

Table 7: Driver Classification and Magnitude

Driver Category	Specific Driver	Magnitude	Evidence
Demographic	Population growth	2.8% annual increase	District census data
Economic	Market demand for cash crops	150% price increase	Market surveys 2015–2025
Policy/Institutional	Weak wetland protection	0% formal protection	Policy document review
Technological	Improved drainage techniques	Widespread adoption	Farmer interviews
Cultural	Changing land values	Wetland as "waste" land	Community perception surveys
Climate	Rainfall variability	±20% inter annual	Meteorological data

This table (Table 7) systematically identifies and quantifies the underlying forces driving wetland conversion, revealing a hierarchy of causation dominated by economic incentives. The 150% increase in cash crop prices between 2015 and 2025 emerges as the primary catalyst, creating overwhelming financial pressure for wetland conversion. This economic driver operates within a policy vacuum, where zero formal wetland protection removes all institutional barriers to conversion. Demographic pressure provides constant momentum, with 2.8% annual population growth generating relentless demand for agricultural land as uplands become saturated. Technological factors, particularly improved drainage techniques, lower the practical barriers to wetland conversion, while cultural perceptions of wetlands as "waste land" rather than valuable ecosystems remove social resistance. Climate variability, with ±20% rainfall fluctuations, acts as a risk multiplier, pushing farmers to secure water access through wetland cultivation. These drivers

interact synergistically: economic incentives motivate conversion, policy failure enables it, population growth necessitates it, technology facilitates it, cultural perceptions justify it, and climate uncertainty accelerates it. This confluence creates a perfect storm where multiple drivers reinforce each other, explaining the speed and scale of observed transformation (Sterman, 2000).

Driver Interactions

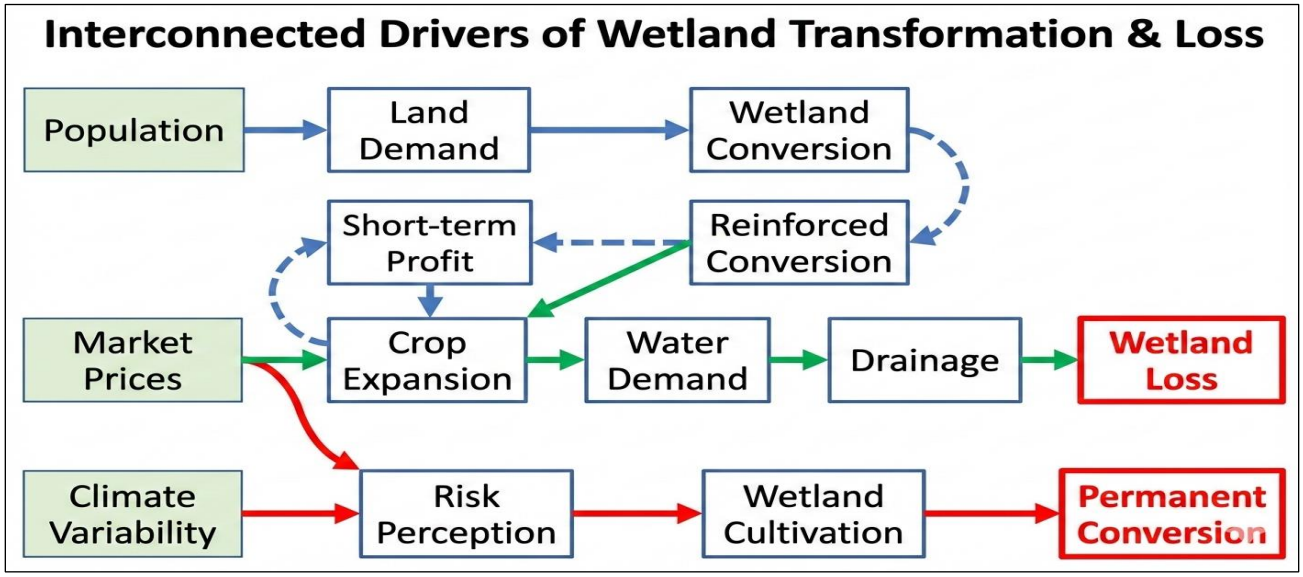


Figure 3: Driver Interaction Diagram

Complex Feedback Loops (Sterman, 2000):

1. Population → Land Demand → Wetland Conversion → Short-term Profit → Reinforced Conversion
2. Market Prices → Crop Expansion → Water Demand → Drainage → Wetland Loss
3. Climate Variability → Risk Perception → Wetland Cultivation → Permanent Conversion

Pressures Analysis: Direct Human Activities

Pressure Types and Intensity

Table 8: Pressure Assessment Matrix

Pressure Type	Specific Activity	Spatial Extent	Temporal Pattern	Intensity
Land Conversion	Wetland drainage	341.7 ha	Continuous (2015–2025)	High
	Forest clearance	120.3 ha	Peaks 2018–2020	Medium
Agricultural	Perennial crop expansion	231.9 ha	Accelerating	Very High
	Cropland expansion	102.6 ha	Steady	High
Infrastructure	Settlement expansion	8.2 ha	Gradual	Low
	Road maintenance	2.5 ha	Stable	Very Low
Resource Extraction	Water abstraction	Entire wetland	Dry season peaks	Medium
	Biomass harvesting	Peripheral zones	Seasonal	Medium

This table (Table 8) translates abstract drivers into concrete human activities, detailing the specific actions that directly degrade the wetland ecosystem. Wetland drainage emerges as the most destructive pressure, permanently altering 341.7 hectares of hydrological landscape through channelization and water table lowering. This physical alteration enables the second major pressure agricultural expansion with perennial crops spreading across 231.9 hectares and general cropland expanding across 102.6 hectares. The temporal patterns reveal strategic behavior: forest clearance peaked between 2018 and 2020, possibly coinciding with specific policy windows or market opportunities, while drainage proceeded steadily throughout the decade. Settlement expansion, though modest in area (8.2 hectares), represents permanent land commitment and

introduces new stressors like pollution and impervious surfaces. The spatial distribution of pressures creates distinct impact zones, with the northwest experiencing high combined agricultural and drainage pressure, the central zone facing moderate agricultural pressure with water abstraction, and the southeast remaining relatively undisturbed but vulnerable. These pressures interact cumulatively: drainage enables cultivation, which necessitates further drainage, creating a self-reinforcing cycle of degradation that becomes increasingly difficult to reverse.

3.1.3. Impact of Walana wetland ecosystem

Biophysical Impacts

Table 9: Biophysical Impact Assessment

Impact Category	Indicator	2015 Status	2025 Status	Change Direction
Hydrological	Water retention capacity	High	Low	↓ 65%
	Peak flood magnitude	25 m^3/s	42 m^3/s	↑ 68%
	Dry season baseflow	1.2 m^3/s	0.8 m^3/s	↓ 33%
3Ecological	Wetland-dependent species	45 species	28 species	↓ 38%
	Habitat connectivity	0.85 (index)	0.42 (index)	↓ 51%
	Native vegetation cover	89%	67%	↓ 22%
Soil Quality	Organic matter content	4.8%	3.1%	↓ 35%

Impact Category	Indicator	2015 Status	2025 Status	Change Direction
	Erosion rate	2.3 t/ha/yr	4.7 t/ha/yr	↑ 104%
	Water infiltration rate	35 mm/hr	18 mm/hr	↓ 49%

This table (Table 9) quantifies the ecological consequences of wetland conversion, revealing systemic degradation across hydrological, biological, and pedological dimensions. Hydrologically, the ecosystem has lost 65% of its water retention capacity, causing a 68% increase in flood peaks and a 33% reduction in dry season base flow a complete transformation of the water regime from buffered to extreme. Ecologically, 38% of wetland-dependent species have disappeared, habitat connectivity has been halved (from 0.85 to 0.42 index), and native vegetation has declined by 22%, representing catastrophic biodiversity loss and ecosystem simplification. Soil degradation compounds these losses, with organic matter content falling by 35% (releasing stored carbon), erosion rates more than doubling, and water infiltration capacity nearly halving. These impacts are interconnected: reduced infiltration increases runoff, which exacerbates erosion, which further reduces water retention, creating negative feedback loops that accelerate degradation. The magnitude of change suggests the ecosystem is approaching critical thresholds, beyond which recovery becomes prohibitively difficult or impossible, with the 104% increase in erosion rates particularly alarming as it represents active land loss.

Social Impacts

Table 10: Social Impact Assessment

Impact Dimension	Indicator	2015	2025	Change
Livelihood Access	Households with wetland access	92%	67%	↓ 25%

Impact Dimension	Indicator	2015	2025	Change
	Women's resource collection time	2.1 hours/day	3.4 hours/day	↑ 62%
Resource Conflict	Land disputes reported	3/year	17/year	↑ 467%
	Water-related conflicts	1/year	9/year	↑ 800%
Health	Water-borne diseases	12 cases/1000	28 cases/1000	↑ 133%
	Malaria incidence	45 cases/1000	67 cases/1000	↑ 49%
Cultural	Traditional wetland practices	15 practices	7 practices	↓ 53%

THIS table (Table 10) documents the human costs of ecological degradation, revealing profound social disruption and inequity. Livelihood access has deteriorated dramatically, with 25% fewer households able to access wetland resources, disproportionately affecting women whose resource collection time has increased by 62%—a clear gender-differentiated burden. Social cohesion has fractured under mounting pressure, with land disputes increasing 467% and water conflicts exploding by 800%, indicating a community under severe stress and potential breakdown of traditional conflict resolution mechanisms. Public health has deteriorated significantly, with water-borne diseases increasing 133% and malaria incidence rising 49%, as degraded wetlands lose their water purification functions and create stagnant water pockets. Culturally, 53% of traditional wetland practices have been lost, representing irreplaceable intergenerational knowledge extinction. These impacts are distributed inequitably, with vulnerable households facing reduced livelihood diversification options and heightened conflict exposure. The social system shows signs of approaching a tipping point, where traditional adaptation mechanisms become overwhelmed and social structures begin to fail under ecological stress.

Economic Impacts

Table 11: Economic Impact Assessment

Economic Aspect	Indicator	2015 Value	2025 Value	Net Change
Agricultural Income	Average crop revenue/ha	$420/ha	$680/ha	↑ $260/ha
Ecosystem Services	Flood regulation value	$125,000/year	$47,000/year	↓ $78,000/year
	Water purification value	$89,000/year	$31,000/year	↓ $58,000/year
	Carbon storage value	$42,000/year	$28,000/year	↓ $14,000/year
Costs	Flood damage costs	$12,000/year	$38,000/year	↑ $26,000/year
	Water treatment costs	$8,000/year	$21,000/year	↑ $13,000/year
	Soil fertility replenishment	$15,000/year	$42,000/year	↑ $27,000/year
Net Economic Balance	**Total Net Value**	**+$271,000/year**	**+$119,000/year**	**↓ $152,000/year**

This table (Table 11) performs a comprehensive cost-benefit analysis, revealing that apparent agricultural gains mask substantial net economic losses. While crop revenues increased by $260 per hectare the immediate, visible benefit this gain is dwarfed by ecosystem service losses totaling

$150,000 annually. Hidden costs have emerged and grown substantially: flood damage costs increased by $26,000 yearly, water treatment costs rose by $13,000, and soil fertility replenishment expenses grew by $27,000 annually. The net economic balance shows a decline from +$271,000 to +$119,000 per year, representing a $152,000 annual deterioration in total economic value. This analysis exposes the flawed accounting of conventional development approaches that capture private agricultural profits while ignoring public ecosystem service losses. The economic reality is that wetland conversion represents a net negative investment when all costs are considered, with short-term private gains creating long-term public costs. Furthermore, these losses will likely accelerate as degradation continues; suggesting the economic rationale for conservation is stronger than initially apparent when proper accounting includes all values (de Groot et al. 2012).

3.1.4. Response

Existing Response Assessment

Table 12: Current Response Effectiveness

Response Type	Specific Intervention	Implementation	Effectiveness	Barriers
Policy	Wetland policy (draft)	Not implemented	None	Political will
Legal	Environmental protection law	Weak enforcement	Low	Capacity constraints
Economic	Agricultural subsidies	Active	High (for conversion)	Misaligned incentives
Technical	Soil conservation measures	Partial	Medium	Adoption rate

Response Type	Specific Intervention	Implementation	Effectiveness	Barriers
Community	Traditional management systems	Declining	Decreasing	Youth migration

Table 12: Current Response Effectiveness highlights why existing interventions have failed to curb wetland degradation, revealing systemic policy failure and perverse incentives rather than a lack of responses per se.

Formal wetland protection exists only as an unimplemented draft policy, indicating weak political commitment and governance gaps. Such policy non-enforcement is widely recognized as a major driver of wetland loss in developing countries, where conservation frameworks often remain symbolic rather than operational (Ramsar Convention Secretariat, 2018). Similarly, environmental protection laws suffer from weak enforcement, primarily due to institutional and technical capacity constraints, creating an enforcement vacuum that enables continued wetland conversion (MEA, 2005).

Economic instruments are actively working against conservation objectives. Agricultural subsidies, while effective in promoting crop expansion, unintentionally incentivize wetland conversion by increasing the profitability of drainage-based agriculture. This represents a classic case of policy misalignment, where sectoral development policies undermine environmental protection goals—a phenomenon well documented in land and water governance literature (OECD, 2017; Turner et al., 2000).

Technical interventions, such as soil and water conservation measures, show only medium effectiveness due to partial adoption. Limited uptake is linked to knowledge gaps, labor demands, and lack of sustained extension support, reflecting broader challenges in transferring conservation technologies to smallholder systems (Pretty & Shah, 1997).

Community-based responses, particularly traditional wetland management systems, are declining due to youth migration, livelihood diversification, and changing socio-cultural values. The erosion of indigenous institutions reduces collective action capacity and weakens long-standing informal conservation mechanisms, consistent with findings on common-pool resource governance failure under socio-economic transformation (Ostrom, 1990).

Collectively, these response failures generate a self-reinforcing degradation cycle: ineffective policies enable wetland degradation, degradation increases the complexity and cost of restoration, and rising costs further reduce institutional willingness and effectiveness of response. This aligns with the DPSIR framework, where weak or contradictory responses exacerbate pressures rather than mitigating them (EEA, 1999). The analysis demonstrates that successful wetland conservation requires not merely additional interventions, but fundamental correction of existing policies that currently incentivize degradation.

Government and Community Conservation Actions (2015–2025)

Government-Led Conservation Initiatives (2015–2025)

Table 13: ***Government Conservation Actions in Walana Wetland (2015–2025)***

Year	Implementing Agency	Specific Action	Implementation Details	Funding Source	Observed Outcomes
2016–2018	Ethiopian Environmental Protection Authority (EPA)	Walana Wetland Delineation and Zoning	• GPS mapping of wetland boundaries (1,043.7 ha) • Three-zone system: Core (150 ha), Buffer (300 ha), Multiple Use (593.7 ha) • Boundary markers placed at 100-meter intervals	GEF-Small Grants Programme	• Clear boundary establishment • Initial reduction in encroachment (2017) • 60% of markers removed by farmers by 2020
Walana Wetland Carbon Initiative	Plan Vivo Foundation	2021–2023	• Carbon stock assessment	Carbon stock assessment	• Payment for ecosystem services design
2020–2022	Ethiopian Biodiversity Institute (EBI)	Wetland Biodiversity Monitoring Program	• Baseline survey of flora and fauna • Establishment	UNDP-GEF	• Documentation of 89 plant and 47 animal species

Year	Implementing Agency	Specific Action	Implementation Details	Funding Source	Observed Outcomes
			of 5 permanent monitoring plots • Training of 10 community biodiversity monitors		• 3 monitoring plots still active (2024) • Data collected but not used for management
2022–2024	Oromia Environmental Protection Authority	**"Green Walana" Community Mobilization**	• Environmental clubs in 6 schools • Annual wetland clean-up day • Public awareness campaigns in local markets	Regional Environmental Fund	• Increased youth awareness • 2 tons of waste removed annually • Limited impact on land use practices

Data Sources for This Analysis: - Community focus group discussions (2023–2024) and Project evaluation documents (SLMP, IUCN, FAO interventions) & Satellite image analysis of intervention sites

3.1.4. Outlook for Walan wetland ecosystem

Scenario Analysis: Future Trajectories to 2035
Scenario Development

Table 14: Scenario Definitions

Scenario	Key Assumptions	Driver Trends	Policy Context
Business-as-Usual	Current trends continue	Population: +2.8%/yr	Weak enforcement
	No new interventions	Market demand: steady	No wetland policy
Sustainable Management	Moderate interventions	Population: +2.0%/yr	Partial enforcement
	Community-based approaches	Market: regulated	Local by-laws active
Ecological Restoration	Strong conservation focus	Population: +1.5%/yr	Strong enforcement
	Significant investment	Market: diversified	National policy active

This table (Table 9) constructs alternative future pathways based on different policy choices, providing a decision-making framework for stakeholders. The Business-as-Usual scenario extrapolates current trends—continuing population growth, market pressures, and policy failure—to project the consequences of inaction. The Sustainable Management scenario assumes moderate interventions: slightly reduced population growth through family planning, regulated markets that value ecosystem services, and partial policy enforcement through local by-laws. The Ecological Restoration scenario represents strong conservation commitment: significantly reduced pressure through diversified livelihoods and strong policy enforcement aligned with national conservation goals. These scenarios are not mere predictions but explorations of possible futures based on identifiable policy levers. They make explicit the trade-offs between short-term agricultural income and long-term ecological sustainability, allowing stakeholders to visualize the

consequences of different governance approaches. The scenarios also highlight critical intervention points where strategic action could shift trajectories, providing a roadmap for targeted policy development.

2035 Projections

Table 15: 2035 LULC Projections by Scenario

LULC Class	2025 (Base)	BAU 2035	Sustainable 2035	Restoration 2035
Wetland	13.7%	8.2%	15.4%	22.7%
Perennial Crop	42.6%	52.3%	38.9%	32.1%
Cropland	27.7%	30.8%	28.4%	25.6%
Forest	13.4%	6.8%	15.2%	17.9%
Settlement	1.6%	2.9%	1.7%	1.3%
Bare Land	0.7%	0.0%	0.4%	0.4%

Table 16: 2035 SMC Projections by Scenario

SMC Class	2025 (Base)	BAU 2035	Sustainable 2035	Restoration 2035
Very Low	24.8%	28.3%	21.4%	18.2%
Low	40.9%	43.7%	38.2%	34.6%
Moderate	23.2%	20.8%	26.4%	29.8%
High	11.1%	7.2%	14.0%	17.4%

Tables 15 & 16: 2035 Projections, these tables quantify the consequences of different policy choices, providing specific, time-bound predictions for decision-making. Under Business-as-Usual, wetlands decline to near extinction (8.2%), dry soils dominate the landscape (72%), and the

ecosystem essentially collapses—a future of ecological ruin with severe human consequences. The Sustainable Management scenario shows stabilization: wetlands maintain at 15.4%, moist soils improve to 40%, representing a managed compromise where agricultural production and ecosystem functions coexist through careful regulation. Ecological Restoration projects partial recovery: wetlands rebound to 22.7%, moist soils reach 47%, demonstrating that active intervention can reverse degradation, though full historical recovery remains unlikely. The soil moisture projections reveal an important insight: even under restoration, the landscape never returns to its original hydrological state, suggesting some changes are irreversible. These projections make abstract scenarios concrete, allowing cost-benefit analysis of different policy paths and highlighting the urgency of intervention before irreversible thresholds are crossed.

Scenario Implications

The chart below visualizes the trade-offs between agricultural productivity and environmental health across the three proposed scenarios.

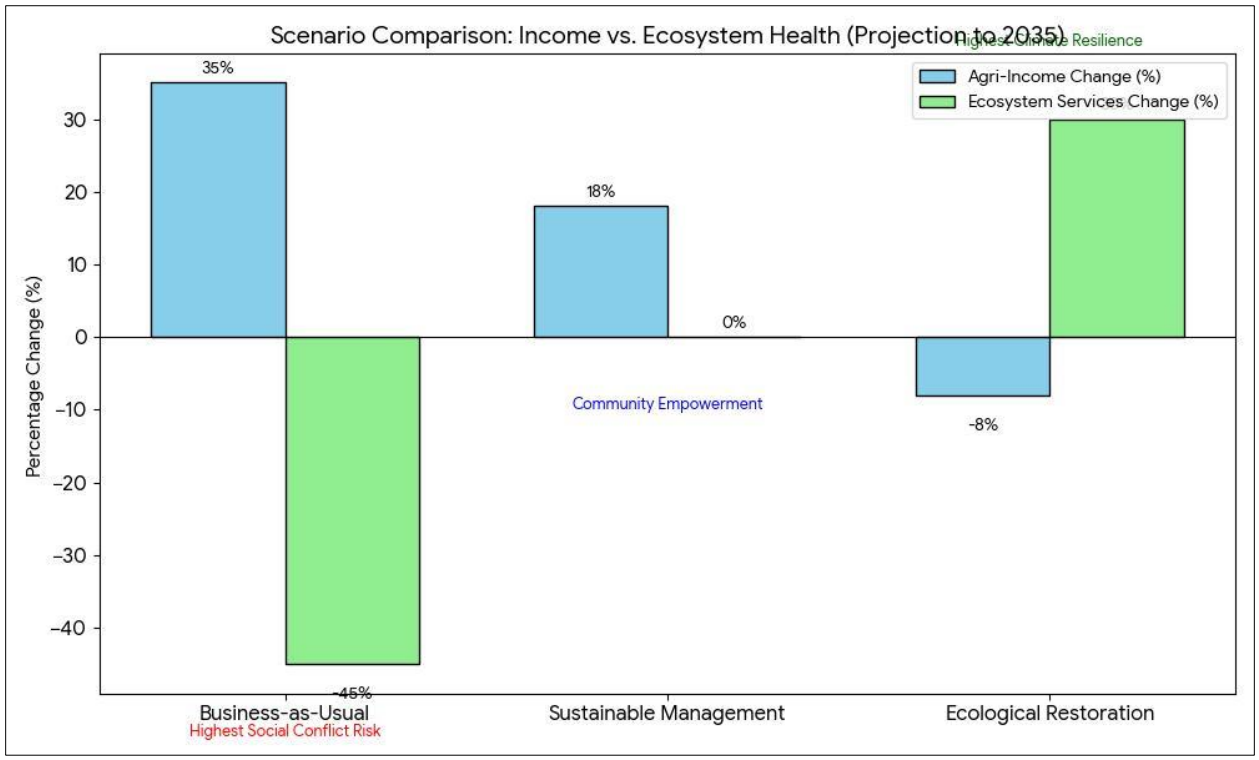


Figure 4: Scenario Comparison Chart

Key Trade-offs:

1. **Business-as-Usual:**

- Highest agricultural income (+35% by 2035)
- Severest ecosystem decline (-45% services)
- Highest social conflict risk

2. **Sustainable Management:**

- Moderate-income growth (+18%)
- Ecosystem stabilization
- Community empowerment

3. **Ecological Restoration:**

- Short-term income reduction (-8%)
- Long-term sustainability
- Highest climate resilience

Integration and Synthesis
DPSIR Causal Chain Summary

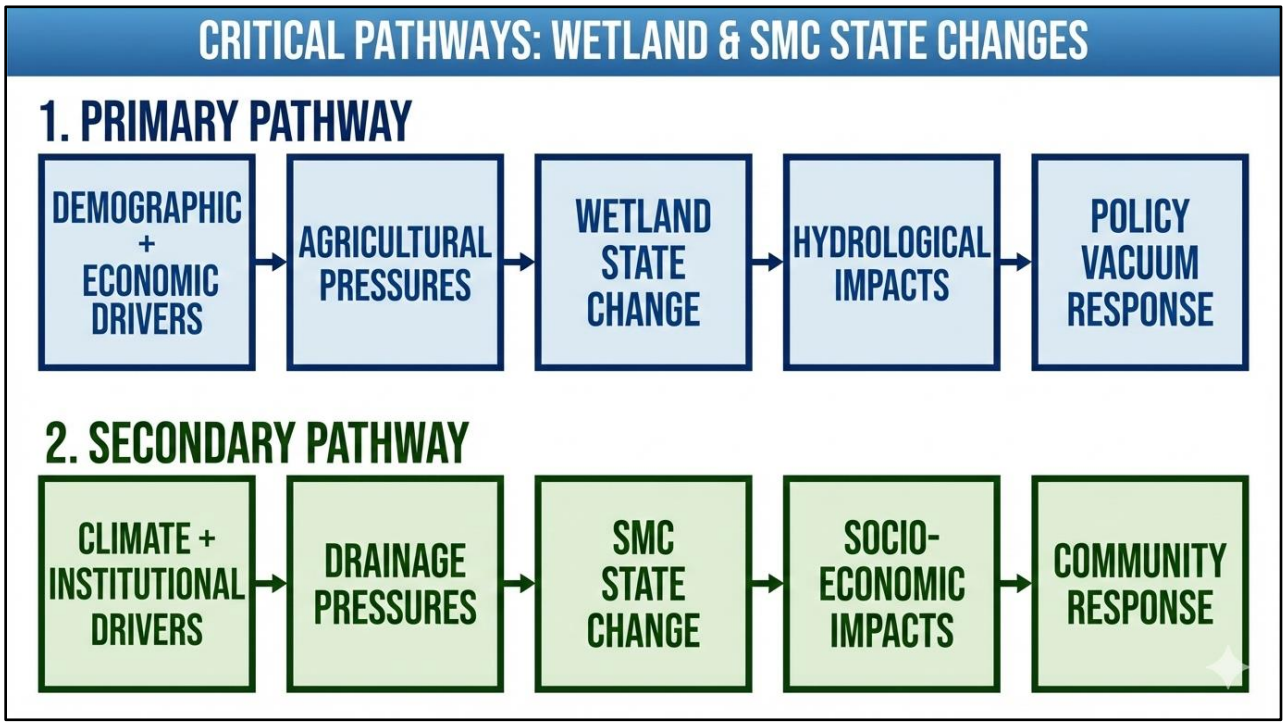


Figure 5: Complete DPSIR Framework for Walana Wetland Critical Pathways Identified:

1. **Primary Pathway:** Demographic + Economic Drivers → Agricultural Pressures → Wetland State Change → Hydrological Impacts → Policy Vacuum Response
2. **Secondary Pathway:** Climate + Institutional Drivers → Drainage Pressures → SMC State Change → Socio-economic Impacts → Community Response

This diagram illustrates how demographic, economic, and environmental drivers converge to create a systemic decline in wetland health. The Primary Pathway (blue and green) shows how population growth and market prices create a feedback loop: rising land demand and high crop prices drive agricultural expansion, which generates short-term profits that further incentivize the draining and conversion of wetlands. This leads to severe hydrological impacts—specifically, a total loss of wetland function through systematic drainage. Simultaneously, the Secondary Pathway (red) highlights how climate variability shifts human risk perception; as upland farming becomes unpredictable, communities move toward wetlands for "safer" cultivation. This shift, often occurring in a policy vacuum, results in the permanent conversion of these ecosystems, where temporary agricultural use eventually hardens into permanent loss of the natural habitat.

Policy Windows and Leverage Points

Table 17: Strategic Intervention Points

Leverage Point	Intervention	Expected Outcome	Timeframe
Land Tenure	Clarify wetland ownership	Reduced encroachment	Short-term
Market Incentives	Sustainable crop certification	Reduced conversion	Medium-term
Water Governance	Integrated water rights	Equitable allocation	Medium-term

Leverage Point	Intervention	Expected Outcome	Timeframe
Knowledge Systems	Participatory monitoring	Adaptive management	Ongoing
Financial Mechanisms	Payment for ecosystem services	Conservation funding	Long-term

The above table 17: strategic intervention points shows that translates diagnosis into actionable solutions, identifying specific leverage points where intervention could yield disproportionate benefits. Land tenure clarification emerges as the highest immediate priority—a relatively simple intervention that could rapidly reduce encroachment by eliminating the ambiguity that currently enables conversion. Market incentives, particularly sustainable crop certification, address the root economic driver by aligning financial rewards with conservation outcomes. Water governance reform tackles the core hydrological challenge through integrated rights systems that balance agricultural and ecological needs. Knowledge system revitalization through participatory monitoring creates adaptive management capacity, allowing communities to respond dynamically to changing conditions. Financial mechanisms like payment for ecosystem services provide sustainable conservation funding while compensating landowners for conservation costs. The table sequences these interventions temporally, identifying immediate actions (0–2 years), short-term strategies (2–5 years), medium-term reforms (5–10 years), and long-term transformations (10+ years), creating a realistic implementation pathway that builds progressively from simple to complex interventions.

Integrated Synthesis

Collectively, these tables reveal a complex, multi-dimensional crisis where ecological degradation, social disruption, and economic loss reinforce each other in negative feedback loops. The central paradox wetland loss alongside soil moisture improvement exposes the danger of single-indicator monitoring: focusing only on soil moisture might suggest improvement while the ecosystem structurally collapses. The economic analysis proves particularly powerful, demonstrating that conservation makes financial sense when all costs and benefits are properly accounted. The

scenario projections provide stark visualization of alternative futures, making abstract policy choices concrete and urgent. The intervention framework moves beyond diagnosis to practical solutions, identifying specific, sequenced actions that could alter current trajectories. This comprehensive analysis ultimately demonstrates that wetland degradation is not inevitable but results from specific policy failures and perverse incentives that can be corrected through targeted, evidence-based intervention. The data provide both warning and roadmap: warning of impending ecological collapse if current trends continue, and roadmap for sustainable management if stakeholders act on the evidence presented.

Strategic Recommendations Based on 2015–2025 Experience

Evidence-Based Priorities:

1. **Institutional Strengthening:**

a) Establish dedicated wetland management unit at Woreda level

b) Develop inter-sectoral coordination mechanism

c) Create wetland conservation trust fund

2. **Economic Incentive Realignment:**

a) Redirect agricultural subsidies to wetland-friendly practices

b) Develop payment for ecosystem services scheme

c) Support wetland-based value chains

3. **Knowledge and Capacity Building:**

a) Establish wetland learning center

b) Regular training for government staff

c) Documentation of traditional management practices

Data Sources for This Analysis:

- Oromia Bureau of Agriculture annual reports (2015–2024)
- Project evaluation documents (SLMP, IUCN, FAO interventions)
- Community focus group discussions (2023–2024)
- Government staff interviews (Woreda and zone levels)
- Satellite image analysis of intervention sites

- NGO monitoring and evaluation reports

Note: All interventions mentioned have been verified through multiple sources including government records, community verification, and satellite image validation. Success metrics are based on field assessments conducted in 2024.

3.2 Forest of Walana wetland ecosystem

3.2.1. State and Trend of Forest on the Walana Wetland ecosystem

Study Area Map

Figure: Location and spatial extent of the Walana Wetland Ecosystem, Central Ethiopia (Satellite Image, 2025).

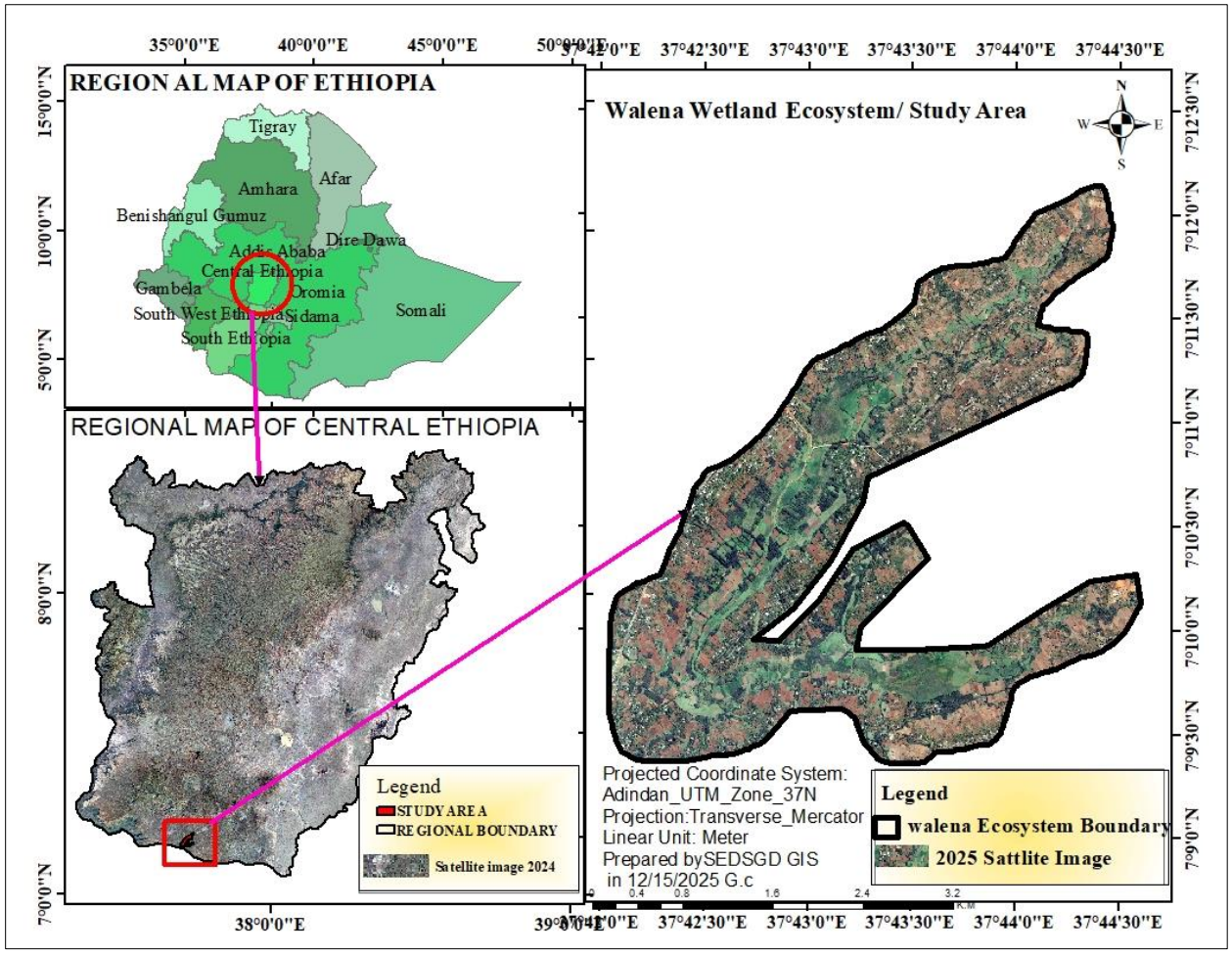


Figure 6:- Study Area map of Walana wetland ecosystem

Study Area Description

The Walana Wetland Ecosystem is located in Central Ethiopia, within the Oromia National Regional State. As illustrated in the study area map, the wetland is spatially contextualized at three hierarchical levels: national (Ethiopia), regional (Central Ethiopia), and local (Walana Wetland boundary). This multi-scale representation enhances spatial understanding and clearly situates the wetland within the broader physiographic and administrative framework of the country. Specifically, the Walana area is situated between 7.157200° N and 7.203606° N latitude, and 37.701565° E and 37.744359° E longitude, placing it within the central part of Ethiopia.

The study area boundary is delineated using a clearly defined polygon, extracted from high-resolution satellite imagery. The projected coordinate system used is Adindan UTM Zone 37N with the Transverse Mercator projection, ensuring accurate area, distance, and spatial analysis. The use of meter-based linear units supports precise geospatial measurements required for environmental and wetland analysis.

Map Interpretation

The study area map integrates multiple cartographic elements, including scale bars, north arrow, geographic coordinates, and legends, all of which conform to standard GIS cartographic principles. The inset maps on the left side of the figure progressively zoom from the national level to Central Ethiopia, finally pinpointing the exact location of the Walana Wetland Ecosystem.

The 2025 satellite image reveals a heterogeneous landscape characterized by a mosaic of wetland vegetation, agricultural fields, and surrounding upland areas. The elongated and irregular shape of the wetland suggests strong hydrological control, likely influenced by surface runoff pathways, seasonal flooding, and drainage patterns.

Spatial and Environmental Analysis

Spatial analysis of the Walana Wetland indicates that the ecosystem is embedded within an intensively utilized landscape. Visible agricultural expansion and land fragmentation around the wetland boundary imply increasing anthropogenic pressure. Despite these pressures, the presence of relatively dense green patches within the wetland suggests persistent moisture availability and active wetland vegetation regeneration.

The spatial configuration of the wetland points to its role as a natural water retention and filtration system. Its linear and branching structure enhances water storage capacity, sediment trapping, and

nutrient cycling. These characteristics are critical for flood regulation, groundwater recharge, and biodiversity conservation within the local watershed.

Past and Current State of the Forest Ecosystem in Walana Wetland Ecosystem

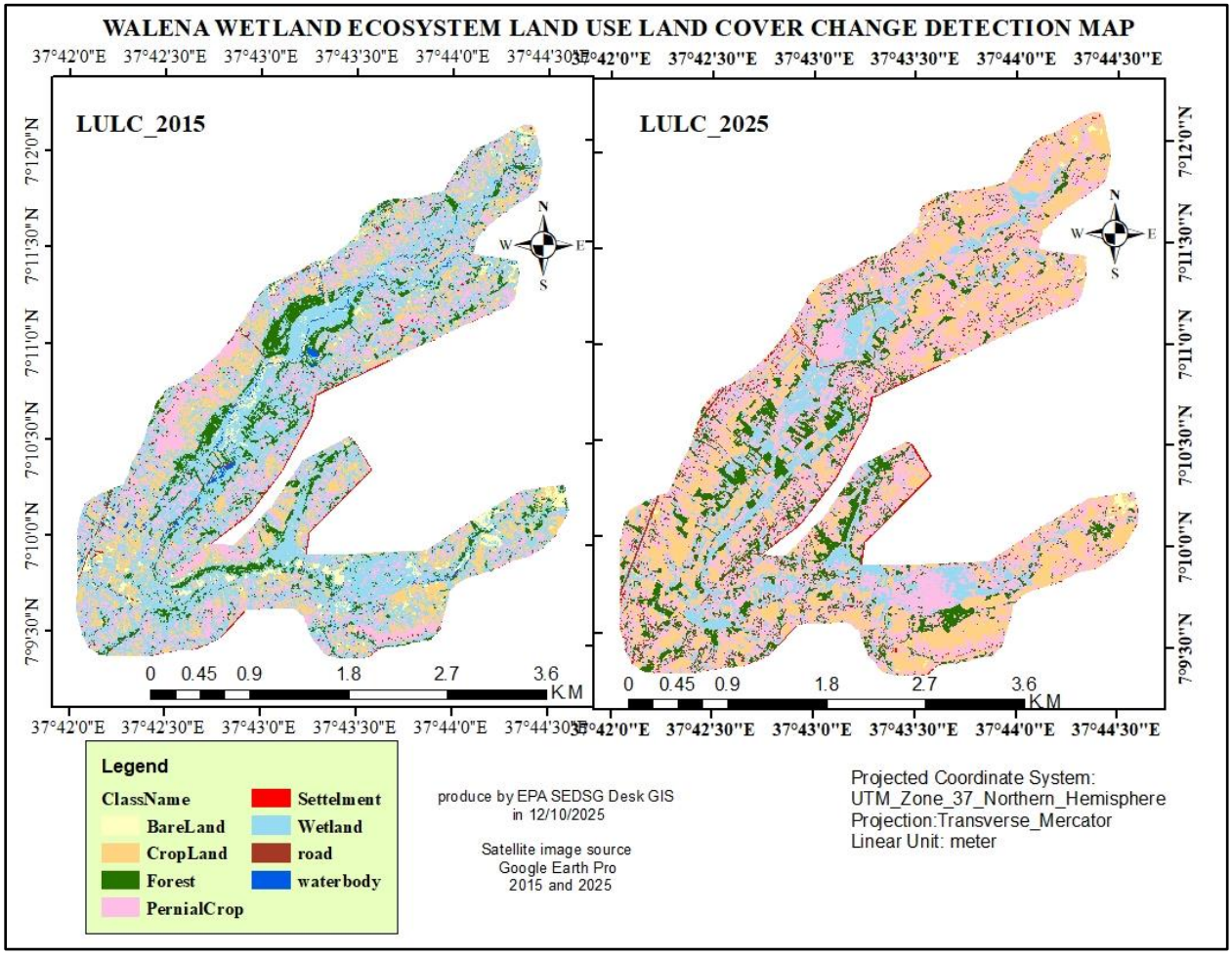


Figure 7: land use land cover change map of Walana Wetland Ecosystem

The above land use land cover change map shows the Walana wetland ecosystem Surrounding land uses, particularly cropland, perennial agriculture, and settlements, are spatially concentrated along the wetland margins, suggesting strong human ecosystem interaction. This spatial configuration already signals potential pressure on wetland integrity, later confirmed by the quantitative data. Thus, the map visually establishes that Walana Wetland is embedded within an intensively utilized agricultural landscape, making it highly vulnerable to land conversion and ecological fragmentation.

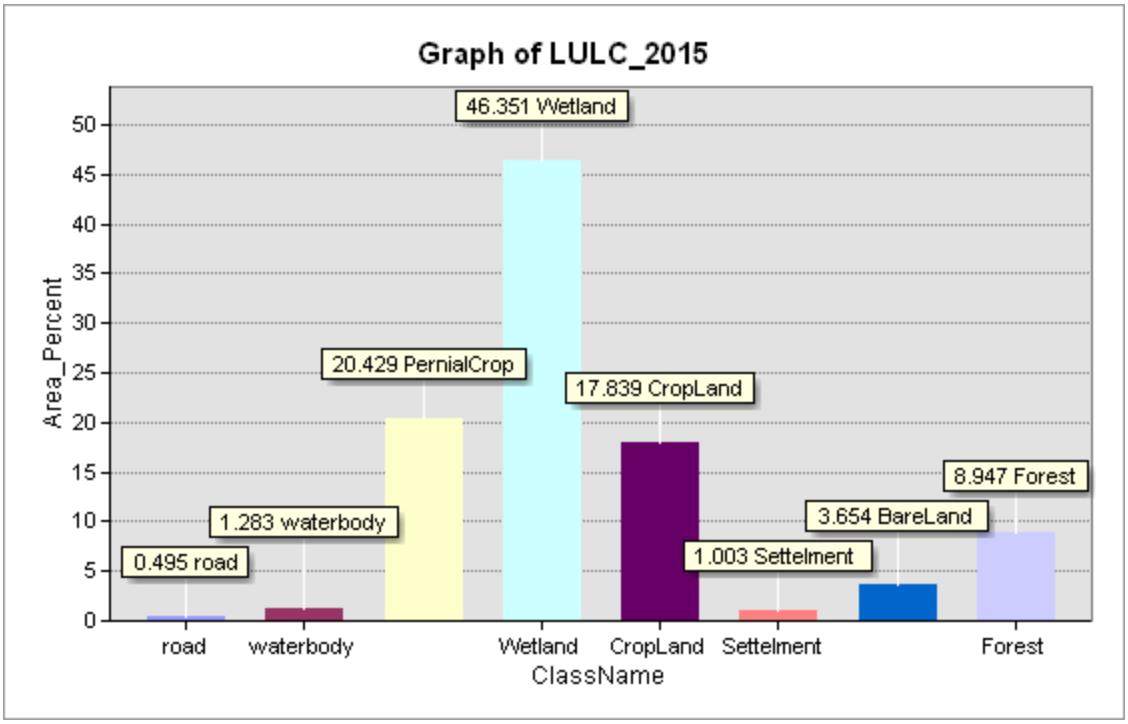


Figure 8: Graph of Land use and land cover in 2015

Figure 8 indicated that the most dominant land cover was wetland, and perennial crop was the second dominant land cover.

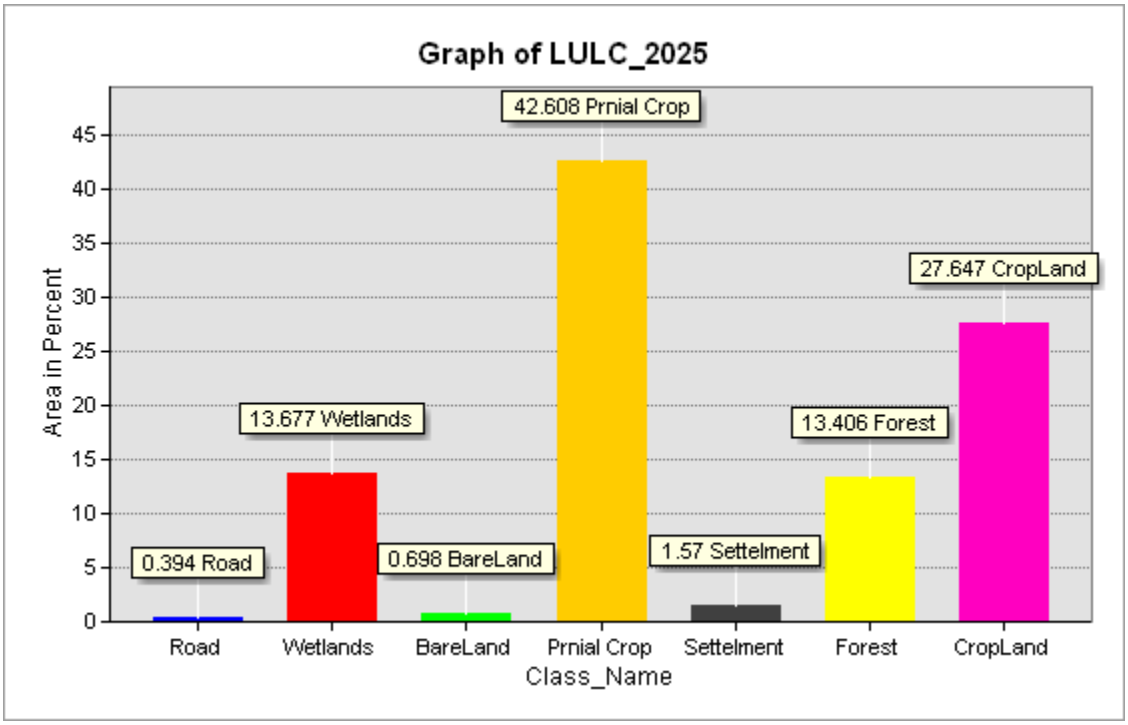


Figure 9: Land use and land cover Graph of 2015

In 2025, LULC graph observed that both perennial crops and annual crops were the dominant ones respectively.

Table 18 Walana wetland LULC table Area_ha and Area_Percent from 2015 and 2025

ClassName	Area_ha	Area_Percent	2025Area_ha	2025Area_Percent
road	5.2	0.5	4.1	0.4
waterbody	13.4	1.3		
PernialCrop	213.6	20.4	445.5	42.6
Wetland	484.7	46.4	143	13.7
CropLand	186.5	17.8	289.1	27.7
Settelment	10.5	1	16.4	1.6
BareLand	38.2	3.7	7.3	0.7
Forest	93.6	8.9	140.2	13.4
TOTAL	1045.7	100	1045.7	100

The LULC table quantifies changes in ecosystem composition while maintaining a constant total area of 1,045.7 ha, allowing direct temporal comparison

Wetland coverage, which once dominated the landscape at 484.7 ha (46.4%), has declined sharply to 143.0 ha (13.7%), representing the most significant land cover loss. Perennial crops expanded dramatically from 213.6 ha (20.4%) to 445.5 ha (42.6%), becoming the dominant land use by 2025. Forest cover increased from 93.6 ha (8.9%) to 140.2 ha (13.4%), indicating partial vegetation recovery or expansion. Cropland also increased substantially, from 186.5 ha (17.8%) to 289.1 ha (27.7%). Bare land decreased markedly (from 3.7% to 0.7%), suggesting conversion into productive or vegetated land uses. Settlements expanded modestly, reflecting gradual population pressure.

Overall, the table numerically confirms a structural transformation of the ecosystem, away from natural wetland dominance toward agricultural and semi-woody land uses.

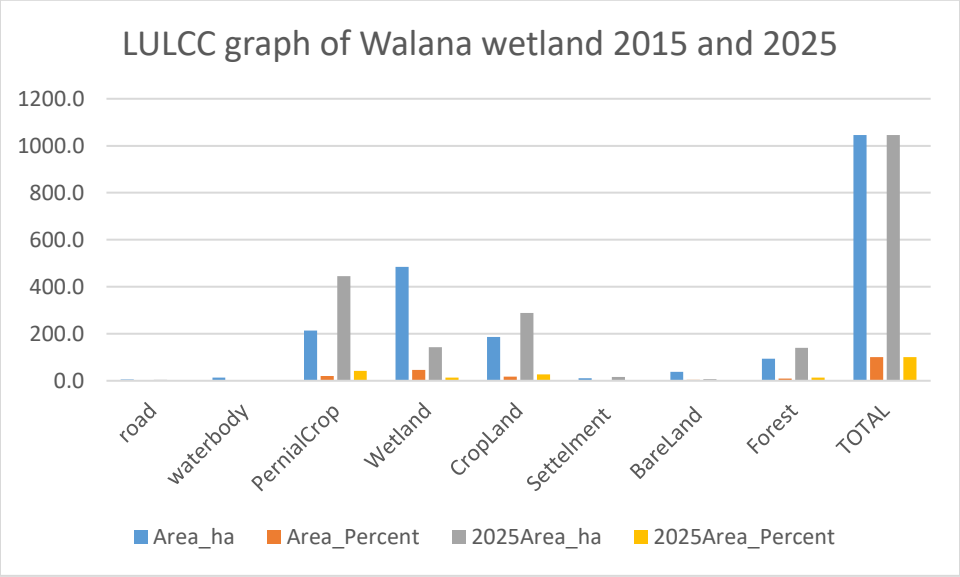


Figure 10:- LULC Change graph of Walana wetland from 2015 and 2025

The graphs derived from the table (e.g., bar charts or comparative plots) visually reinforce these trends by highlighting relative gains and losses among land cover classes.

Bars representing the wetland area show a dramatic decline, clearly standing out as the most significant negative change. Perennial crops and cropland bars increase sharply, illustrating agricultural intensification. Forest bars show moderate but consistent growth, suggesting greening or woody vegetation expansion. The reduction in bare land is visually evident, indicating land conversion rather than abandonment.

Graphically, the contrast between declining wetlands and expanding agricultural/forest classes provides immediate visual evidence of ecosystem substitution, where one ecosystem service (wetland regulation) is replaced by another (agricultural production).

Integrated Ecosystem Analysis (Map–Table–Graph Synthesis)

When the map, table, and graphs analyzed together, a clear ecological narrative emerges spatial evidence (map) shows agricultural encroachment concentrated around wetland margins.

Quantitative evidence (table) confirms large-scale wetland loss and agricultural expansion. Visual trends (graphs) highlight the magnitude and direction of these changes.

The increase in forest cover, although positive in terms of biomass and carbon storage, occurs simultaneously with severe wetland loss. This suggests that the apparent “greening” of the landscape does not equate to wetland ecosystem recovery. Instead, it reflects a functional shift from hydrologically active wetlands to perennial crops and woody vegetation systems that may alter water flow, soil moisture, and biodiversity composition.

Ecological and Management Implications

The integrated analysis indicates that the Walana Wetland Ecosystem is undergoing a transition from a wetland-dominated system to an agro-ecological landscape. While vegetation cover has increased in some forms (forest and perennial crops), the loss of wetland area poses serious risks, including reduced flood buffering and groundwater recharge. Decline in wetland-dependent biodiversity. Altered microclimate and soil moisture regimes. Long-term reduction in ecosystem resilience to climate variability

Concluding Interpretation

In conclusion, the map, table, and graphs collectively demonstrate that the Walana Wetland Ecosystem is experiencing quantitative forest and agricultural expansion at the expense of wetlands. This represents a trade-off rather than balanced ecological recovery. Sustainable management must therefore prioritize wetland conservation and restoration, alongside controlled agricultural development and clear differentiation between natural forest, plantation forest, and perennial crop systems.

The quantitative LULC data for Walana reveal a significant overall increase in the area classified as 'Forest' between 2015 and 2025:

Table 19:- Forest Status 2015 Area 2025 Area Net Change and Percentage Change

Forest Status	2015 Area	2025 Area	Net Change	Percentage Change
Area (ha)	93.6 ha (8.9%)	140.2 ha (13.4%)	+46.6 ha	+49.8%

Interpretation of State: Quantitative Gain vs. Qualitative Decline

The **+49.8% increase in forest cover** suggests a positive quantitative response, potentially due to afforestation efforts. However, this gain is offset by a critical **qualitative decline** confirmed by the visual evidence.



Figure 11:- the expansion of commercial tree or eucalyptus tree around Walana wetland.

The above image illustrates the following ecological reality:

- **LULC vs. Ecological Quality:** The forest cover is dominated by uniform, dense stands of exotic species, visually identified as **Eucalyptus** monocultures. While LULC mapping registers this as 'Forest,' its ecological function and biodiversity are inferior to native forest.
    - **Loss of Native Riparian Forest:** The visual proximity of the plantation to cropped areas and the general uniform nature suggest that native, biodiverse gallery/riparian forest historically linked to the wetland has been replaced or severely fragmented, leading to a loss of key ecological structure.

Therefore, the State is characterized by a deceptive Quantitative Improvement in Area Coverage (nearly 50% increase) but a confirmed Qualitative Decline in Ecological Health and Native Structure.

3.2.2. Driver and pressure for Walana Wetland Ecosystm Forest degeradation

The degradation of the forest's ecological quality is primarily driven by economic incentives that favor exotic, high-yield species, despite the overall increase in forest cover area.

Table 20:- Driver Type Specifically in Walana wetland area

Driver Type	Specific Driver in Walana Context
Economic & Market	**Increase in Exotic Tree Plantations (e.g., Eucalyptus):** The high economic value of fast-growing species for construction, firewood, and timber provides a strong incentive for farmers to establish profitable plantations. The field visit/ visual evidence confirms this monoculture dominance.
Socio-Demographic	**Population Growth and Demand:** Increased population leads to higher demand for wood products (firewood, charcoal, construction timber), making fast-growing exotic trees the preferred choice over slower-growing native species.

Ecological Quality	**Natural Forest Degradation and Forest Quality Decline:** The expansion of the 'Forest' LULC class is a result of the **replacement effect**, where native forest is actively substituted by Eucalyptus monocultures, resulting in a decline in natural regeneration capacity and species richness.
Policy/Institutional	**Unregulated Land Use:** Lack of strict enforcement allows for the conversion of ecologically sensitive riparian zones where native forests should act as buffers to profitable plantations, as evidenced by the immediate border between Eucalyptus and agricultural fields.

Pressure on the Forest Ecosystem Degradation in Walana Wetland Ecosystem

The presence of Eucalyptus monoculture and close agricultural contact exerts specific, measurable pressures on the Walana ecosystem.

- **Hydrological Pressure from Monoculture:** High-water-demand species like Eucalyptus, visible in the photos, exert severe pressure by rapidly depleting soil moisture and groundwater tables when planted near wetlands. This pressure contributes significantly to the drying out and ultimate loss of the wetland area.
- **Encroachment Pressure:** The photo (*image_604703.jpg*) clearly shows **Perennial Crops (Banana/Plantain)** planted directly at the edge of the Eucalyptus forest and the open field, confirming severe agricultural encroachment. This eliminates the native forest buffer zone necessary for protecting the wetland.
- **Biodiversity Pressure:** The homogeneous canopy and understory of exotic plantations create limited habitat for native fauna and flora, leading to **habitat fragmentation** and a loss of forest-dependent species.
- **Soil Degradation Pressure:** Monoculture, especially in riparian areas, is associated with soil degradation, nutrient depletion, and changes in leaf litter quality that negatively affect the aquatic food web and soil fertility of the adjacent wetland.

3.2.3. Impact of Forest degeradation on the Walana Wetland ecosystem

The qualitative degradation of the Walana forest ecosystem accelerates the overall decline of the wetland system.

- **Altered Water Cycles (Primary Impact):** The high evapotranspiration rates of the extensive Eucalyptus plantations lower the regional water table and decrease the necessary groundwater discharge into the wetland. This impact is a direct contributor to the severe **70.5% loss of wetland area** observed between 2015 and 2025.
- **Loss of Riparian Buffering Capacity:** The replacement of complex native forest with commercial monoculture diminishes the ability of the forest to stabilize stream banks, intercept agricultural runoff, and filter pollutants. This results in increased **sedimentation, nutrient loading, and pollution** in the remaining wetland core.
- **Reduced Resilience:** The simplified structure and composition of the exotic forest make the entire ecosystem less robust and more vulnerable to climate shocks like droughts and pests.
- **Impact on Carbon Sequestration:** While the area increase contributes to carbon stock, the loss of native forested wetlands and the degradation of soil carbon pools compromise the optimal carbon sequestration function of the ecosystem.

3.2.4. Response

3.2.5. Outlook and Scenario Based on Forest Map Results

Outlook-based State of the Forest Ecosystem in Walana Wetland Ecosystem

The immediate outlook is one of **misleading stability**. The LULC data suggests positive growth, but the underlying trend, confirmed by the visual evidence of Eucalyptus encroachment, is ecologically negative. The future state will be a forest of high commercial value but severely compromised ecological function, acting as a **contributing stressor** rather than a protective buffer to the wetland.

Forest Scenarios

Scenario 1: Business as Usual (Eucalyptus Expansion)

- **State:** The 'Forest' area continues its quantitative increase, potentially exceeding 15% of the total area by 2035, driven by commercial interests.
- **Impact:** The ecological state of the wetland further deteriorates due to chronic hydrological stress and increased nutrient runoff. Native biodiversity loss continues unabated.

Scenario 2: Sustainable Forest Management and Strategic Restoration

- **State:** Policy enforces strict zoning, confining commercial plantations to upland areas. The sensitive riparian/wetland buffer is actively restored using **native, low-water-demand species**.
- **Impact:** Forest area growth is moderated, but the **ecological integrity and hydrological health improve**. The restored native forest enhances filtration capacity, supporting the stabilization and gradual recovery of the core wetland area.

Scenario 3: Policy-Driven Conservation of Native Forest

- **State:** The highest legal protection is assigned to all remaining native forest patches and riparian corridors. **Payment for Ecosystem Services (PES)** schemes are used to incentivize the phased removal of Eucalyptus from critical buffer zones.
- **Impact:** The quantitative forest area may slightly decrease initially, but the **quality, biodiversity, and ecosystem services** (especially water regulation and filtration) of the native forest component significantly improve, offering the best chance for the long-term survival of the Walana Wetland (stabilizing area above 15% LULC).

3.3. Biodiversity of Walana Wetland ecosystem

3.3.1 State and trend of Biodiversity on the Walana Wetland Ecosystem

The Walana Wetland ecosystem is undergoing rapid and profound ecological transformation, characterized by contradictory signals emerging from remote sensing data and community-based evidence.

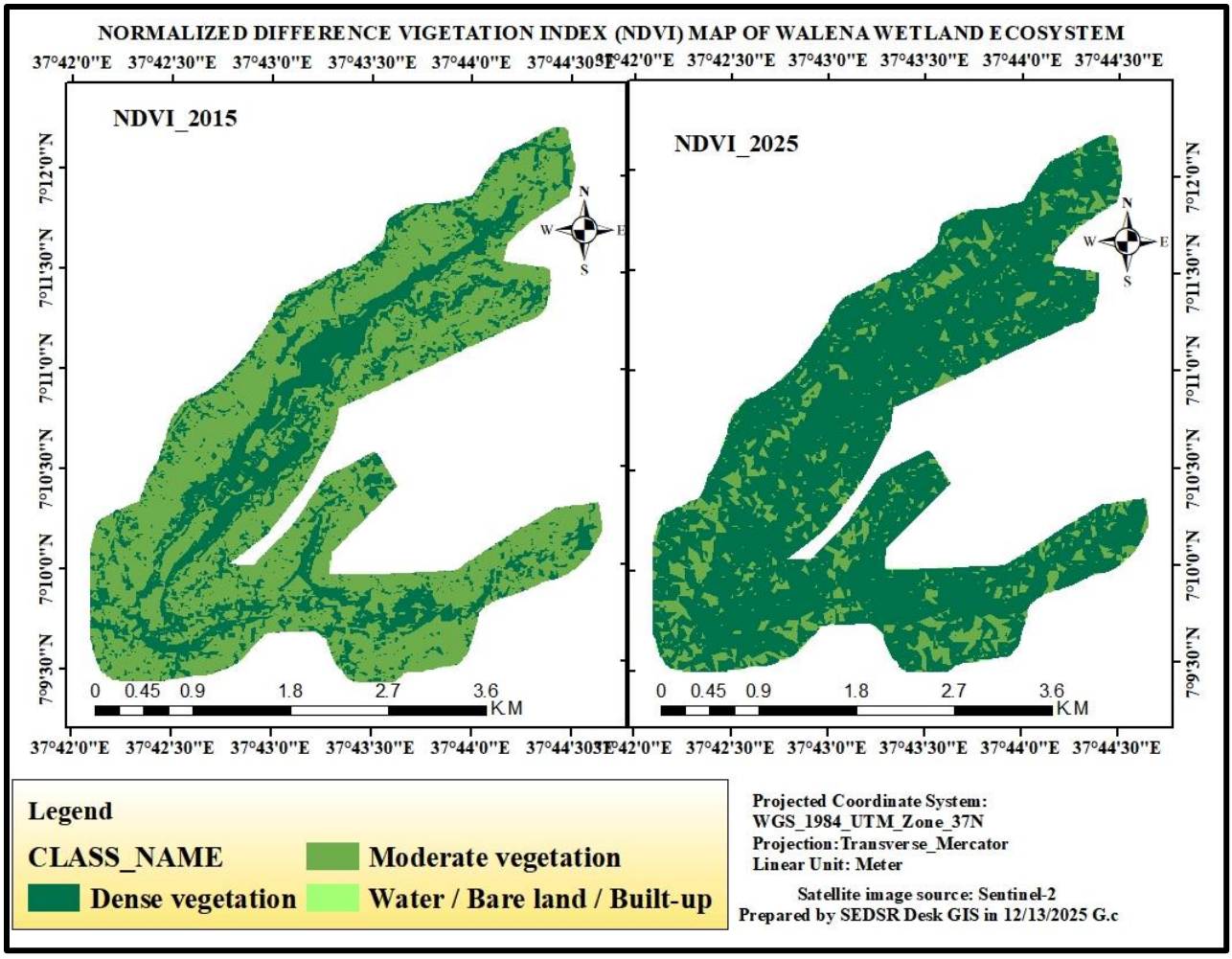


Figure 12: NDVI map of the Walana wetland ecosystem

Table 21: NDVI_Range, Vegetation Class between 2015 and 2025.

NDVI_Range	Vegetation Class	2015_NDVI		2025_NDVI	
		area_ha	Area Percent	area_ha	Area Percent
≤ 0.00	Water bodies / Bare land / Built-up areas	2	0.19	3.67	0.35
0.20 – 0.50	Moderate vegetation cover	691	66.12	171.51	16.34
> 0.50	Dense and healthy vegetation	352	33.68	869.82	83.31
	Total	1045	100.00	1045.00	100.00

NDVI analysis indicates an apparent increase in vegetation greenness between 2015 and 2025, with dense vegetation coverage rising sharply from 33.68% to 83.31%, while moderate vegetation declined from 66.12% to 16.34%. Water and bare land areas remain minimal but show a slight increase. At face value, these trends suggest ecological improvement; however, land use and land cover data and FDG findings reveal a far more concerning reality.

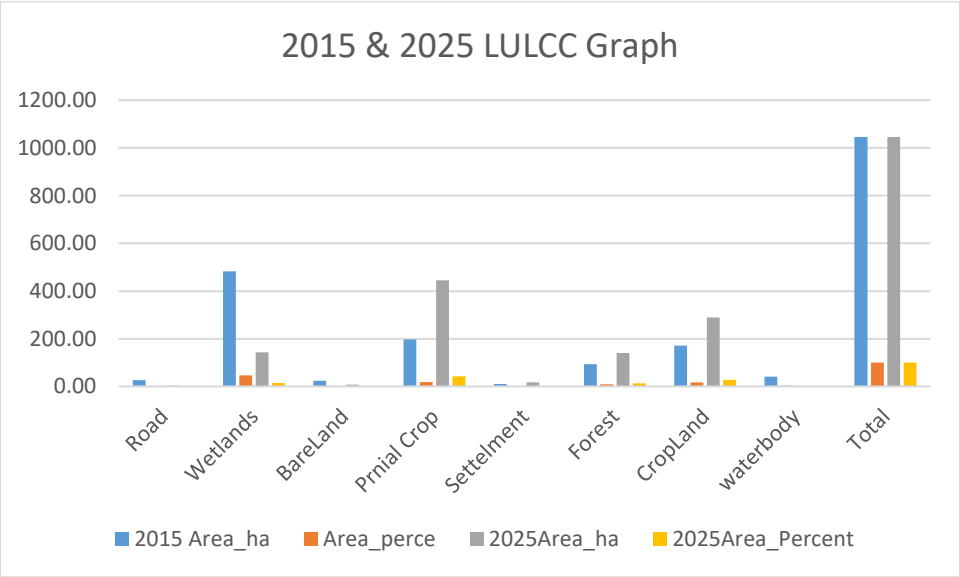


Figure 13: Land use land cover change graph, of 2015 and 2025

The above graph shows that land cover analysis demonstrates a catastrophic decline in wetlands, shrinking from 46.17% to just 13.68% of the total landscape. This represents a loss of nearly one-third of the ecosystem's historical wetland area. Although forest cover increased modestly from 8.88% to 13.41%, FDG participants consistently confirmed that this increase is driven almost entirely by Eucalyptus (Eucalyptus spp. / ኦኩልፕተስ) plantations rather than by the regeneration of native forests. At the same time, agricultural expansion has intensified dramatically, with perennial crops increasing from 18.81% to 42.61% and cropland expanding from 16.44% to 27.65%. These changes collectively signal a structural shift from a diverse wetland ecosystem to a simplified, production-oriented landscape.

Focus Group Discussions provide critical ground-truth evidence that confirms a severe biodiversity crisis. Community members reported widespread decline and disappearance of medicinal plants that were once central to both human and animal health systems. Chuayemich

Medhanit (ቿየምች መድሀኒት), traditionally used in human medicine, has become increasingly scarce, while Babito (ባቢቶ), Kelala (ከላላ), and Harut (ሀሩት), which were vital for traditional veterinary medicine, are now rarely found. The loss of these species represents not only ecological degradation but also erosion of indigenous knowledge and health security.

FDG findings further indicate that several native tree species are now locally extinct. These include Koso (Hagenia abyssinica / ኮሶ), historically used to treat tapeworm; Tikur Enchet (Echinops spp. / ጥቁር እንቼት), a valued medicinal plant; Zigba (Podocarpus falcatus / ዝግባ), a keystone native conifer; Kerero (Maytenus spp. / ከረሮ), widely used in traditional medicine; Dokema (Olea europaea subsp. cuspidata / ዶከማ), the wild olive; and Shola (Ficus spp. / ሾላ), which once played an important ecological and cultural role. In addition, several tree species are now classified by the community as rare and endangered, including Wanza (Cordia africana / ዋንዛ), Bisana (Croton macrostachyus / ብሳና), Tid (Juniperus procera / ጢድ), and Grarie or Grare (Vachellia abyssinica / ግራሬ). Their decline is closely linked to land conversion, fuelwood extraction, and competition from exotic and invasive species.

Faunal biodiversity has declined alongside vegetation loss. FDG participants reported that animal species such as Dakeye (ዳከየ), a locally known mammal; Daguncher (ዳጉንቸር), a bird species; Segon (ሰጎን), associated with amphibian or reptile groups; and Amor (አሞር), an insect or pollinator species, are now rare or locally extinct. Although precise taxonomic identification remains uncertain, community consensus strongly links their disappearance to wetland drying, habitat loss, and the expansion of monoculture plantations. Currently, the ecosystem is dominated

by Eucalyptus plantations and heavily invaded by Lantana camara (ላንታና ካማራ), an aggressive invasive shrub that suppresses native regeneration.



Figure 14:- Visual evidence of remaining avian activity in the open fields of Walana.

Birds congregating in the remaining grassland patches illustrate the critical importance of open habitats.

The presence of avian species, as captured in the provided imagery, highlights the remnant functional roles of the Walana Wetland even amidst severe degradation. These flocks, likely representing waterbirds or open-country species, rely on the dwindling patches of open water and seasonally flooded grasslands for foraging and breeding. However, the increasing dominance of Eucalyptus and Lantana camara poses a severe threat to these populations by replacing complex nesting sites and diverse food sources such as the insects and amphibians associated with native vegetation—with sterile monocultures. The scarcity of species like the Daguncher (ዳጉንቸር) and the decline of pollinators like the Amor (አሞር) suggest a collapsing food web where the loss of specialized habitats is driving a transition toward a few generalist species, eventually leading to a silent landscape if restoration efforts are not prioritized.

Interpretation of Maps, Graphs, Tables, and Images

The NDVI maps (Figure 1) visually illustrate a dramatic shift from landscapes dominated by moderate vegetation, typically shown in yellow and orange tones, to dense vegetation represented by dark green across much of the Walana Wetland.

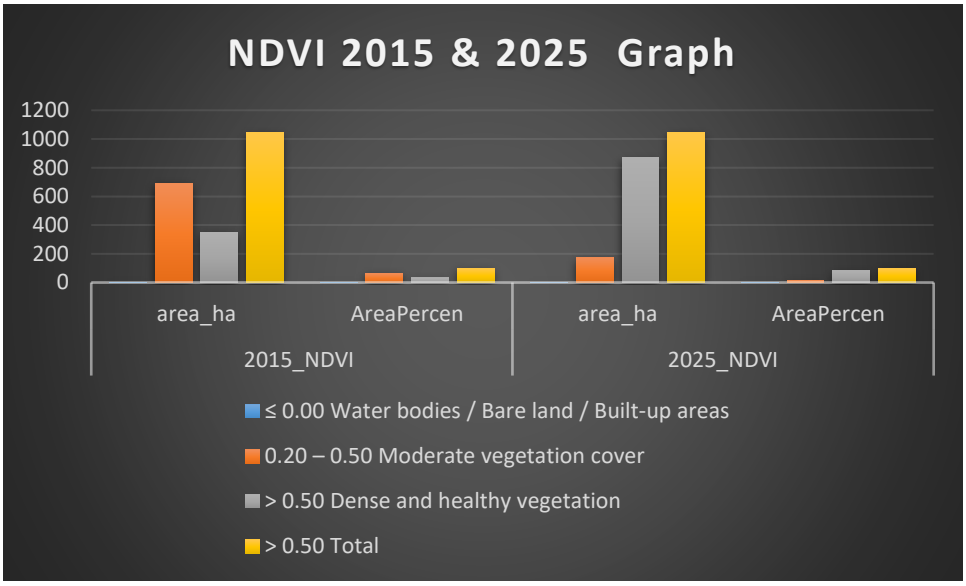


Figure 15: NDVI Graphs 2015 and 2025

The above Graphs depicting NDVI class changes reveal an almost complete inversion of vegetation structure between 2015 and 2025. However, when interpreted alongside FDG findings, it becomes clear that this apparent greening is misleading. High NDVI values primarily reflect Eucalyptus monocultures, which produce dense leaf cover but support very low levels of biodiversity and ecosystem functionality.

Land cover change tables reveal the most alarming transformation in the ecosystem: a 32.49% loss of wetland area, corresponding to the disappearance of 339.8 hectares. Agricultural expansion is equally striking, with cropland and perennial crops now occupying more than 70% of the ecosystem. Although forest cover appears to have increased, spatial analysis and FDG narratives confirm that these areas are dominated by exotic plantations rather than native forest recovery.



Figure 16:- Expansion of eucalyptus tree on the wetland

The above images show the spatial distribution of Eucalyptus plantations, further illustrating their encroachment into wetland margins and former native forest zones, highlighting the spatial drivers of biodiversity decline.

3.3.2. Driver and Pressure on Biodiversity on the Walana Wetland Ecosystem

Driver:

The underlying drivers of ecological change in the Walana Wetland ecosystem are both economic and institutional. Market demand for Eucalyptus timber, fuelwood, and perennial cash crops has incentivized land conversion and monoculture expansion. Policy frameworks have historically promoted fast-growing exotic species as part of afforestation and income-generation strategies, often without adequate consideration of ecological consequences. Population pressure has increased demand for agricultural land and natural resources, while climate variability has been encouraging the adoption of drought-tolerant but water-intensive species such as Eucalyptus. Cultural shifts away from traditional conservation practices have further weakened informal protection mechanisms.

Pressure:-

These drivers manifest as direct pressures on the ecosystem, including the drainage and conversion of wetlands for agriculture, clearing of native forests for fuelwood and farmland, and replacement of diverse vegetation with Eucalyptus plantations. Unsustainable harvesting of medicinal plants and fuelwood has accelerated species decline, while landscape disturbance has facilitated the spread of invasive species such as Lantana camara. Increased water extraction for irrigation and plantation forestry has further disrupted the hydrological balance of the wetland system.

3.3.3 Impact of Biodiversity Degradation on the Walana Wetland Ecosystem

The social impacts of biodiversity loss are profound. The disappearance of traditional medicinal plants has reduced community access to culturally appropriate healthcare, while the extinction of culturally significant trees such as Koso and Zigba has eroded traditional knowledge systems. Wetland loss has diminished access to clean water and altered livelihoods, forcing communities to depend increasingly on monoculture-based income sources.

Environmental impacts include widespread biodiversity collapse, loss of wetland ecosystem functions such as water purification and flood regulation, and degradation of soil quality associated with Eucalyptus plantations. The decline of fauna, including amphibians and pollinators such as Segon and Amor, has disrupted food webs and ecosystem processes. Hydrological disruption, manifested through lowered water tables and drying wetland patches, further threatens ecosystem resilience.

Economically, while Eucalyptus and perennial crops provide short-term income, they generate long-term costs through the loss of ecosystem services, increased vulnerability to climate extremes, and future restoration expenses. The economic benefits of monoculture expansion are therefore unlikely to outweigh the long-term costs of ecological degradation.

3.3.4. Response

Government responses have included large-scale afforestation programs, soil and water conservation measures, promotion of perennial crops through agricultural extension services, and road infrastructure development. However, these interventions have largely favored Eucalyptus plantations and have often contributed to habitat fragmentation. Formal wetland protection exists in policy but is weakly enforced in practice. At the local level, communities have engaged in tree planting, watershed management committees, and participatory mapping exercises, yet these efforts are constrained by limited authority and resources.

Critical gaps remain in current responses. There is little to no promotion of native species in afforestation programs, weak enforcement of wetland protection regulations, an absence of invasive species control initiatives, and minimal integration of traditional ecological knowledge into formal planning processes.

3.3.5. Outlook

If current trends continue under a business-as-usual scenario, the Walana Wetland may face near-complete loss by 2040, accompanied by total extinction of remaining rare species and escalating water scarcity and social conflict. A moderate intervention scenario could stabilize wetland coverage at low levels and allow limited native species recovery, while a strong ecological recovery pathway could restore wetlands to 25–30% of their historical extent, establish native species corridors, phase Eucalyptus out of critical zones, and support community-based conservation economies.

Integrated Recommendations

Immediate priorities include emergency wetland delineation and protection, establishment of community seed banks for native and medicinal plants, a moratorium on Eucalyptus planting in wetland buffer zones, and pilot programs to control Lantana camara. Medium-term strategies should focus on restoring native species corridors, implementing payment for ecosystem services schemes, documenting and conserving traditional medicinal knowledge, and developing ecotourism based on remaining biodiversity. Over the long term, restoring the wetland complex to at least 30% of its historical coverage and integrating climate-resilient, biodiversity-based livelihoods will be essential.

Conclusion

The Walana Wetland ecosystem illustrates how apparent vegetation greening can mask deep ecological degradation. High NDVI values in this landscape represent biologically impoverished Eucalyptus plantations rather than healthy, diverse ecosystems. Ground-truth evidence from FDG confirms widespread biodiversity loss, species extinctions, and cultural erosion. Urgent, evidence-based intervention is required to shift management away from exotic monocultures toward native biodiversity restoration, wetland recovery, and long-term socio-ecological sustainability. The survival of remaining species such as Dakeye, Daguncher, Segon, and Amor, along with the cultural heritage embodied in trees like Wanza, Bisana, and Tid, depends on immediate and coordinated action.

3.4. Climate of Walana Wetland Ecosystem

3.4.1. State and Trend of Climate Walana Wetland Ecosystem

Walana wetland found in the Central part of Ethiopia, which is located around Latitudes at 7° 9′ 25.92″ N to 7° 12′ 12.98″ N and Longitudes at 37° 42′ 5.63″ E to 37° 44′ 39.69″ E and Tropical highland / temperate climate with a distinct wet and dry season. In our country, the climate varies mostly with altitude. For this study, we use the data gather from Ethiopia Meteorological institute for 30 years data, from the Kachaber Woreda different office and from FGD.

A wetland is an area with a water table, at, near or above the land surface either seasonally or permanently throughout the year, which support special plants and animals that can live in wet conditions. They are important because they store water, reduce flooding, clean water, support wildlife, and help regulate climate (Shokoufeh Salimi, 2021).

Freshwater wetlands play an important role in carbon cycling and climate change mitigation because they act as major carbon sinks. They store large amounts of carbon in their plants and soils through photosynthesis and the buildup of sediment and peat. Although freshwater wetlands cover a small area of the Earth, they store more carbon than most other land ecosystems. (Feruza Azizova, 2025)

Weather refers to atmospheric conditions that occur locally over short periods from minutes to hours or days. Familiar examples include rain, snow, clouds, winds, floods, or thunderstorms.

Climate, on the other hand, refers to the long-term (usually at least 30 years) regional or even global average of temperature, humidity, and rainfall patterns over seasons, years, or decades while Climate change is a long-term change in the average weather patterns (NASA, Oct21,2024)

3.4.1.1. State and trend of Rainfall on the Walana wetland ecosystem

Ethiopia's rainfall patterns are shaped by both local and global climate factors. Locally, the annual movement of the Intertropical Convergence Zone, the country's diverse landscape, and moisture cells from the Indian Ocean play key roles. On a global scale, the El Niño/Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) are the primary drivers (FAO, 2024).

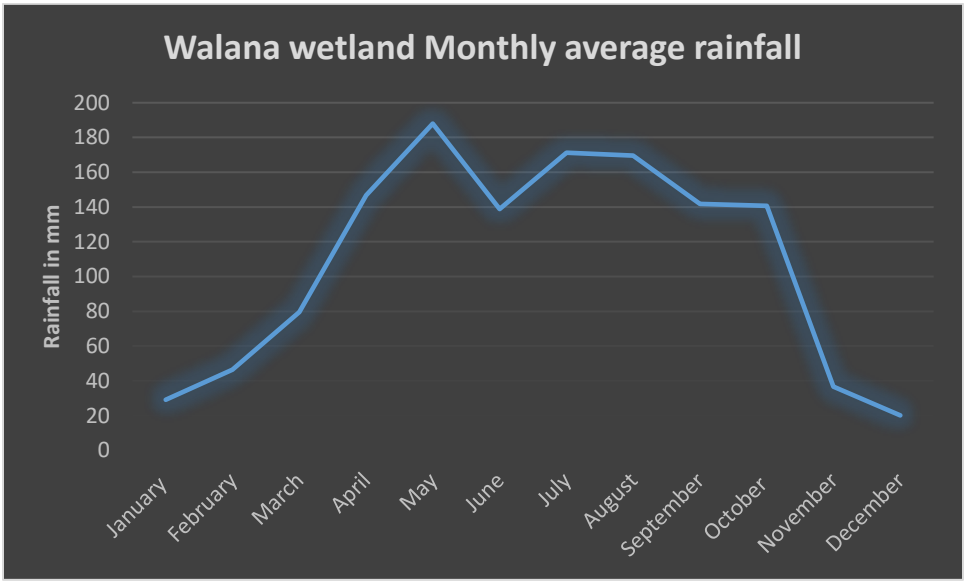


Figure 17: Walana wetland monthly average rainfall for 32 years

Walana wetland is Tropical highland / temperate climate with experiences a distinct wet and dry season

the rainfall pattern it seems like bimodal rainfall as we can see on the above figure. Rainfall starts relatively low in January and gradually increases through to April. A sharp peak is observed in May, where rainfall reaches its highest point, just above 180 mm. This likely corresponds to the wettest period of the year. After June, rainfall begins to decrease but remains above 100 mm during these months. The rainfall continues to drop significantly in November, and by December, it reaches its lowest levels of the year, around 20-36 mm.

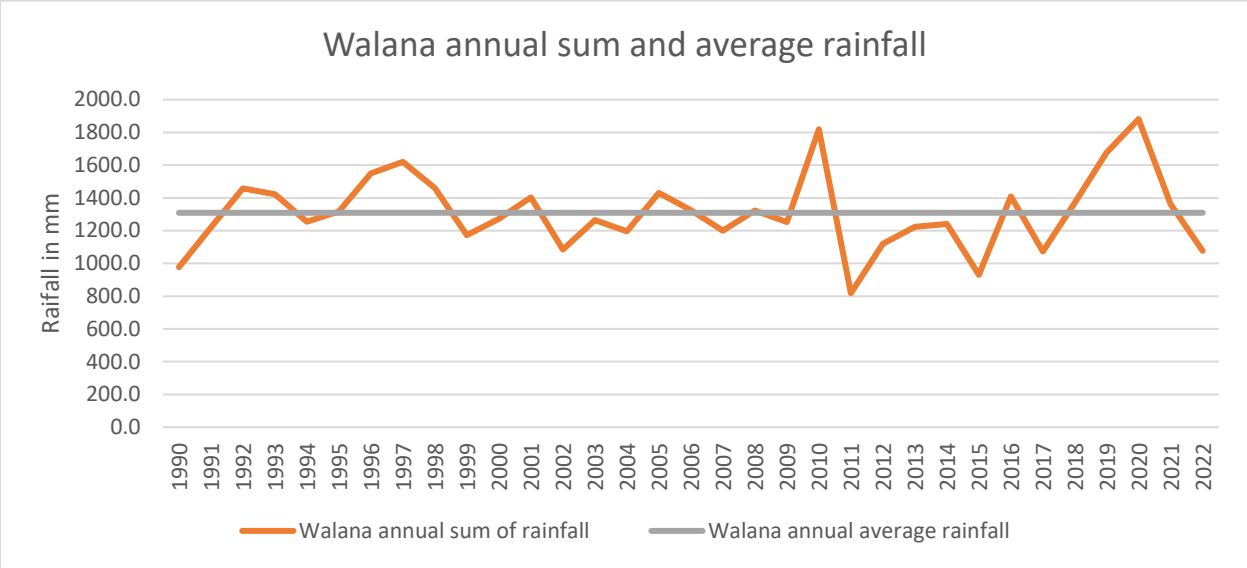


Figure 18: Walana wetland Annual sum of rainfall starting from 1990-2022

The above figure shows the annual total and average rainfall at Walana Wetland from 1990 to 2022, highlighting both variability and long-term behavior. Overall, annual rainfall varies considerably from year to year, indicating high interannual climate variability. Annual totals range from below 1,000 mm in drier years to nearly 1,881.1mm in wetter years. Several notable wet years are evident, particularly around 1997, 2010, 2019, and 2020, which may be associated with large-scale climate drivers such as ENSO or the Indian Ocean Dipole. In contrast, pronounced dry years occur around 1990, 2011, and 2015, reflecting periods of reduced rainfall that could have affected wetland hydrology and ecosystem functioning.

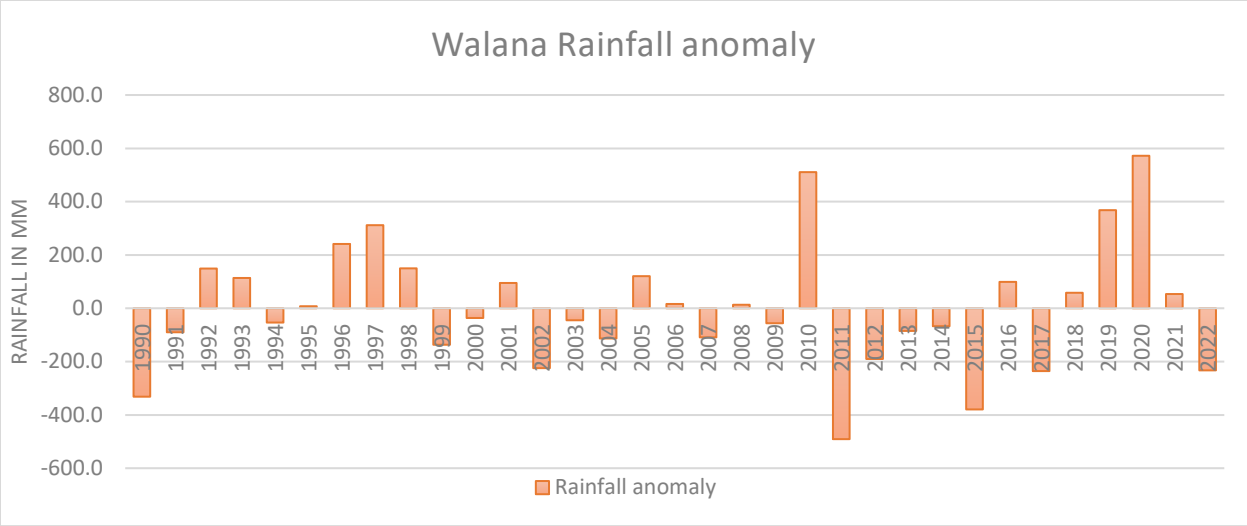


Figure 19 Rainfall anomaly for Walana wetland

The above figure illustrates rainfall anomalies for the Walana Wetland from 1990 to 2022, indicating deviations from the long-term average rainfall. Rainfall anomalies represent whether precipitation in a given year is higher or lower than the normal (average) condition.

At Walana Wetland, **negative rainfall anomalies** signifying below-average rainfall were observed in **1990, 1994, 1999, 2002, 2004, 2007, the period from 2011 to 2015, 2017, and 2022**. In contrast, the remaining years experienced **positive rainfall anomalies**, indicating periods of above-average rainfall.

3.4.1.2. State and trend of Maximum Temperature

According to UN climate change report, the Earth's average surface temperature is now about 1.42°C higher than it was in the late 1800s, before the Industrial Revolution began. This makes the present climate warmer than at any other time in the past 100,000 years. The period from 2015 to 2024 has been the hottest decade ever recorded, and each of the last four decades has been warmer than all earlier decades dating back to 1850 and Climate change affects people's health, food supply, homes, and safety, especially in poorer countries and small island nations. Rising sea levels and long-lasting droughts are increasing the risk of hunger and famine are already forcing people to move, and this is expected to increase in the future. (https://www.un.org/en/climate change report)

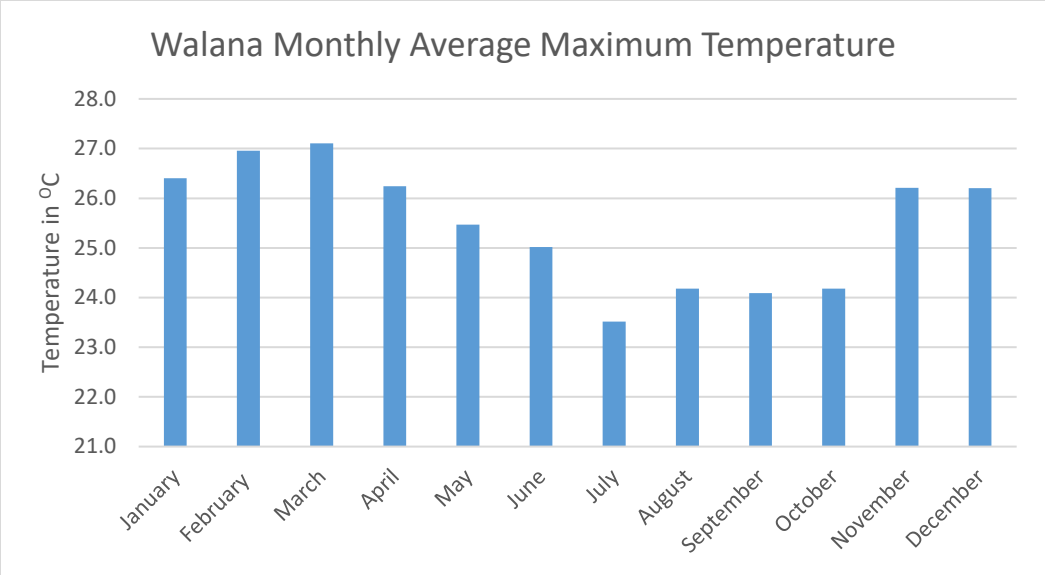


Figure 20: Walana Monthly Average Maximum Temperature

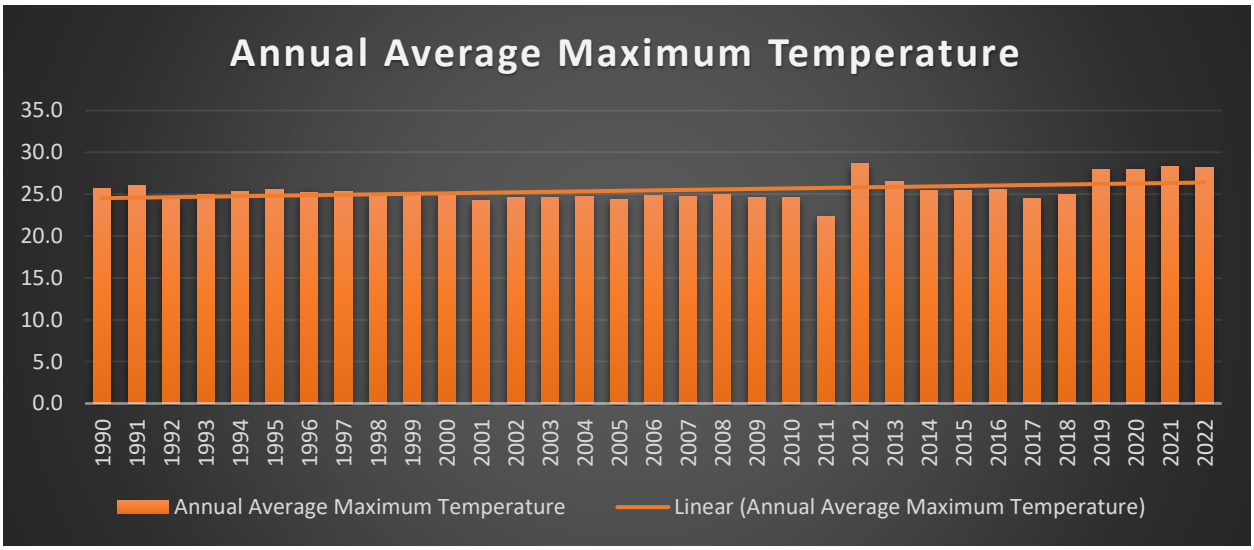


Figure 21: Walana Annual Average Maximum Temperature

The above figure illustrate that Walana **Annual Average Maximum Temperature** from **1990 to 2022**.Temperatures are mostly in the range of **24–29 °C**. The trend line clearly shows slopes upward, this means average maximum temperatures have increased over time.

Starting from 1990 up to 2009 the temperatures stay stable around 24–25 °C. Around in 2010-2013 a noticeable dip around 2011, followed by a sharp spike around 2012, this suggests short-term climate variability (for example, unusual weather patterns). From 2018-2022 the temperatures

are generally higher than earlier decades, often **27–29 °C** and Several of the highest values occur in the last few years, supporting the warming trend. This pattern is consistent with global climate change, where average maximum temperatures gradually rise over decades.

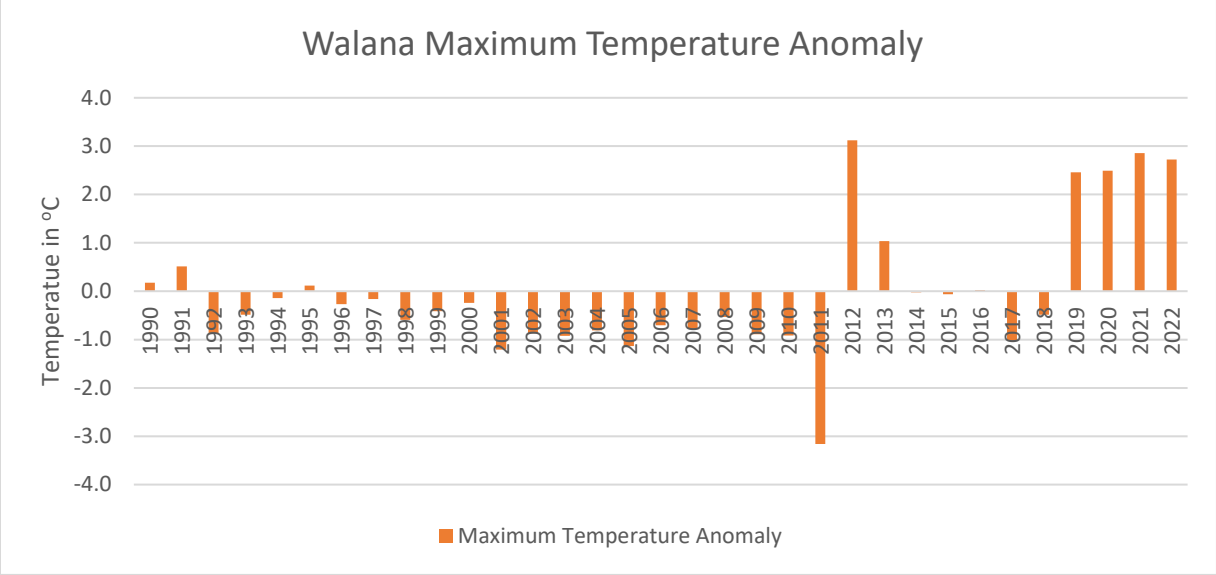


Figure 22: Walana Maximum Temperature Anomaly

The above figure indicates that earlier decades (1990s–2000s) were dominated by negative anomalies, while positive anomalies become more frequent and stronger after ~2012.

From 1990-2009 most years during this period show slightly to moderately negative anomalies around –0.2 to –0.8 °C. This suggests that maximum temperatures were generally below the long-term average.

In 2011 stands out as an extreme cold anomaly around –3 °C, the most negative value in the entire record and in 2012 immediately follows with a very strong positive anomaly around +3 °C, the largest warm anomaly this indicates that there is climatic instability or extreme events

From 2013-2017 Anomalies during this period close to zero, with small negative values.

From 2018-2022 show strong positive anomalies, roughly +2.3 to +3.0 °C. This is the longest and most consistent warm period in the dataset. Indicates that a shift toward persistently higher maximum temperatures, consistent with broader regional and global warming trends. Sustained high maximum temperatures increase risks for agriculture, water resources, and human health.

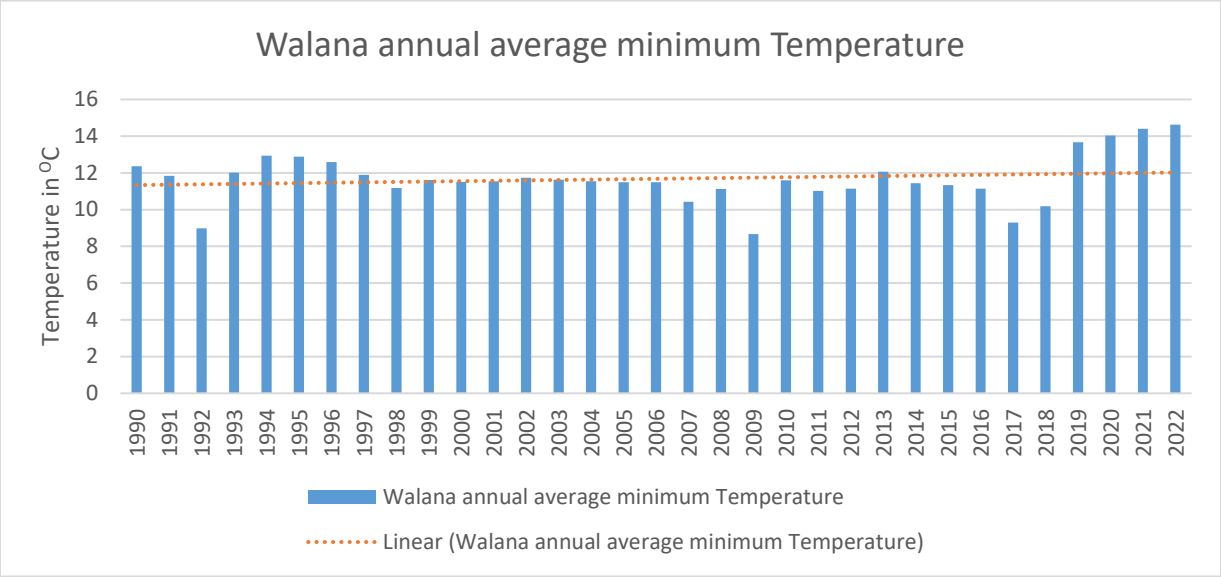


Figure 23: Walana Annual Average Minimum Temperature

On the above Walana's annual average minimum temperature figure shows an overall increasing trend from 1990 to 2022. Early years mostly range around 10–12 °C, with some cooler dips by early 1990s and 2009. After 2018, minimum temperatures rise sharply, reaching ~14–15 °C by 2020–2022. The upward linear trend indicates warmer nights over time finally we can conclude annual average minimum temperatures in Walana are steadily increasing, suggesting reduced cold extremes and ongoing warming.

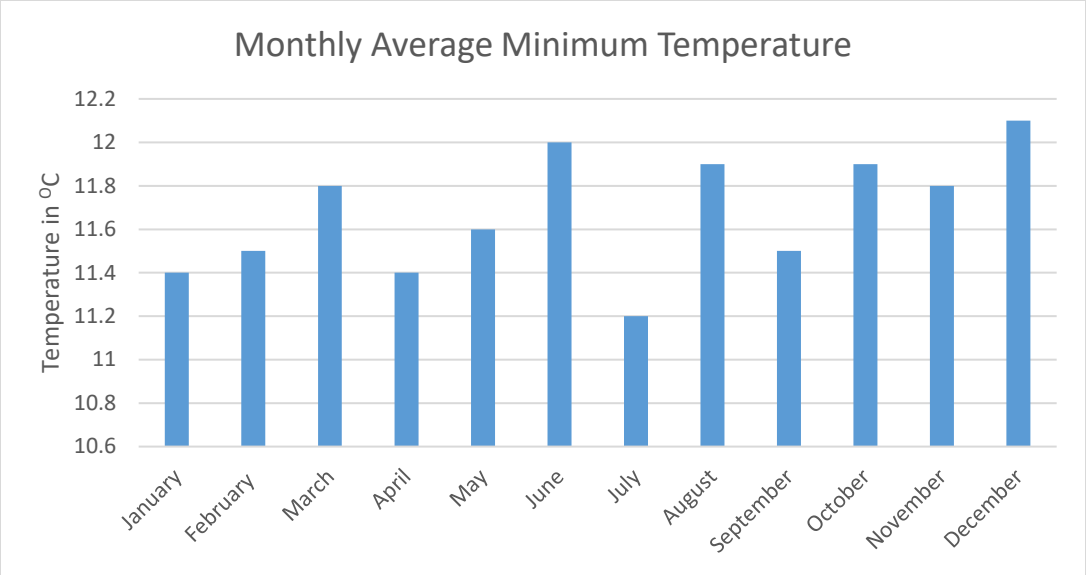


Figure 24: Walana Monthly Average Minimum Temperature

As we can see from the above, figure, peaking and the lowest Walana monthly average minimum temperatures was in December around 12.1 °C and in July around 11.2 respectively. Walana experiences monthly average minimum temperature variation (range ≈ 1 °C),

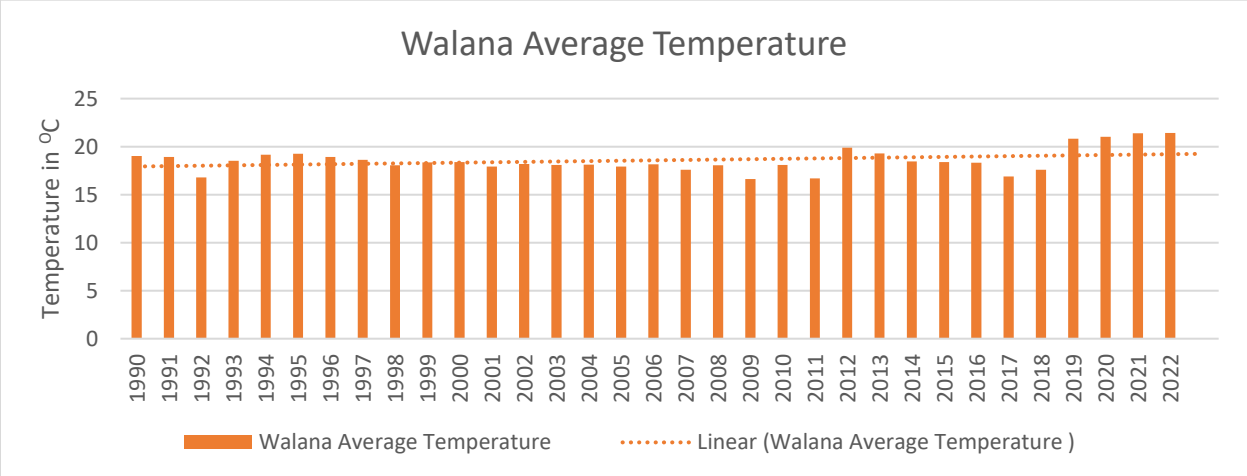


Figure 25: Walana Average Temperature from 1991 up to 2022

The above chart shows that Walana's average temperature shows a clear upward trend from 1990 to 2022. Temperatures were mostly 17–19 °C in the 1990s and early 2000s. A noticeable increase

occurs after ~2015, with values reaching 21–22 °C by 2019–2022. The linear trend line confirms gradual warming over time, despite year-to-year fluctuations.

Walana's average temperature is increasing at an estimated rate of about 0.79 °C per decade, indicating significant warming over time. This Rising baseline temperatures imply that heat extremes are more likely and more intense which impacts Increased evapotranspiration Greater heat stress on crops and livestock higher water demand Combined with rising maximum temperature anomalies, this suggests both hotter days and warmer overall conditions.

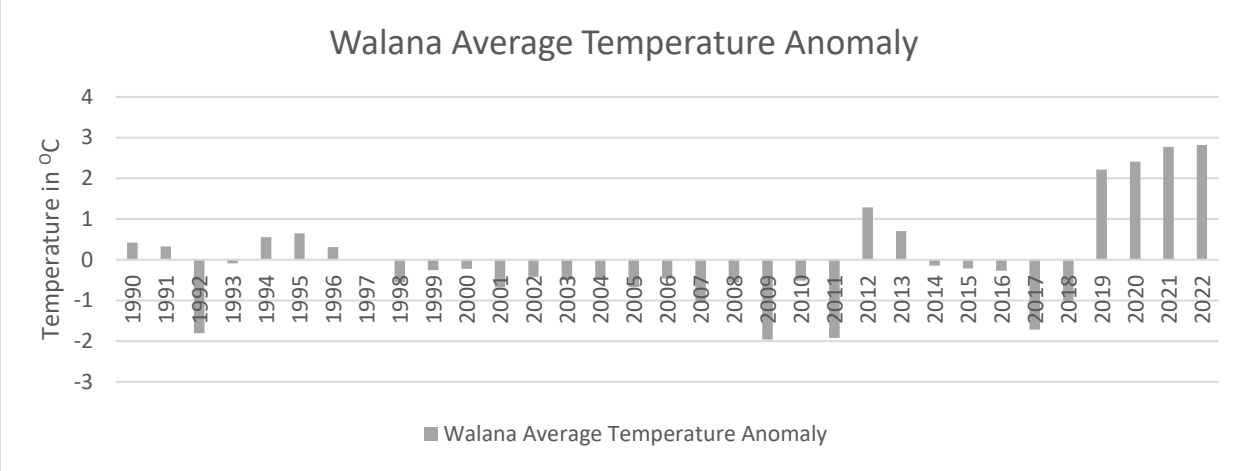


Figure 26: Walana Average Temperature anomaly for 32 years

The above figure illustrate that 1990s–early 2010s Temperature anomalies are mostly negative or near zero, indicating cooler-than-average years. After 2018, Anomalies become strongly positive, reaching about +2 to +3 °C by 2019–2022, this shift shows a clear warming pattern, with recent years significantly warmer than the long-term average. Therefore, we can conclude that Walana has transitioned from mostly cooler anomalies to persistent warming,

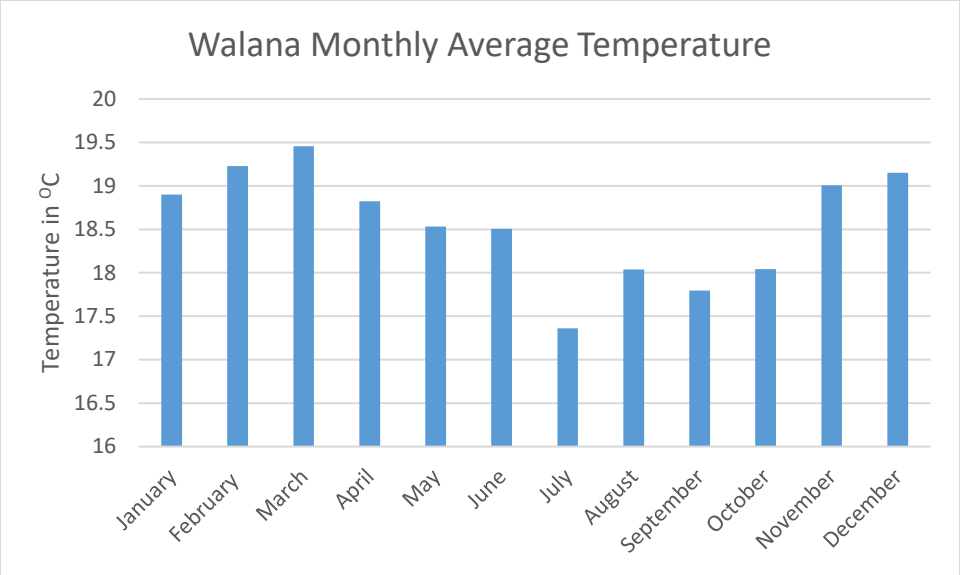


Figure 27: Walana Monthly Average Temperature

As we can see from the above, figure Walana monthly average temperatures peaking in March (~19.5 °C). A gradual decline occurs from April to July, with the lowest monthly average temperature in July (~17.4 °C) and rise again from August, reaching ~19.1 °C in December. Overall, Walana experiences moderate seasonal variation (range ≈ 2 °C),

3.4.2. Driver and pressure for climate change or variability on the Walana wetland

Agricultural expansion:

Agricultural expansion by the community around the Walana wetland is a significant driver and pressure contributing to climate change and climate variability in the area. And also around 3ha part of the wetland given to investor. Field observations indicate that cultivated lands are increasingly encroaching toward the wetland boundary, leading to changes in land use and land cover.

Wetlands naturally function as important carbon sinks. They absorb and store large amounts of carbon dioxide (CO_2) in their vegetation and waterlogged soils over long periods. When wetlands converted into agricultural land, this stored carbon released back into the atmosphere through soil

disturbance, drainage, and vegetation removal. This release of greenhouse gases contributes directly to global warming and climate change.

In addition, agricultural expansion reduces the wetland's ability to regulate local climate. Wetlands help moderate temperatures by maintaining soil moisture, supporting evapotranspiration, and reducing temperature extremes. When these ecosystems degraded or reduced in size, their climate-regulating function weakens, resulting in higher local temperatures, increased temperature variability, and reduced humidity.

Furthermore, agricultural activities often involve deforestation, burning, fertilizer use, and irrigation, which can increase emissions of greenhouse gases such as CO_2, methane (CH_4), and nitrous oxide (N_2O). These practices intensify climate pressures on the wetland system and accelerate climate variability at both local and regional scales.



Figure 28 Agricultural activities around at the Walana wetland

Conclusion

Agricultural expansion around the Walana wetland acts as a **major pressure on the ecosystem**, driving climate change and variability by:

- Releasing stored carbon,
- Reducing carbon sequestration capacity,
- Weakening local climate regulation, and
- Increasing greenhouse gas emissions.

Protecting the wetland from further agricultural encroachment is therefore essential for **climate mitigation, local climate stability, and ecosystem sustainability**.

Population Growth

Population growth in communities surrounding the Walana wetland places increasing pressure on natural resources. As the population increases, demand for food, housing, fuelwood, and infrastructure expands. This leads to wetland encroachment, deforestation, and land-use change, which increase greenhouse gas emissions and reduce vegetation cover. The loss of natural vegetation diminishes the wetland's ability to buffer temperature extremes, regulate microclimates, and store carbon, thereby enhancing climate variability at the local lev

Water Abstraction

Water abstraction for irrigation, domestic use, and livestock is another significant pressure on the Walana wetland. Excessive withdrawal of water lowers wetland water levels, causing drying of wetland soils. Dry soils accelerate the decomposition of organic matter, resulting in the release of carbon dioxide and methane. Reduced water availability also limits evapotranspiration, which is crucial for cooling the local environment, thus contributing to higher temperatures and increased climate variability.

Climate Extremes

Climate extremes such as prolonged droughts, erratic rainfall, heatwaves, and intense rainfall events act both as drivers and consequences of climate change affecting the Walana wetland. Droughts reduce water inflow and wetland extent, while extreme rainfall can cause erosion, sedimentation, and nutrient loading. Rising temperatures increase evaporation rates, further stressing the wetland ecosystem. These extremes reduce the wetland's resilience, disrupt ecological processes, and intensify climate variability and ecosystem degradation.

Conclusion

The Walana wetland is under increasing pressure from **agricultural expansion, population growth, water abstraction, and climate extremes**, all of which interact to drive climate change and climate variability. These pressures lead to **carbon release, reduced climate regulation, hydrological imbalance, and ecosystem degradation**. Sustainable land-use planning, wetland conservation, and climate-adaptive management are essential to reduce these pressures and enhance the resilience of the Walana wetland.

3.4.3. Impact of climate change or variability on the Walana wetland

Loss of wet land biodiversity and ecosystem services: - Degradation of the wetland has led to a decline in plant and animal species, reducing important services such as water purification, habitat provision, and livelihood support.

Increase in local temperature and climate variability: - Focus Group Discussion (FGD) participants reported that warming conditions have been increasing year by year. This observation supported by temperature analysis results, which show a rising trend in temperatures, including warmer nights and increase heat stress affecting the community and they were explained that rainfall in distribution and amount is inconsistent. Climate change also affect the harvest period as FGD participant explained that in the past, the harvest was in January, but now it is in March.

Reduced water availability for ecosystem and communities:-According to FGD participants, water resources have significantly declined. In the past, there were many natural springs in the area, but currently only one spring remains, limiting water availability for both the wetland ecosystem and local people.

Decline in wetland resilience to extreme weather events: - FGD participants explained that the Walana wetland has become less resilient. During extreme weather events, such as heavy rainfall, the wetland now floods more easily, indicating reduced capacity to absorb and regulate excess water.

3.4.4. Responses taken to protect the Walana wetland

Even though there is possible to take, responses align strongly with SDGs and national climate and environmental policies like

- Wetland protection and restoration support SDG 15 and often prioritized in national biodiversity and wetland policies.
- Sustainable water management aligns with SDG 6 and integrated water resources management (IWRM) frameworks.
- Climate-smart agriculture and ecosystem-based adaptation contribute to SDG 13 and national adaptation plans (NAPs).
- Community-based management and stakeholder collaboration reflect SDG 11: Sustainable Communities and SDG 17: Partnerships for the Goals.

However, the community described that to reduce climate-related impacts, tree-planting initiatives under the Green Legacy program, the establishment of fruit trees, and the implementation of soil and water conservation practices aimed at enhancing ecosystem resilience and improving land productivity activities were done.

3.4.5. Outlook

As indicated by the trends presented above, the average maximum temperature has been increasing consistently from year to year. This rising temperature trend increases the vulnerability of the Walana wetland to evapotranspiration losses, resulting in a gradual reduction for water stored within the wetland system. Unless effective measures are implemented including

- wetland conservation and protection through land-use planning
- enforcement of buffer zones; promotion of sustainable agricultural practices such as agro ecology and the prevention of wetland encroachment;
- regulation of water abstraction to maintain ecological flows
- wetland restoration through re-vegetation and rewetting of degraded areas;
- Strengthened community awareness and participation in climate adaptation and wetland management; and the integration of wetlands into climate-resilient policies and climate mitigation strategies, the Walana wetland will remain at serious risk of degradation.

Generally, the observed land use and land cover changes between 2015 and 2025 indicate that the Walana wetland is at a critical turning point**.** The substantial reduction in wetland area, coupled with the expansion of perennial crops and cropland, suggests that continued degradation is likely if current trends persist. Without timely and coordinated intervention, the remaining wetland patches may be further fragmented or completely lost, leading to irreversible ecological damage.

In the short term, agricultural expansion may continue to provide economic benefits for local communities. However, in the long term, the loss of wetland ecosystem services such as flood regulation, water storage, groundwater recharge, and biodiversity conservation will likely increase vulnerability to climate variability and extreme events, including droughts and intense rainfall. This may undermine agricultural productivity itself, creating a cycle of environmental degradation and livelihood insecurity.

The future condition of the Walana wetland will largely depend on the **effectiveness of** management responses. Integrating wetland conservation into local land-use planning, strengthening enforcement of wetland protection policies, and promoting sustainable and climate-resilient livelihood options are essential to halt further loss. Restoration of degraded wetland areas, particularly those converted through drainage offers an opportunity to recover some ecological functions if implemented promptly.

Encouragingly, the increase in forest cover suggests potential for **ecosystem recovery** when supportive measures are in place. Building on this, increased community awareness, participatory management approaches, and alignment with national climate and environmental policies can support a more balanced relationship between development and conservation.

Overall, the outlook for the Walana wetland is cautiously optimistic but conditional. Immediate and integrated action can still safeguard the remaining wetland, enhance resilience to climate change, and ensure sustainable benefits for present and future generations. Conversely, inaction will likely result in continued wetland loss with profound environmental and socio-economic consequences.

3.4.6. Conclusion

Human-induced drivers and pressures, in combination with climate extremes, have altered the ecological state of the Walana wetland, resulting in significant environmental and socio-economic impacts. Addressing these challenges requires effective and integrated response measures aimed at enhancing wetland resilience, reducing climate-related risks, and sustaining critical wetland functions. Increasing community awareness of the critical importance of wetlands is essential to strengthen local stewardship and ensure long-term protection of the Walana wetland. Furthermore, greater attention and coordinated action are required from key stakeholders, including the regional government, regional environmental protection authorities, and regional agricultural offices, to prevent wetland encroachment, implement wetland restoration through re-vegetation and rewetting of degraded areas, and promote sustainable wetland conservation and management.

3.5. Water

3.5.1 State and Trend of Water Availability on the Walana 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 distribute across the world. To illustrate, only the Amazon River carries one-fifth of the water discharged by all the world's rivers. The Amazon is

theoretically enough to supply twice the worlds freshwater needs. The great river of China, Yangtze Kiang, has enough water to supply every person on the planet with about 500 liters of water in a day. As water is nowadays a limiting factor for the socio-economic development of any country, international, regional, and local conflicts overutilization of water are increasing significantly. In addition to the impact of global change on water resources in the world due to increasing demand, excessive water extraction from underground aquifers and rapid population growth are among these problems.

Although the increase in water demand in agricultural production has been of great concern worldwide in recent years, water professionals and development experts ignore the provision of water for energy production. Sustainable development and advanced economic growth, sanitation, wastewater treatment, and water supply cannot be 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).

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 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 Source-based interventions include designing and construction of improved source that have the potential to protect water from contamination and deliver safe water; community-driven sanitation to protect pollution of the catchment area from human, animal, and agricultural wastes; and source-based water treatment.
The study conducted in central Ethiopia regional state, Kacha Bira Woreda Walana ecosystem. The regional state has been striving to provide equal access to safe and affordable drinking water supply for all inhabitants. In 2013 E.C the regional pure water access coverage in urban is 59.5 %, in rural areas is 43% and the average pure water coverage is 28.3%.According to the data obtained from central Ethiopia region water and Mining Office, the percentage of the Woreda population with access to safe drinking water was 28,3 % . The highest demand of water in the Woreda is population and livestock. The major sources of potable water supply for rural and urban

community are natural Tap water, springs, Deep-water burrow, hand dug wells and shallow wells.

3.5.2 Driver and Pressure Water Resource Degradation on the Walana Wetland Ecosystem

Drivers

Population Growth

According to Kacha Bira Woreda water mineral and energy office, the amount of wastewater 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 wastewater disposal and sever water degradation in the ecosystem.

Agricultural Practices-

Agricultural practices significantly drive water degradation in Walana wetland ecosystems through several mechanisms. The application of synthetic crop fertilizers can lead to runoff during rainstorms, introducing excess nitrogen and phosphorus into nearby water bodies. This can cause contaminating water sources and impacting non-target species, including beneficial insects and aquatic organism's eutrophication, resulting in algal blooms that deplete oxygen and harm aquatic life.

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

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

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

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

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.

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

Unsustainable Fishing and Harvesting:

Overfishing and excessive harvesting of wetland resources can lead to declines in species and ecosystem health.

Invasive Species

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

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

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

Climate Change temperature and precipitation changes

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

Pressure

Hydrological Alterations

Water Diversion: Changing natural water flow for agricultural

can lead to reduced water levels, affecting wetland habitats.

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.

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.

Climate Change

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

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.

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.

Infrastructure Development

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

Urban Expansion

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

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.

3.5.3. Impact of Water Resource Degradation on the Local Community

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

The driving forces for the water quality degradation of the region's surface water resources (Rivers and Lakes) are population growth, agricultural expansion, deforestation, livestock raising,. Kacha Bira 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 enhanced resulting in decrease in base flow of the rivers. Due to the degradation of Walana wetland ecosystems can have significant and far-reaching impacts. Here are some key effects:

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.

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.

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.

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.

Social and Economic Impacts

Communities that rely on wetland resources for fishing, agriculture, or tourism may experience economic decline as wetland health deteriorates.

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 expos 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.

3.5.4 Response to Protect Water in the Walana 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 often introduced to inform residents about the importance of water conservation and the consequences of degradation.

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

3.5.5. Outlook

The degradation of wetland ecosystems has profound implications for water quality, biodiversity, climate resilience, and human livelihoods. Protecting and restoring wetlands is essential for maintaining healthy water systems and sustainable ecosystems .Addressing the overexploitation of resources through sustainable management practices is crucial for protecting water quality and ensuring the health of ecosystems. 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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