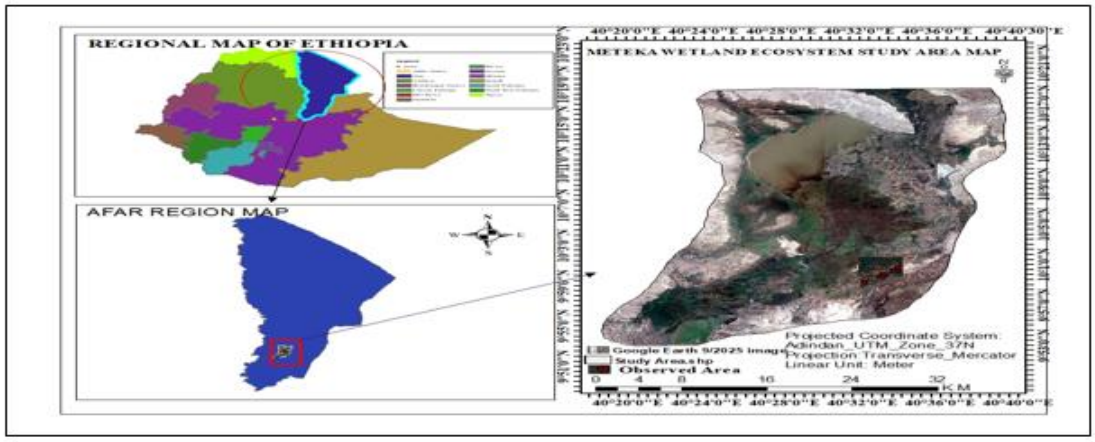
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

ENVIRONMENTAL PROTECTION OUTORITY

FACT–SHEET OF

METEKA WET LAND ECOSYSTEM

AFAR REGION





Prepared By

State of Environment Data Study and Report Preparation Desk

ADDIS ABABA, 2025

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Abbreviations

AGP—Agricultural Growth Program

Avr – Average

CBD – Convention on Biological Diversity

CDM- Clean Development Mechanism

CRGE – Climate Resilience Green Economy

CSA - Central Statistical Agency

DPSIR: Driver, Pressure, State, Impact and Response

E.C. - Ethiopian Calendar

EPA – Environmental Protection Authority

FAO –Food and Agriculture Organization-

FGD: Focus Group Discussion

GDP: Gross Domestic Product

GHG: Green House Gas

GTP: Growth and Transformation Plan

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation Nature

IWRM - Integrated Water Resources Management

KI: Key informants

Max – Maximum

MEA-Millennium Ecosystem Assessment

Min – Minimum

MoWIE - Ministry of Water, Irrigation, and Electricity

NGO - None Governmental Organizations

RF- Rain Fall

T – Temperature

UNEP - United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

WHO - World Health Organization

WWAP - World Water Assessment Programme

1. General Back ground

1.1 Environment for Green Economy Development

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

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

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

Sustainable development is development, which meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The concept of sustainable

Development takes into account the interlinking of the environment, economic and social issues.

The idea of development, in this sense not based on a straight-line progression from traditional to modern mass-consumption society, which results in social inequalities and negative environmental impacts. Instead, the kind of development aspired here is that remedies social inequities and environmental damage while maintaining a sound economic base. The kind of economy developed in this case is green economy that results in improved human-wellbeing and social equity wile significantly reducing environmental risks and ecological scarcities.

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

Social green economy Human well-being; social equity; socially inclusive; reduced inequalities; Better quality of life; social development; equitable access; addressing needs of women and youth.

Social green growth Well-being, socially inclusive, access to basic commodities for the impoverished; meeting demands for food production, transport, construction, housing and energy, Economic green economy Growth in income and employment; public and private investments; resilient economy; economic growth; new economic activity.
Economic green growth Economic growth and development; technology and innovation; environmentally sustainable economic progress; more resilient; sustained economic growth; driver for economic growth; new growth engines; green technology; new job opportunities; qualitative growth rather than simply increasing GDP; job creation or GDP growth.

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

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

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

The Government of the Federal Democratic Republic of Ethiopia and the Regional State governments are striving to fulfill their responsibilities to their citizens. They strive to provide social services and security, ensure adequate functioning of infrastructure, provide a climate conductive employment and pay their debts. In addition, promoting development and achieve their national aspirations using the resources available at their disposal. To be able to achieve the desired social and economic development, the government has already started to pursue its development endeavors following the green growth path.

Accordingly, the country's 5 years Growth and Transformation Plan (GTP) that aims at improving the livelihoods of its people implemented. The GTP, which aims at sustaining the rapid and broad-based growth of the country, hinges on seven pillars and four of these (i.e. sustaining faster and equitable economic growth, maintaining agriculture as a major source of economic growth, creating favorable conditions for the industry to play key role in the economy, and enhancing expansion and quality of infrastructure development). Furthermore, the environmental sector plan is one of the GTP of the country.

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

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).

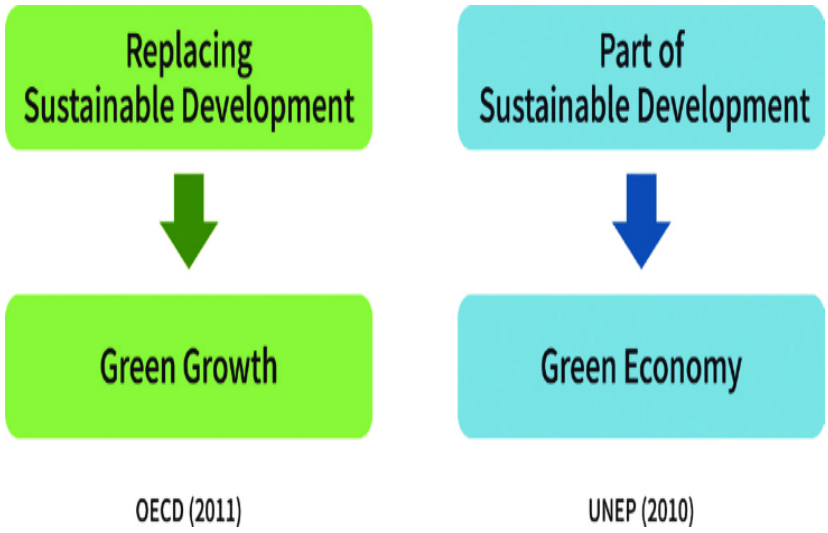


Figure 1: **Conceptual diagram of green growth and green economy**

1.2. Frame works/Approaches

1.2.1. The Driver-pressure-state impact response framework

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

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

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

STATE: Environmental state also includes trends, often referred to as environmental change, which could be both naturally and human induced. One form of change, such as climate change,

(referred to as a direct driver in the MA framework) may lead to other forms of change such as biodiversity loss (a secondary effect of climate gas emissions);

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

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

1.3. Social and Economic Environment

1.3.1. Social Environment

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

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

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

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

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

In order to enrich their lives, people have used natural resources, and in the process have brought about many changes in the natural environment; human settlements, roads, farmlands, dams, and

many other elements have all developed through the process. All these man-made components are included in human cultural environment

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

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

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

Wetlands; defined as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"(Ramsar Convention Bureau, 1997), provide invaluable uses and benefits to human beings.

According to Roggeri (1995), they use as groundwater discharge and recharge, flood control, shoreline stabilization and nutrient retention, source of water, food, fuel wood, wildlife, fisheries, forage and agricultural resources. Meteka wetland, found in Gewane wereda of Afar National Regional State is the only source of water for both human and livestock in the study area. However, it is facing tremendous pressures in a number of ways. The livelihoods of the pastoralists dwelling there are almost entirely dependent on the wetland. They are using it intensively as a source of water and feed for their animals, charcoal production, fuel wood, and above all; as a raw material (Typha angustifolia) for locally made mattress called Gadeta, which exacerbates the situation, as it is the only available commodity that generates immediate case

Meteka is a town in northeastern Ethiopia. Located in Administrative Zone 3 of the Afar Region, 30 kilometers south of Gewane, it has a latitude and longitude of 9°52′N 40°31′E with an elevation of 628 meters above sea level. It is one of two towns in Gewane Woreda.

Meteka marks the southern boundary of the Meteka Wetlands, a marshy portion of the lowlands of the Awash River. Ten kilometers west of the town is Lake Hertali.

Based on figures from the Central Statistical Agency in 2005, this town has an estimated total population of 1579, of whom 879 are men and 700 are women.

1.3.1.1. State and trend of social environment

Population

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

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

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

Table 1. Population Trend of Gwane Woreda (2020-2024)

Year (G. C)	rural populati on			Urban. FEMALE		population on	Total in 4 years
	MALE	FEMALE	TOTAL	MALE	Total	TOTAL	
2021	21545	25789	47334	14786	17985	32774	80108
2022	24589	25654	50243	25909	28545	55454	105697
2023	28909	31693	60602	30123	32333	62456	123058
2024	30267	32690	62957	30989	30412	61401	124358

Source:- Gwane Woreda (2024)

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, which we saw in the nearby Meteka wetland Ecosystem due to high population the demand for grazing land and agriculture courses the distraction of the ecosystem.

Education

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

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

NO	Level of School	Number of schools	Students in Gwane Woreda												
			2020		2021		2022		2023		2024		2025		
			M	F	m	F	m	F	m	f	M	F	M	F	
1	Elementary schools 1-6	19	1318	1200	1339	1020	1449	1208	831		1011	952	1123	1090	
2	Primary School (7-8)	12	330	231	253	202	229	160	145	80	132	64	94	40	
3	High school (9-12)	1	302	245	285	343	255	123	246	118	390	167	55	88	
4	Number of teacher n		135	87	143	92	101	41	102	38	93	45	88	32	

Source: Gewane Woreda education office

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

According to Gwane Education office report 12 primary school, 19 elementary school, 1 Preparatory school, School are Available in the Woreda.

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

No							Total
		2012	2013	2014	2015	2016	
1	Governmental Health Center	2	2	2	2	1	9
1.1	Primary Hospital	o	0	0	0	1	1
	Private pharmacy	5	5	5	5	4	24
1.2	Health center	0	0	0	0	0	0
1.3	Health post	8	8	8	8	5	28
2	Private Health Centers	o	0	0	0	0	0
2.1	Primary Health clinics	5	5	5	5	4	9
	Total						

Source: - Gwane WoredaWoreda Health Report 2016

As indicated on the above tables, the numbers of Governmental Health Institutions in the *Woreda* is constant no increment. As we seen from the table, no health centers problem in the Woreda. Due to high temperature associated with cline water shortage in the Woreda the community are suffering with malaria and several water born disease because of this reason the number of health institutions and health professionals in the Woreda are not sufficient to tackle this problem

Road transport

The level of development of transport Facilities and services including the road are determining factor for other development activities. Thus transport sector play a key role in the socio-economic development of Gwane 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).

Table 4: **Types and length of Roads, in Gwan Woreda in the year 2017**

No	**Road type**	**Length in km**	% of population who has access to Road
1	Asphalt	60	45%
2	All weather rood	20	20.5%
3	Dray weather rood	56	50.%
	Total	136	

Source: Woreda land office

Water Resource and Supply

Water is an inorganic compound with the chemical formula H_2O. It is a transparent, tasteless, odorless, and nearly colorless chemical substance. It is the main constituent of Earth's hydrosphere and the fluids of all known living organisms in which it acts as a solvent. Water,

being a polar molecule, undergoes strong intermolecular hydrogen bonding which is a large contributor to its physical and chemical properties. It is vital for all known forms of life, despite not providing food energy or being an organic micronutrient. Due to its presence in all organisms, its chemical stability, its worldwide abundance and its strong polarity relative to its small molecular size, water is often refer to as the "universal solvent".

In the *Woreda*, there is no sufficient drinking water for human and animals, elder in the *Woreda* under lined that currently due to various environmental and social problems the wetland and springs were dried, while the volume of existing small streams and river as well as the discharge rate of springs has been decreasing from time to time. Because of this risen, the percentage of population who has access to cline water is 41%.

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. Gwane *Woreda*, has 24 hours telephone services, from total population 80% has access to communication services.

Housing

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

Electricity

Electricity is an essential infrastructure for a given area of economic and social development. In Gwane Woreda 48% of the population has access to electric service

1.3.1.2. Drivers and pressure of social environment

Meteka wetland Ecosystem is one of highly degraded ecosystem. The main drivers for the deterioration of the ecosystem are mainly population growth and water use fore care wash, which results to degradation.

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

1.3.1.3. Impacts due to social environment change

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

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

1.3.1.4. Responses to social Environment Change

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

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

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

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

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

(ii) Provision of expanded family planning services;

(iii) Strengthening of training in

population; Promotion of the status of women.

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

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 Meteka wetland ecosystem they were done conservation work and without affecting social and Economic value of ecosystem for the

community they were tries to beekeeping and produce nursery.

1.3.1.5. Outlook for Socio Environment

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

1.3.2. Economic Environment

1.3.2.1. State and trend of the economic Environment

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

According to FGD Water shortage is one of the problem for expanding agriculture including animal production in Gwane Woreda and the region.

1.3.2.2. Drivers and pressures of the economy

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

1.3.2.3. Impacts due to the Economic Condition

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

Thus, the agricultural, industrial and service sectors are used. Agriculture have a higher direct impact on the environment than the other sector. Natural resources and bio diversity of Meteka 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 Meteka wetland ecosystem is increasing.

1.3.2.4. Response Measure

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

i. Closing the gap between high population growth and low economic productivity through Planned reduction of population growth;
ii. improving the carrying capacity of the environment by taking appropriate environmental protection measures; and
iii. Improving the social and economic status of vulnerable groups (women, children and elderly).

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

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

- Establish favorable conditions for sustainable state building through the creation of stable democratic and developmental state.

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

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

- Sustaining faster and equitable economic growth
- Maintaining agriculture as a major source of economic growth
- Creating favorable conditions for the industry to play key role in the economy
- Enhancing expansion and quality of infrastructure development
- Enhancing expansion and quality of social development
- Building capacity and deepen good governance
- Promote women and youth empowerment and equitable benefit
- Biodiversity conservation including wetland management should be done
-

1.3.2.5 Outlook for Economy

Because of high biodiversity lose and inappropriate utilization of the ecosystem If everything continues business as usual, Meteka wetland Ecosystem in Gwane Woreda the natural environment could not be able to provide the environment service.

Options for future Action

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

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

2. Biophysical Environment

2.1 Land

Land is internationally defined as a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below the surface, including those of the near-surface climate, the soils and the terrain forms, the surface hydrology (including shallow lakes, rivers, marshes, and swamps), the near-surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity.

Land use -land cover

The status of land includes both the land use and land cover. The land use refers to the purpose for which that particular land is being used.

Land use refers to man's activities and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land .

Land use

Land use refers to a series of operations on land, carried out by humans, intending to obtain products and benefits through using land resources including soil resources and vegetation resources. In its wider sense, the term land use denotes the human employment of the land, which includes settlements, cultivation, grazing, recreational areas, or industrial zones. Whereas the land cover represents the biophysical cover of the land.

Land cover

The term land cover originally referred to the kind and state of vegetation, such as forest or grass cover but it has broadened in subsequent usage to include other things such as manmade structures like buildings, soil type, biodiversity, surface, and groundwater (Meyer, 1995).

Land use land cover Changes

Land use and land cover change altered principally by direct human use of agriculture and livestock raising, forest clearing, and urban development. A serious problem the living earth is facing at present

is the deterioration of both the natural environment and natural resource. Pparticularly in Ethiopia land is the major natural resource on which economic, social, infrastructure, and other human activities are undertaken. Changes in land use and land cover have always occurred in the past, and present, and are likely to continue in the future.

2.1.1. State and Trends of LU/LC Change in Meteka Wetland Ecosystem

According to our observation and information from the FGD and documented study obtained we understand the status and trend of land use land cover changes of the wetland catchment area over the period of 2005, 2015 and 2025 are described as follow in the map and table.

In addition, during the field survey it was clear that the Meteka wetland catchment area was degraded. The FGD also emphasized that around 25 years the catchment area was covered by forest but now due to rapid population growth huge amount of forest and Shrub land have changed in species composition to cultivating (agriculture) and the size and depth of the wetland was in a declining mainly due to siltation problem.

People living in the near by the Meteka wetland catchment are highly dependent on the wetland includes the grazing land, crop, and other resources (mat making, car washing/Lavageo) for their live -hood.

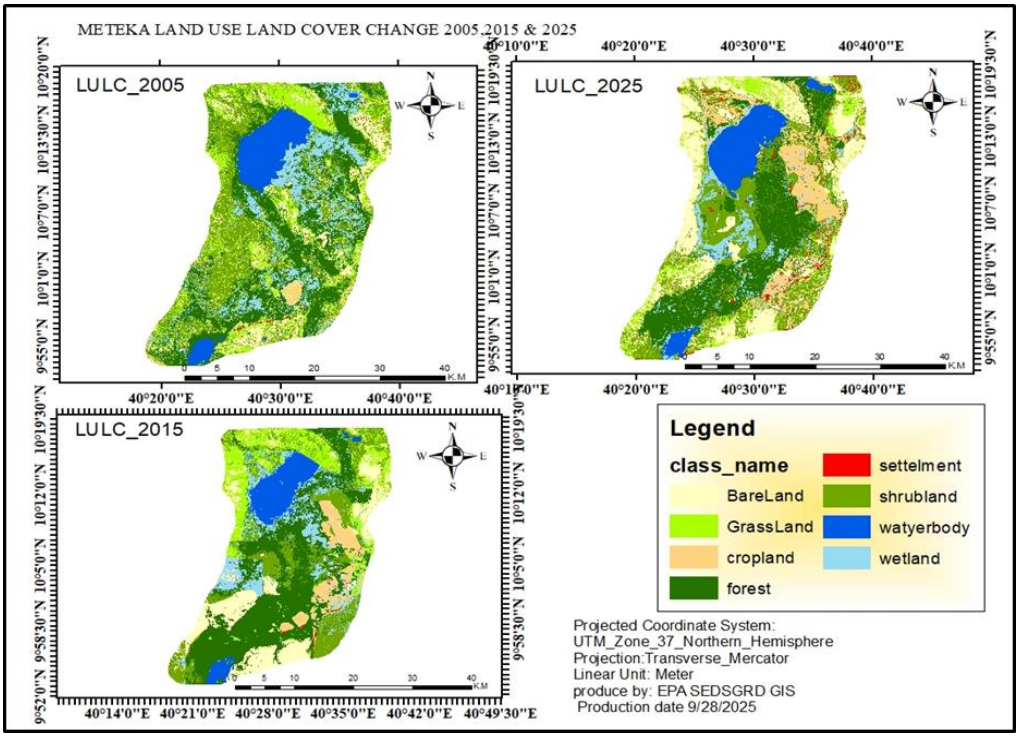


Figure 2.Land use land cover change map of Meteka Wetland ecosystem between 2005, 2015 and 2025.

As we have seen from the map and table cultivated land, settlement and forestland composition in Meteka wetland catchment area, land use and land cover change has been increasing starting from year 2005 to 2025.

From the year 2005 to 2025 the land-use and land cover changes detection matrix show that increase in the forest and shrub land was increased by 45 % , crop land was increased by 11% and Grazing Land was increased by 5% .

Table 5. Meteka Wetland ecosystem land use land cover in % and hectare. Also each feature class from total land coverage % change.

Class name	2005		2015		2025	
	Area_ha	Percent	Area_ha	Percent	Area_ha	Percent
WATER BODY	10545.87	9.04	10200.81	8.75	11871	10.18
Crop	1368.26	1.17	6753.388	5.79	13759.1	11.80
Wetland	15,515.74	13.30	11384.03	9.76	7184.61	6.16
Settlement	678.2526	0.58	327.7508	0.28	1631.73	1.40

BARLAND	13307.17	11.41	16761.81	14.37	22452.3	19.25
Grassland	15199.95	13.03	15006.31	12.86	6897.47	5.91
Forest	30162.26	25.86	36552.52	31.34	24694	21.17
Shrub land	29867.45	25.61	19658.33	16.85	28154.7	24.14
Total	**116644.9**	**100**	**116644.9**	**100**	**116644.9**	**100**

Land use land cover Governance

The wetland land catchment area was governance by the Tribe of Gewanea. Currently, the local state involvement in governance is weak or insignificant. The tribes are full responsible for managing and controlling land holdings as well as dispute resolution among the clans.

2.1.2. Driver and Pressures of Meteka Wetland Ecosystem Catchment Land use/Land cover Change

The rapid increase in human population and strive for growth in the standard of living has put great pressure on natural resources. Through conversion and intensification of land use human have caused huge changes in the balance of terrestrial ecosystems. Land use land cover change is dynamic, widespread and accelerating process, mainly driven by natural phenomena and anthropogenic activities.

The Meteka wetland catchment ecosystem land use-land cover is as constantly changes in response to the dynamic interaction between underlying drivers of human- induced activities and environmental factors causing deterioration the wetland ecosystem.

The major causes of land use land cover change dynamism is primarily associated with invasive tree species of *Prosopis Julifelerea* and agricultural investment expansion activities are the main causes of wetland degradation. The main drivers behind the land use – land cover changes that had occurred are describe as follow:-

Expansion of agricultural investment

The growing population growth leads many societies to demand more from the earth's resources mainly expansion of agricultural lands affect the land use land cover changes at an ever-increasing rate in the wetland

Animal population pressure

In the postural communities of Ethiopia like the Gewanea communities, land use land cover change is exacerbate more not by an unbalanced human population growth but animal population growth exarbate big portion for worsened natural resource degradation and land cover changes.

This rapid increased animal population has contributed to over grazing causing a large land use land cover change and to extinction of indigenous vegetation's and exposing the area to invasive trees /Prosopis and herbs/Adey Abeba damage the potential grazing lands.

Land use planning problem

In Gewanea pastoral communities Meteka wetland has been considered an important socio-economic asset for their livestock and the status and prestige of community are determine. However, the community governs this land significantly. The state mainly Agriculture Office involvement and support is insignificant. So the wetland catchment ecosystem is managed by the traditional way with no scientific and climate change issues consideration. As a result the lack of land planning the land use land cover spontaneous changes making it vulnerable to environmental change, fragile natural resources and ecosystems, and a high rate of erosion and land degradation.

Forest Degradation composition

According to FAO, 2015, Ethiopia's forest cover estimated to be 11.4% or about 12,499,356 ha. In addition, planted forest accounts for 972,000 ha. FAO, 2010 continued that Ethiopia lost an average

of 140,900 ha (0.93%) of forest per year between 1990 and 2010. In total, Ethiopia lost 18.6% of its forest cover, or around 2, 818,000 ha. in 20 years (Prof. Badege Bishaw, 2020).

From 2002 to 2021, Ethiopia lost 80.1kha of humid primary forest, making up 18% of its total tree cover loss in the same period. The total area of humid primary forest in Ethiopia was decreased by 4.2% at this time (World Resource Institute, 2022)

Flash flooding of Awash River

Every year due the climate change caused rainfall amount increase in the central Ethiopia High lands of Shewea Awash river flood flash problems were causing in Afar mainly around Geweane- Meteka wetland 2 – 3 km riverbank was flooded causing irrigation areas damages and people to migrate.

Tenure insecurity and natural resource degradation

There is a strong link between tenure insecurity and land degradation in Ethiopia. Land tenure insecurity affects how farmers manage and use the resources available to them. If farmers do not feel secure in their control over a particular piece of land, they are less likely to invest time and money into its conservation. This results in land degradation which leads to reduced soil fertility, loss of biodiversity, and more frequent natural disasters

2.1.3. Impact of LU/LCC in Metka Wetland ecosystem

Loss of soil fertility

Land use land cover changes are perhaps the most prominent form of environmental change phenomenon occurring at spatial and temporal scales in the study area. The changes in land use and land cover aggravate land degradation and soil degradation, Loss of biodiversity, habitat destruction, species transfer and environmental deterioration, negative impact on both the environment and socio-economic settings. As FGD explained that, the Soil fertility status of the catchment areas decreased time to time.

Loss of Biodiversity

As the consequence of Land use Land cover Change, particularly of forest and shrubs degradation vulnerable to invasive species numerous indigenous plant and animal spacious were eliminating in alarming rate.

Soil salinity and soil acidity in Ethiopia

Salt-affected soils occur mainly in the arid and semi-arid regions compared to the humid regions. In this regard, we have observed in the Meteka wetkand catchment areas salt affected soils due to human-induced and natural causes. Although no systematic data on the extent and content of salinity problem available specifically on the area.

Saline soils recognized visually by the presence of white crusts of salts on the surface during dry weather formed through evaporation. Saline soils are generally flocculated, well-structured with permeability equal to or higher than that of normal soils. Chemically saline soils are composed of Cl', S042', Na+, Ca2+, Mg24 ions and small amounts of NO, -, HC03-, and K+, with soluble Na+ seldom exceeding the sum of the other cations and thus not adsorbed on soil exchange complex to extent (Asad et al., 2019).

Loss of productivity due salinity and forest compostion

Land use and land cover changes degrade the land's capacity for sustained use and regaining its natural cover. Specifically, changes in land use and land cover have a significant influence on soil resources and biodiversity.

2.1.4. Response

It is a long time the regional state Environmental Protection Authority in collaboration with the Woreda as well as with NGOs has been studying and averting the indigenous forest and shrubs as well as the grazing biodiversity and land use land cover changes due to invasive tree species mainly *Prosopis Julifelerea* and herbs like Adey Abeba but the problem remain aggravated.

The afforestation efforts under way in support of the federal and regional states has established integrated water shade management activity approaches to enhance the area of Meteka ecosystem

like soil and water conservations practices. But the limitation of these activities in area covered the siltation is remained a problem to the wetland

Even the Wereda Revenue office is not in a position to demand land taxation for the community livelihood is dependent and beneficiary from the land use-land cover. However, the Ethiopian government has been working to implement a land taxation system in connection with land ownership.

2.1.5. Outlook

As shown in the table from year 2004 to 2024 farm land increased by +187.7% growth rate, the of shrub land decreased by -*69.93*% as a result the erosion and consequence siltation has been increased causing a negative effect of wetland area decrease by – 162.74%. If this siltation trends in the coming 5 to 10 years, the wetland will be change to farmlands.

Table 6 projective land use land cover change

Class name	2025		2035	
	Area_ha	Percent	Area_ha	Percent
WATER BODY	11871	10.18	16330	14
Crop	13759.	11.80	16330	14
Wetland	7184.	6.16	8165	7
Settlement	1631.	1.40	2332	2
BARLAND	22452.	19.25	11664	10
Grassland	6897.	5.91	3499	3
Forest	24694	21.17	11664	10
Shrub land	28154.	24.14	46667	40
Total	**116644.**	**100**	**116644.**	**100**

The principal issue related to land use land cover change in Meteka wetland ecosystem causes by invasive species are affecting salinity problems. As a result, the wet land is getting highly alkaline affecting the biodiversity of the wet land and this could invite favorable environment to other invasive species too.

So indigenous species conversion trees and shrub has to be enhanced to divert the land use land cover of the ecosystem and in collaborations with the state, NGO and private sectors in changing the Prosopis Julifelerea danger of invitation to an opportunities and diver the danger,

In the near the future after 5 to 10 years the manger land use land cover will be completely change to wood lands and consequences salinity of wetland will face a danger on the existence of the wetland ecosystem

2.1.6. Recommendation

Beside the controlling the invasive species efforts of the federal and regional states the Wereda has to encourage private sector involvement in changing the threats to an opportunity through encouraging and incentivizing locality and farmer problem solving creative researches.

2.2 Forest

The Meteka Wetland Forest Ecosystem, situated within the Rift Valley of Ethiopia, represents one of the most ecologically and socioeconomically significant landscapes in the country. The Meteka Wetland situated between 9∘53′5.94″ N and 10∘18′34.18″ N latitude, and 40∘18′40.24″ E and 40∘39′30.41″ E longitude, placing it in the heart of Ethiopia's Rift Valley ecosystem. Over the past two decades, however, the integrity of this ecosystem has undergone severe degradation. Land cover assessments conducted for 2005, 2015, and 2025 reveal a dramatic transformation in which wetlands and forests have steadily declined, while agricultural land, shrub land, and bare land have expanded. This trajectory reflects not only the consequences of direct human activity—such as wetland drainage, agricultural expansion, and logging—but also the cumulative impacts of institutional weakness, demographic pressure, and climate variability (Davidson, 2014; FAO, 2020; IPCC, 2022).

The data show that wetlands have contracted from 13.30% of the landscape in 2005 (15,515.74 ha) to just 6.16% in 2025 (7,184.61 ha). This reduction of more than 50% over two decades signals the collapse of hydrological regulation and wetland biodiversity. Forests, which once covered more than 30% of the area at their peak in 2015, have fallen to 21.17% (24,694 ha) by 2025, primarily due to logging, charcoal production, and agricultural encroachment. Grasslands have also shrunk by more than half, from 13.03% in 2005 to only 5.91% in 2025, reflecting pressures from overgrazing and

cropland expansion. At the same time, cropland has grown tenfold—from 1.17% (1,368.26 ha) in 2005 to 11.80% (13,759.1 ha) in 2025—making agriculture the leading direct driver of ecological change. Even more alarming is the expansion of bare land, which increased from 11.41% in 2005 (13,307.17 ha) to 19.25% in 2025 (22,452.3 ha), marking widespread soil erosion, nutrient depletion, and desertification processes (Lal, 2015). Water bodies appear to have expanded slightly (from 9.04% in 2005 to 10.18% in 2025), but field observations and satellite studies indicate that this increase is due not to genuine ecological recovery but rather to sediment accumulation and siltation, which have expanded shallow water surfaces at the expense of wetland vegetation (Liu et al., 2023).

The degradation of Meteka Wetland Forest has multiple interacting drivers. Rapid population growth in Ethiopia, which averaged around 2.5% annually during the past two decades, has increased demand for agricultural land, food production, and settlement space (World Bank, 2021). Economic pressures further exacerbate the problem, as both subsistence and cash crop farming provide short-term livelihood benefits at the cost of long-term ecological sustainability. Weak governance, insufficient enforcement of environmental laws, and institutional fragmentation undermine the ability of the state and local actors to safeguard wetlands and forests (UNEP, 2019). Climate variability and the broader impacts of climate change—such as shifting rainfall regimes, rising temperatures, and increased drought frequency—compound these anthropogenic pressures, making ecosystems less resilient to disturbance (IPCC, 2022).

The impacts of this transformation are both environmental and socio-economic. Biodiversity loss is profound, with habitat specialists in wetland and forest ecosystems facing heightened extinction risks. Hydrological services, such as groundwater recharge, flood regulation, and drought buffering, have been disrupted, making local communities increasingly vulnerable to water scarcity and climatic extremes. Water quality has declined due to sedimentation and agricultural runoff, affecting aquatic ecosystems and human health (Reed et al., 2019). Land degradation, visible in the expansion of bare land, reduces soil fertility, undermines agricultural productivity, and accelerates the desertification process. Socio-economically, these environmental changes translate into reduced water security, diminished agricultural returns, heightened livelihood vulnerability, and increased risks of conflict and displacement.

Government and community responses have so far been fragmented and insufficient. Afforestation campaigns in the 2005–2015 period temporarily boosted forest cover, but gains were unsustainable

due to weak local enforcement, lack of community ownership, and continued pressure from agricultural expansion. Non-governmental organizations and community groups have undertaken small-scale restoration projects, yet these remain piecemeal and inadequate relative to the scale of degradation (FAO, 2020). Without transformative and coordinated action, the Meteka Wetland Forest is likely to experience ecological collapse under a business-as-usual (BAU) scenario, leading to a barren and unproductive landscape dominated by shrub land and bare land.

An alternative rehabilitation scenario, however, remains possible. If urgent interventions are implemented—including wetland restoration, reforestation, climate-smart agriculture, and integrated watershed management the trajectory could be altered. By 2035, proactive measures may stabilize remaining wetlands and forests, reduce bare land expansion, improve water quality, and gradually restore ecosystem resilience (He et al., 2022; Liu et al., 2023). This would not only safeguard biodiversity but also enhance human well-being, food security, and climate resilience.

The case of Meteka mirrors global experiences in which wetlands and forests, despite their ecological importance, are increasingly vulnerable to anthropogenic drivers. Satellite-based studies consistently demonstrate that land-use change, rather than climate alone, is the dominant factor behind wetland and forest loss (He et al., 2022). Remote sensing data confirm that forest degradation in Ethiopia aligns with broader African and global patterns, with agricultural expansion and weak governance as the primary culprits (Bojer et al., 2024; Wassie et al., 2020). Thus, the Meteka Wetland Forest ecosystem serves both as a warning and as an opportunity: without urgent intervention, ecological collapse is imminent, but with coordinated rehabilitation, it could become a showcase of sustainable restoration.

2.2.1. State and Trend of Flora and Founa in the Meteka Wetland Ecosystem

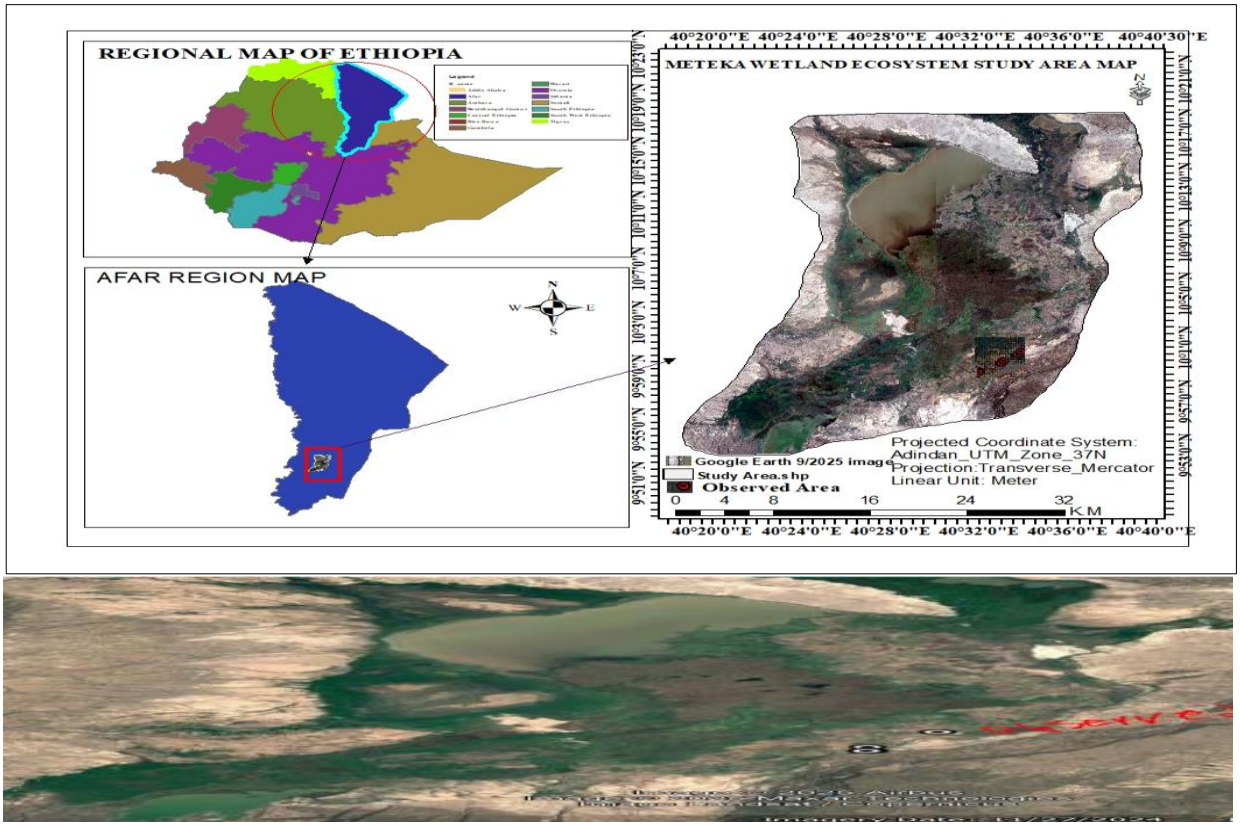


Figure 3 Geographic location and overview of the Meteka Wetland Forest Ecosystem in the Ethiopian Rift Valley.

Interpretation and Explanation of the Meteka Wetland Study Area Map

The map is a composite of three interconnected panels that progressively zoom in to pinpoint the location of the Meteka Wetland Forest Ecosystem.

Regional Map of Ethiopia (Top-Left Panel)

This panel provides the national context for the study area.

Location: The map shows all the regional states and chartered cities of Ethiopia, with the Afar Region highlighted in a darker color (blue/purple).

Study Area Highlight: A red circle with a light blue outline is placed over the Afar Region, indicating the general location of the Meteka Wetland area within the Rift Valley of Ethiopia.

Afar Region Map (Bottom-Left Panel)

This panel provides the regional context, detailing the specific location of the study area within the Afar Region.

Region Outline: The map displays the full extent of the Afar Region, where the Meteka Wetland is situated.

Study Area Box: A small, bright red rectangle (the study area) is highlighted in the southern part of the Afar Region, with a line connecting this small box to the main study area map on the right. This shows the precise political/administrative location of the Meteka Wetland Forest Ecosystem.

Meteka Wetland Ecosystem Study Area Map (Right Panel)

This is the main focus of the image, showing the actual study area with satellite imagery and geographic coordinates.

i. Location and Context: The image is a satellite view (dated 9/2025 in the image, likely referring to the image acquisition for the study) centered on a large water body and the surrounding landscape. This imagery visually corresponds to the Meteka Wetland Forest Ecosystem.
ii. Geographic Coordinates: The map uses a grid with coordinates: The study area's coordinates are varies between 9∘53′5.94″ N and 10∘18′34.18″ N latitude, and 40∘18′40.24″ E and 40∘39′30.41″ E longitude, placing it firmly in the Ethiopian Rift Valley.
iii. Projection System: The map uses the Projected Coordinate System: Adindan_UTM_Zone_37N, with the Projection: Transverse_Mercator, which is a standard system for mapping this region of Ethiopia.
iv. Legend: The legend highlights the "Study Area" boundary and the "Observed Area" (indicated by small red/dark red squares/polygons), which marks specific sites where field data was collected for the study. The scale bar shows a distance of 32 Kilometers at its maximum.
v. Land Cover Visuals: The satellite imagery shows a mix of water, dark green vegetation (likely remaining forest or dense shrubland), and lighter, brownish/bare land, which visually supports the study findings of wetland contraction, forest fragmentation, and bare land expansion in the ecosystem by 2025.

The Meteka Wetland Forest ecosystem in 2025 reflects a landscape that has undergone severe transformation over the past two decades. Land cover analysis indicates that wetlands, forests, and grasslands have declined sharply, while cropland, shrub land, and bare land have expanded. Water bodies show minor changes, although their apparent increase masks sedimentation impacts rather

than genuine ecological recovery. Understanding the current state of each land cover type is crucial for interpreting ecological degradation, assessing ecosystem services, and designing restoration interventions (FAO, 2020; Liu et al., 2023).

Table 7: Land Cover Change in the Meteka Wetland Forest Ecosystem (2005-2025)

Class Name	2005 Area (ha)	2005 (%)	2015 Area (ha)	2015 (%)	2025 Area (ha)	2025 (%)
WATER BODY	10,545.87	9.04	10,200.81	8.75	11,871.00	10.18
Cropland	1,368.26	1.17	6,753.39	5.79	13,759.10	11.80
Wetland	15,515.74	13.30	11,384.03	9.76	7,184.61	6.16
Settlement	678.25	0.58	327.75	0.28	1,631.73	1.40
BARLAND	13,307.17	11.41	16,761.81	14.37	22,452.30	19.25
Grassland	15,199.95	13.03	15,006.31	12.86	6,897.47	5.91
Forest	30,162.26	25.86	36,552.52	31.34	24,694.00	21.17
Shrubland	29,867.45	25.61	19,658.33	16.85	28,154.70	24.14
Total	**116,644.90**	**100.00**	**116,644.90**	**100.00**	**116,644.90**	**100.00**

The data in Table 1 quantifies the dramatic shifts in the ecosystem. The contraction of wetlands and forests, alongside the explosive growth of cropland and bare land, defines the degradation narrative. A key dynamic illustrated by this data is the inverse relationship between wetland loss and the apparent increase in water body surface area. As wetlands are drained and cultivated, the resulting erosion leads to sediment accumulation in lakes and rivers. This siltation expands shallow water

surfaces at the expense of ecologically productive wetland vegetation, leading to the observed, but misleading, increase in "WATER BODY" coverage.

Wetlands

Wetlands in Meteka have experienced catastrophic loss, declining from 15,515.74 ha (13.30%) in 2005 to just 7,184.61 ha (6.16%) in 2025. This represents a reduction of over 50% within twenty years, signaling the collapse of wetland-dependent ecological functions, such as water filtration, flood regulation, and habitat provision for aquatic and semi-aquatic species (Davidson, 2014; IPCC, 2022). The main drivers of wetland loss are drainage for agricultural expansion, encroachment by smallholder farms, and unsustainable extraction of wetland resources such as reeds and fish. Field observations and satellite imagery reveal that many remaining wetlands are fragmented, shallow, and dominated by invasive vegetation, reducing biodiversity and hydrological connectivity. Increased sedimentation, caused by upstream soil erosion, further diminishes wetland productivity and leads to silted water surfaces that give a false impression of wetland recovery (Liu et al., 2023).

Forests

Forest cover has similarly declined, from approximately 30.2% of the landscape in 2015 to 21.17% (24,694 ha) in 2025. This reduction reflects both legal and illegal logging, charcoal production, and clearing for agriculture.



Figure 4: is a composite showing two aspects of land degradation related to the loss of mature forest cover in Meteka:

Left image: Forest Fragmentation and Proximal Degradation: This side displays a hillside covered by sparse, low-lying shrubs and small, scattered trees, indicating that the original, structurally complex forest has been degraded and fragmented. The proximity of a small settlement structure suggests that degradation is severe near human habitation and transport corridors, where logging and clearing for agriculture are easily facilitated. The extensive shrub cover is a transitional land cover reflecting the expansion of invasive alien specious and landscape's response to disturbance like selective logging, fire, and grazing.

Right image: Shrub Encroachment and Secondary Vegetation: This side shows a dense thicket of green, fine-leaved shrubland encroaching upon a small patch of grass and bare earth. This visually supports the LULCC observation that Shrub land has increased as forest and grassland have declined. This shrub land often represents secondary succession on abandoned or degraded land, but lacks the structural complexity and biodiversity of the original forest. This transition undermines crucial ecosystem services like carbon storage and soil stabilization previously provided by the mature forest.

The loss of forested areas undermines carbon storage, soil stabilization, and local climate regulation (Wassie et al., 2020). Forest degradation has been particularly severe near settlements and transport corridors, where accessibility facilitates timber extraction. Remaining forest patches are increasingly fragmented, limiting habitat availability for forest-dependent fauna, including birds and small mammals. Secondary succession has occurred in some abandoned agricultural lands, yet the structural complexity and biodiversity of secondary forests remain far below historical levels (Bojer et al., 2024).



Grasslands

Grasslands have diminished from 13.03% of the landscape in 2005 to 5.91% (6,892 ha) in 2025, primarily due to overgrazing, conversion to cropland, and shrub encroachment. These areas were historically important for livestock grazing, biodiversity

conservation, and soil protection. Overgrazing has not only reduced vegetative cover but also

Figure 5: ***part of the remaining grassland/riparian zone***

compacted soils, accelerating erosion and decreasing water infiltration capacity. Loss of grasslands reduces forage availability for livestock and wildlife alike, threatening food security and local livelihoods (Lal, 2015).

The above image shows the degradation of grasslands and the state of the remaining vegetation in the Meteka Wetland Forest ecosystem.

The combined image (a diptych) shows a dense patch of tall, green, reed-like vegetation, which is typical of a riparian zone or wetland fringe rather than the broad, low-lying grasses commonly associated with traditional grasslands.

According the image illustrates the condition of a remaining riparian/wetland zone that is under pressure, as discussed in the broader document:

Bare/Silted Ground: The exposed, dry, sandy-looking earth in the foreground and along the edge of the water is evidence of bare land expansion and soil erosion. This erosion is accelerated by overgrazing and the loss of vegetative cover, as mentioned in the "Grasslands" section. The bare ground contributes sediment runoff, which further degrades the system.

Water Edge/Siltation: The small, shallow pool of water visible in the right panel indicates a fragmented wetland area. The document explains that upstream soil erosion (visible as bare land) leads to siltation and sediment accumulation in water bodies, which compromises their ecological function and reduces the water storage capacity of the area.

Litter/Pollution: The visible plastic debris in the water on the right panel highlights the decline in water quality and the impact of human activity like car wash, which is a key driver of degradation in the Meteka ecosystem.

Context for Grasslands and Riparian Zones

While the text discusses the decline of general grasslands due to overgrazing and conversion to cropland (decreasing from 13.03% to 5.91% of the landscape), this image specifically represents the condition of the remaining riparian or wetland-adjacent zone.

The image visualizes the consequences of the overall degradation:

i. The adjacent bare land, resulting from the loss of grasslands and forests, is causing erosion.
ii. The erosion, in turn, accelerates siltation of the water body, threatening the survival of the dense, tall, riparian vegetation shown in the image.
iii. The reduction of these zones compromises the essential hydrological functions like groundwater recharge and flood regulation provided by both wetlands and adjacent natural grasses.

Cropland

Cropland expansion is the most striking anthropogenic change observed in Meteka. From a modest 1.17% (1,368.26 ha) in 2005, cultivated areas now cover 11.80% (13,759.1 ha) of the landscape. Agricultural intensification is driven by population growth, which averaged 2.5% annually over the past two decades, and by the need to meet both subsistence and cash crop demands (World Bank, 2021). While agriculture provides essential livelihood support, its expansion often comes at the cost of natural habitats, contributing to soil degradation, nutrient depletion, and disruption of hydrological cycles. Moreover, improper land management practices, including continuous monocropping and limited soil conservation measures, exacerbate erosion and reduce long-term agricultural sustainability (FAO, 2020).

Shrub land

Scrubland has increased as forests and grasslands decline, serving as a transitional land cover between natural vegetation and degraded landscapes. In 2025, shrub land occupies **16.0%** of the area, up from **11.0%** in 2005.

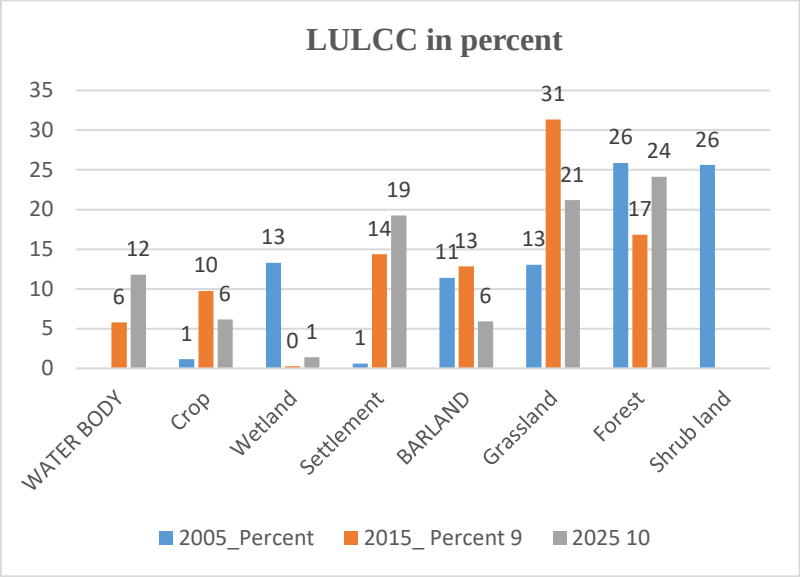


Figure 6: Meteka wetland forest ecosystem land use land cover change 2005-2025



Figure 7: the expansion invasive vegetation of shrub land as forests and grasslands decline.

The rapid expansion of shrubland primarily driven by anthropogenic factors, particularly the intensification of land use change. As agricultural frontiers push into natural areas and overgrazing reduces grass cover, the competitive advantage shifts to woody shrubs, which are generally more resilient to high-frequency disturbances. Climate change also plays a significant role, with altered precipitation patterns and warmer temperatures favoring drought-tolerant shrub species over historically dominant forest or grass communities, establishing a positive feedback loop for shrub encroachment.

This shift in vegetation composition presents a significant ecological challenge, as it represents a form of degradation that is difficult to reverse. The dense, often fire-prone structure of shrubland can disrupt local hydrological cycles by reducing groundwater recharge and increasing surface runoff. Furthermore, the homogenization of landscapes by a few invasive shrub species can severely impact specialist wildlife, accelerating local extinction rates and diminishing the overall resilience of the ecosystem to future environmental pressures.

This growth often reflects the natural response of landscapes to disturbance, including selective logging, grazing, and fire. Although shrubland provides some ecosystem functions, such as soil protection and carbon storage, it supports lower biodiversity and has limited water regulation capacity compared to intact forests or wetlands (He et al., 2022).

Bare Land

The extent of bare land, representing exposed and highly degraded soil surfaces, has increased dramatically from 11.41% (13,307.17 ha) in 2005 to 19.25% (22,452.3 ha) in 2025. This trend indicates severe land degradation, soil erosion, and nutrient loss. Bare land expansion is concentrated in areas previously occupied by grasslands and forests, where anthropogenic pressures have removed protective vegetation cover.

Without intervention, bare land contributes to desertification, reduces agricultural potential, and accelerates sedimentation in downstream water bodies, further degrading wetland habitats (Lal, 2015; Reed et al., 2019).

Water Bodies

Water bodies, including rivers, ponds, and small reservoirs, show a marginal increase from 9.04% in 2005 to 10.18% in 2025. However, this apparent gain is misleading.



Figure 8: Lake Cadabassa

Table 8: **Lake Caddabaassa 2005, 2025 in Area Ha**

Year	Area Ha
2005	8500
2025	8929
Increased by	429

Interpretation and Implications

The image and accompanying data show a significant increase in the surface area of Lake Caddabassa from 8500 Ha in December 2005 to 8929 Ha in September 2025, representing an expansion of 429 Ha.

Visual Evidence of Expansion

A. Red Outline (12/2005): Marks the smaller, historical boundary.
B. White Outline (9/2025): Marks the current, larger boundary, visually confirming the lake's growth.

Implications of the Surface Area Increase

This growth suggests a positive net water balance, where water *inflow* and *storage* have exceeded *outflow* and *evaporation* over the past two decades.

a) Increased Rainfall/Inflow: Higher than average precipitation in the lake's catchment area or an increase in the flow from feeding rivers.
b) Reduced Water Abstraction: A decrease in the amount of water being withdrawn for irrigation, domestic, or industrial use.

Clarification on Sedimentation and Siltation

While sedimentation and siltation are continuous, crucial processes in any lake, their typical effect is to reduce water depth and volume, not necessarily increase the surface area:

1) Sedimentation: The process where sediment (silt, clay, organic matter) settles at the bottom of the lake.
2) Effect on Area: As the lake bed rises due to accumulated sediment, the lake's volume is reduced. If the volume reduction forces the water level to stay high (due to continuous inflow), the water may be forced to spread out over surrounding shallower land to maintain hydrostatic equilibrium, potentially contributing to a slight *lateral* expansion.
3) Long-Term Impact: However, the primary effect of severe siltation over the long term is lake shallowing and eventual reduction in surface area as surrounding vegetation encroaches on the new, shallower areas.

In summary, while the primary drivers for a large 5% surface area increase are almost certainly increased inflow/reduced abstraction, ongoing sedimentation processes are also a reality for the lake:

i. Positive Impact (Area): In the short term, if the basin is relatively flat, high sedimentation *combined with high inflow* can force the water to spread, causing the observed increase.
ii. Negative Impact (Volume/Future): Siltation is a long-term threat to the lake's volume and lifespan,

and will eventually lead to a reduced area if not mitigated.

Remote sensing and field observations indicate that siltation and sediment deposition have expanded shallow water surfaces at the expense of wetland vegetation, rather than reflecting true ecological recovery (Liu et al., 2023).

Water quality in these bodies has deteriorated due to increased sediment load, nutrient runoff from croplands, and human waste discharge, posing risks to aquatic life and local communities dependent on these resources (Reed et al., 2019).

Summary of Ecosystem Condition

Summary of Land Cover Change (2005-2025)

The dramatic transformation of the Meteka landscape over the past two decades starkly summarized in the data below, which quantifies the trends described in the preceding sections.

Table 9:- Land Cover Change in the Meteka Wetland Forest Ecosystem (2005-2025)

Land Cover Type	Area (ha) 2025	% of Total 2025	Trend 2005–2025	Key Observations
Wetland	7,184.61	6.16	↓ from 15,515.74 ha (13.30%)	Severe habitat loss (>50%)
Forest	24,694	21.17	↓ from 31.34% (2015 peak)	Sharp decline after 2015 peak
Grassland	6,897.47	5.91	↓ >50%	Lost to agriculture and overgrazing
Cropland	13,759.1	11.80	↑ expansion	Agricultural expansion into natural ecosystems
BARLAND (Bare Land)	22,452.3	19.25	↑ significant increase	Marker of soil erosion/desertification
Shrubland	24.14	-	Dynamic (initial decline → recovery)	Secondary succession following deforestation
Water Body	-	-	Slight ↑ (sedimentation-driven)	Net increase due to siltation, not recovery

In summary, the Meteka Wetland Forest ecosystem of 2025 exhibits a clear pattern of degradation across multiple land cover types, as detailed in Table 1. Wetlands and forests—the two most ecologically valuable components—have declined sharply, grasslands have almost halved, and bare land and cropland have expanded significantly. While shrubland and water bodies have slightly increased, these changes do not compensate for the loss of ecosystem services. The interplay of human activity, weak governance, population growth, and climate variability has driven this transformation, producing a landscape with diminished biodiversity, impaired hydrology, and reduced agricultural resilience. Without immediate and coordinated intervention, these trends are likely to continue, further undermining ecological integrity and human well-being in the Meteka region (FAO, 2020; IPCC, 2022; He et al., 2022; Liu et al., 2023).

2.2.2. Drivers and Pressures of Degradation in Meteka Wetland Forest Ecosystem

The degradation of the Meteka Wetland Forest ecosystem is the result of a complex interplay of anthropogenic, institutional, and climatic drivers. Understanding these drivers is essential for designing effective interventions to halt or reverse ecosystem decline. These drivers operate at multiple scales, from local livelihood pressures to regional climate variability, and their interactions amplify ecological stress (FAO, 2020; IPCC, 2022).

Anthropogenic Drivers

Agricultural Expansion

Agricultural expansion is the most immediate and dominant driver of ecosystem degradation in Meteka. Cropland increased tenfold from 1.17% (1,368 ha) in 2005 to 11.80% (13,759 ha) in 2025. This expansion has primarily occurred at the expense of wetlands, grasslands, and forested areas. Farmers often convert marginal lands, including wetland fringes, into cultivated plots to meet food and cash crop demands. This process disrupts hydrological cycles, increases soil erosion, and reduces habitat connectivity for flora and fauna (Lal, 2015; Bojer et al., 2024).

- **Logging and Charcoal Production**

Commercial and subsistence logging, coupled with charcoal production, has driven substantial forest loss in Meteka. Forest cover declined from over 30% in 2015 to 21.17% in 2025. Logging removes mature trees that provide structural habitat, regulate microclimates, and stabilize soils. Charcoal production often targets accessible forest areas near settlements, accelerating degradation and increasing the vulnerability of remaining forests to fire and invasive species (Wassie et al., 2020).

- **Overgrazing and Livestock Pressure**

Grasslands have declined from 13.03% to 5.91% over the past two decades, largely due to overgrazing. High livestock densities compact soils, reduce vegetative cover, and trigger shrub encroachment, which further reduces grassland productivity. Overgrazing also contributes to increased sediment load in wetlands and rivers, exacerbating siltation and water quality decline (Reed et al., 2019).

- **Wetland Resource Exploitation**

Communities rely on wetlands for fish, reeds, and fodder, leading to overharvesting and habitat fragmentation. Drainage for rice cultivation and vegetable production further diminishes wetland area and compromises ecological functions such as water purification and flood regulation (Davidson, 2014; He et al., 2022).

Institutional and Governance Drivers

- **Weak Environmental Governance**

Ecosystem degradation is compounded by weak governance at local and regional levels. Environmental laws, such as regulations protecting wetlands and forests, are inconsistently enforced. Institutional fragmentation, lack of coordination between government agencies, and limited technical capacity reduce the effectiveness of conservation measures (UNEP, 2019). Afforestation campaigns and community-based restoration projects have often been short-lived due to these institutional weaknesses.

- **Land Tenure and Policy Challenges**

Unclear or insecure land tenure encourages unsustainable land-use practices. Farmers are incentivized to maximize short-term agricultural returns rather than invest in long-term land stewardship, leading to deforestation, wetland drainage, and soil degradation. Policy frameworks aimed at sustainable land management are underdeveloped or poorly implemented, further enabling degradation (FAO, 2020).

Demographic and Socioeconomic Drivers

Rapid population growth in Ethiopia, averaging 2.5% annually over the past two decades, has heightened pressure on land and water resources. Increased demand for food, fuelwood, and settlement areas accelerates deforestation, wetland conversion, and grassland loss. Poverty and limited alternative livelihoods drive reliance on natural resource extraction, creating a feedback loop of degradation and socio-economic vulnerability (World Bank, 2021).

Economic drivers, including the need for cash crops and market-oriented agriculture, incentivize land conversion and overexploitation of forests and wetlands. Short-term economic gains often outweigh long-term ecological considerations, leading to persistent ecosystem decline (Lal, 2015).

Climatic and Environmental Drivers

- **Climate Variability and Drought**

The Meteka region has experienced shifts in rainfall patterns, increased frequency of droughts, and rising temperatures over the past two decades. These changes reduce ecosystem resilience, making wetlands and forests more susceptible to human pressures and natural stressors. Prolonged dry spells reduce soil moisture, weaken vegetation, and increase vulnerability to fire and erosion (IPCC, 2022; He et al., 2022).

- **Soil Erosion and Degradation**

Soil erosion, driven by deforestation, overgrazing, and unsustainable cultivation, is both a consequence and a driver of ecosystem degradation. Bare land expansion from 11.41% in 2005 to 19.25% in 2025 indicates widespread nutrient loss and reduced soil fertility, which in turn limits the recovery potential of degraded areas. Sediment runoff contributes to wetland siltation, reducing water storage capacity and altering aquatic habitats (Lal, 2015; Reed et al., 2019).

Interactions between Drivers

Degradation in Meteka rarely caused by a single factor; rather, multiple drivers interact synergistically. For example, population pressure intensifies agricultural expansion, which exacerbates soil erosion and wetland loss. Weak governance amplifies these impacts by failing to regulate land use and enforce conservation measures. Climate variability further compounds the vulnerability of forests, grasslands, and wetlands to anthropogenic stressors. These interactions create a feedback loop, accelerating ecosystem decline and reducing resilience (FAO, 2020; Liu et al., 2023).

Summary

The current degradation of the Meteka Wetland Forest ecosystem results from intertwined anthropogenic, institutional, demographic, and climatic drivers. Agricultural expansion, logging, and overgrazing directly remove or degrade critical habitats, while weak governance, insecure land tenure, and economic pressures exacerbate these impacts. Climate variability and soil erosion further undermine ecosystem resilience. Understanding these drivers highlights the urgency of integrated and multi-sectoral interventions to prevent ecological collapse and to support sustainable livelihoods in the region (He et al., 2022; IPCC, 2022; FAO, 2020).

2.2.3. Impacts of Drivers and Pressures on Metka Wetland Forest

The Meteka Wetland Forest ecosystem provides critical ecological functions, including water regulation, biodiversity support, soil fertility, and climate mitigation. However, cumulative pressures from land use change, overexploitation, and climate variability have significantly diminished these services. The following subsections describe the major pressures and their consequences.

Land Degradation and Habitat Loss

The landscape shown in **Figure 9** illustrates widespread shrub land and scattered trees, indicative of forest fragmentation and grassland decline. This pattern reflects conversion of natural vegetation to cropland and grazing areas, as well as degradation from overharvesting and fire. Forest and

grassland loss reduces habitat connectivity for wildlife, disrupts nutrient cycling, and increases vulnerability to erosion.



Figure 9: **Fragmented shrubland and degraded forest patches in Meteka (Photo: 2025).**

Fragmented shrubland and degraded forest patches in Meteka (Photo: 2025). Similarly, **Figure 10** highlights hillsides dominated by sparse vegetation and exposed soil, reflecting soil erosion and degradation. Bare or sparsely vegetated areas accelerate sediment runoff into wetlands and rivers, contributing to siltation, water quality decline, and loss of wetland biodiversity.



Figure 10: **Hillside degradation and sparse vegetation, showing soil erosion and habitat pressure (Photo: 2025).**

Impacts on Hydrological Services

Wetland contraction, forest loss, and soil erosion have disrupted water regulation in the Meteka ecosystem. Wetlands historically functioned as natural reservoirs, buffering flood events and recharging groundwater. The reduction from 13.30% to 6.16% of wetland area between 2005 and 2025, coupled with siltation from eroded hillsides, has reduced water storage capacity and increased vulnerability to droughts and floods (Davidson, 2014; Liu et al., 2023).

The decline in critical ecosystem services, particularly hydrological regulation, is visually evident across the Meteka landscape.



Figure 11: provides a clear illustration of how wetland contraction and soil erosion converge to reduce water storage capacity and compromise water quality.



Figure 12: show the reduced water storage capacity and the siltation issues compromising hydrological services (Field Survey: 2025).

Wetland Contraction and Fragmentation: The image displays only a very small, fragmented, and shallow patch of water surrounded by sparse wetland grass, representing the catastrophic loss of wetland area, which dropped from 13.30% in 2005 to just 6.16% in 2025. This reduction severely compromises the wetlands' historical function as natural reservoirs for groundwater recharge and flood buffering.

Siltation and Reduced Storage: The visible shallow water and the light brown/silty material surrounding it demonstrate the high level of sedimentation resulting from soil erosion in upstream areas. This siltation is a key reason for the reduced water storage capacity and is misleadingly contributing to a superficial "increase" in water body surface area at the expense of productive wetland vegetation.

Deteriorated Water Quality: The water itself appears turbid and muddy, reflecting the decline in water quality due to increased sediment load and potential nutrient runoff from surrounding agricultural activities. This deterioration negatively affects aquatic life and the local communities who depend on these resources.

Increased Vulnerability: The exposed, bare earth in the foreground and the degraded, dry vegetation on the surrounding hillsides (background) confirm the process of land degradation and soil erosion. The compromised hydrological function makes local communities increasingly vulnerable to water scarcity and climatic extremes like droughts and floods

Water quality has also deteriorated due to sedimentation and nutrient loading from agricultural runoff, negatively affecting aquatic life and community water use. These pressures compromise not only ecological integrity but also the livelihoods of local populations dependent on reliable water resources (Reed et al., 2019).

Impacts on Biodiversity

Habitat loss and fragmentation have led to declines in both plant and animal species. Forest specialists, wetland-dependent species, and grassland fauna are particularly vulnerable. The reduction of contiguous habitat areas reduces species richness and increases local extinction risk. Overgrazing and shrub encroachment further degrade wildlife habitat, limiting the availability of food and shelter. This loss of biodiversity diminishes ecosystem resilience and the capacity to provide essential services such as pollination, pest control, and seed dispersal (Wassie et al., 2020).

Impacts on Soil and Land Productivity

Bare land expansion from 11.41% in 2005 to 19.25% in 2025 indicates severe land degradation. Soil erosion and nutrient loss reduce agricultural productivity and increase dependence on chemical fertilizers, which may further degrade soil quality and contaminate water bodies. Shrubland

expansion and vegetation decline reduce organic matter inputs to soils, limiting their capacity to retain moisture and nutrients (Lal, 2015).

Socioeconomic Implications

The cumulative ecological impacts directly affect human well-being. Reduced water security, declining soil fertility, and biodiversity loss threaten food production and livelihoods. Increased competition for scarce resources can lead to conflict over water and grazing land, while declining ecosystem services exacerbate vulnerability to climate extremes (World Bank, 2021). Restoration of wetlands and forests, as well as sustainable land management practices, is essential to stabilize ecosystem services and support local communities.

Summary

The Meteka Wetland Forest ecosystem is under intense pressure from land cover change, overexploitation, and climate variability. The photos provided illustrate current conditions of forest fragmentation, shrubland dominance, and soil degradation, which together compromise hydrological regulation, biodiversity, and soil productivity. Without coordinated restoration and sustainable management, these pressures will continue to undermine ecosystem services and human well-being (FAO, 2020; He et al., 2022; Liu et al., 2023).

2.2.4. Response Taken to Improve the Status of the Meteka Wetland Forest. Government and Community Responses (2005–2025)

Government Policy Interventions

The Ethiopian federal and regional governments introduced several policy frameworks aimed at ecosystem restoration and sustainable land management. In 2006, the **Ethiopian Wetlands Policy** is enacted, emphasizing wetland conservation, sustainable use, and integrated watershed management (FDRE, 2006). The policy explicitly targeted areas showing high rates of degradation, including the Meteka Wetlands, mandating the establishment of protected zones and buffer areas to limit agricultural encroachment.

According to FDG in the Meteka area, which is a rugged region, there once existed a large forest known as Dabaleta Forest. However, it has now completely disappeared and has been replaced by Prosopis juliflora. The main reasons for its disappearance are: Expansion of farmland, and Charcoal production. As a solution, we have started acacia trees protecting from human cutting because we are exposing and imprisoning what is found when cutting.

Effectiveness and Remaining Challenges

While government policies and community initiatives contributed to localized forest and wetland recovery, overall ecosystem health continued to decline. The primary challenges included ongoing agricultural expansion, unregulated settlement, and limited capacity for large-scale wetland restoration. Nevertheless, the integrated approach combining policy enforcement, community engagement, and targeted restoration laid a foundation for longer-term ecosystem resilience (Mekonnen et al., 2019).

2.2.5. Outlook

The future of Meteka Wetland depends heavily on management choices over the next decade. Two contrasting scenarios **Business-as-Usual** and Rehabilitation illustrate the potential trajectories of land cover, hydrology, and ecosystem resilience.

Business-as-Usual Scenario

Under a Business-as-Usual scenario, ongoing pressures on the Meteka Wetland are expect to exacerbate current degradation trends. Wetland fragments will continue to disappear, forest cover will decline further, and shrub land or cropland will expand into previously forested zones. The central water body is project to become shallow and heavily silted, diminishing its ecological functionality. Simultaneously, bare land (BARLAND) will increasingly dominate, resulting in a barren, unproductive landscape with limited ecological or economic value.

Rehabilitation Scenario

Proactive interventions can significantly reverse degradation and promote ecosystem recovery. Wetland restoration measures including halting drainage, re-flooding, and re-vegetation—can stabilize hydrology and improve habitat quality. Sustainable land management practices, such as

climate-smart agriculture, soil conservation, and agroforestry, help reduce erosion and degradation, while large-scale reforestation and forest protection programs rebuild native vegetation cover. Integrated water resource management, including selective desilting and erosion control, further supports ecological restoration.

Visual Evidence and Narrative Integration

A visual examination of Meteka Wetland (Figure 3) underscores the stark contrast between ongoing degradation and potential rehabilitation. The image illustrates areas where wetland fragments have already disappeared, forests have thinned, and bare land dominates the landscape, reflecting the Business-as-Usual scenario's projected trajectory. Without intervention, these degraded patches are likely to expand, leaving a landscape that is both ecologically unproductive and socially vulnerable. Conversely, the photograph also highlights areas where initial reforestation and wetland restoration activities have begun to take effect. Small clusters of regionerated vegetation along water margins demonstrate the feasibility of re-vegetation, selective desilting, and integrated water management. These interventions, if scaled, could stabilize remaining wetlands, reduce bare land dominance, and improve hydrological function and ecosystem resilience by 2035 (He et al., 2022; Liu et al., 2023). The visual evidence thus reinforces the scientific consensus that targeted restoration, combined with sustainable land management and agroforestry, can reverse decades of degradation and secure long-term ecological and socioeconomic benefits.

Expected Outcome (2035+)

If rehabilitation measures are implemented, wetlands and forests are expected to stabilize, BARLAND will reduce, water quality will improve, and overall ecosystem resilience will gradually recover (He et al., 2022; Liu et al., 2023).

Table 10: different scenario option

Aspect	Business-as-Usual Scenario	Rehabilitation Scenario
Wetland Condition	Fragmented, further loss	Stabilized, restored hydrology

Forest Cover	Declines, replaced by shrubland/cropland	Increased through reforestation and protection
Water Body	Shallow, silted, low functionality	Improved depth and water quality through desilting
Bare Land	Expands, unproductive	Reduced through vegetation and soil conservation
Biodiversity	Declining species richness	Gradual recovery of flora and fauna
Ecosystem Services	Severely compromised	Improved provisioning, regulating, and supporting services
Socioeconomic Impact	Reduced agricultural productivity, water scarcity	Enhanced livelihoods, sustainable resource use
Management Actions	Minimal intervention, continued land-use pressure	Wetland restoration, agroforestry, soil conservation, integrated water management

Projected Outcomes

Scientific Context

The degradation trajectory of Meteka Wetland reflects global trends where anthropogenic pressure often overrides natural resilience. Wetland and forest ecosystems are highly sensitive to climate variability, yet land-use change remains the primary driver of loss. Comparative studies indicate that integrated restoration and sustainable management practices can significantly reverse ecosystem degradation, improve biodiversity, and support local livelihoods (He et al., 2022; Liu et al., 2023).

2.3. Biodiversity

2.3.1. State and Trend of Biodiversity on the Meteka Wetland

The ecological state of the Meteka Wetland reflects an ecosystem nearing a critical threshold, where the capacity to support key biodiversity is severely diminished.

NDVI METEKA WETLAND ANALYSIS

Interpretation, Explanation, and Analysis of the NDVI Map

The map titled **"Average NDVI Map of Meteka Wetland"** presents the normalized difference vegetation index (NDVI) for the Meteka Wetland area, covering the period from March 2000 to July

2023, derived from MODIS (MOD44B) data. NDVI values range from **-0.1087 to 0.7568**, with higher values (green) indicating healthy, dense vegetation and lower values (orange to red) indicating sparse vegetation, bare soil, or degraded wetland cover.

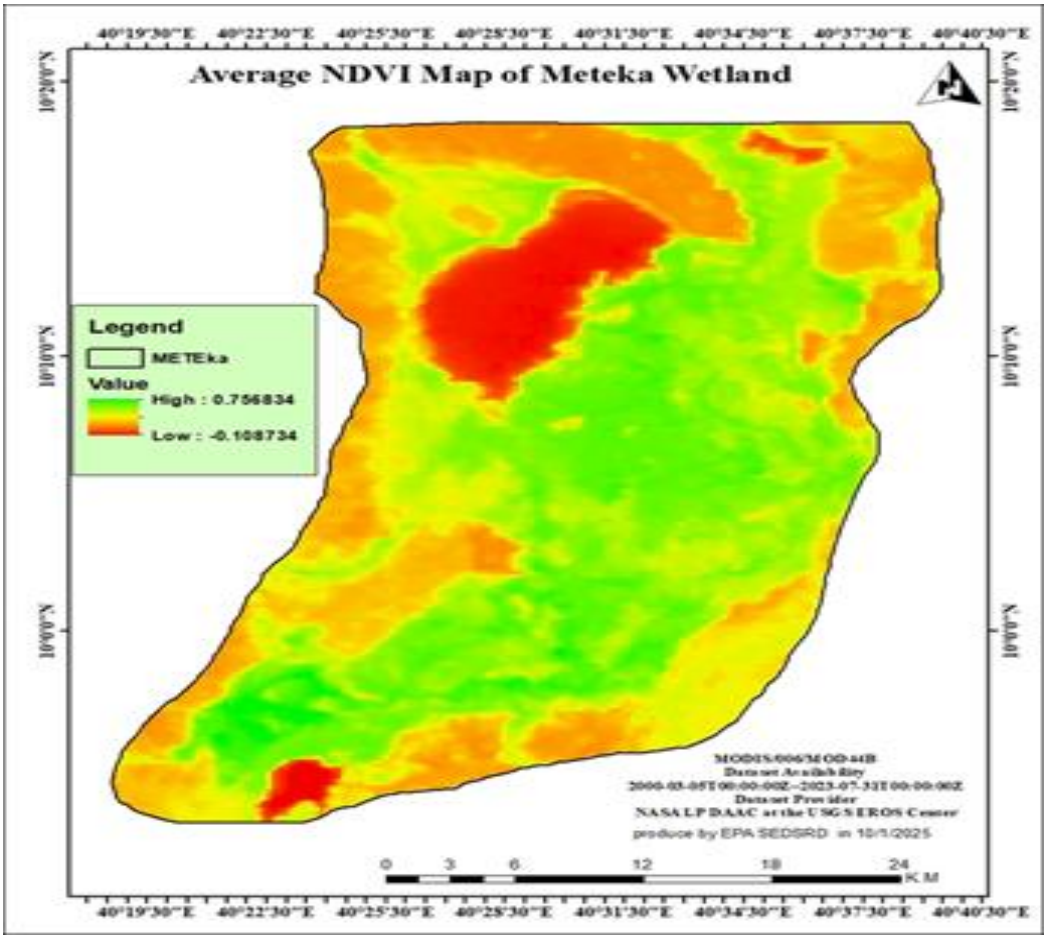


Figure 13 NDVI Map of Meteka Wetland Ecosystem

The main Observations

a) **Vegetation Health and Distribution**

i. The central and southwestern portions of the wetland show low NDVI values (red to orange), suggesting degraded vegetation, bare soil, or persistent waterlogged zones.

ii. The eastern and southeastern edges display moderately high NDVI (green to light green), representing relatively better vegetation cover and wetland grasses.

iii. The northern part shows a mosaic of moderate to low NDVI, suggesting mixed land cover transitions.

b) **Land Cover Degradation Trends**

The map indicates that substantial areas of the wetland ecosystem are experiencing degradation, with healthy vegetation being confine to smaller patches. This is consistent with broader land use changes in the Awash River Basin, where agricultural expansion, invasive species, and water diversion have reduced wetland vegetation cover (Dessu & Melesse, 2013).

c) **Drivers of NDVI Decline**

i. Agricultural Expansion: Irrigated farming for cotton and sugarcane around the Awash Basin has reduced water flow to wetlands (Ayenew & Legesse, 2007).
ii. Grazing Pressure: Overgrazing has depleted wetland grasses, lowering NDVI values.
iii. Hydrological Alterations: Upstream damming and water abstraction for irrigation decreased wetland recharge, contributing to vegetation stress (Kassahun et al., 2022).
iv. Climate Variability: Increasing drought frequency in the Rift Valley has compounded vegetation stress (Gebremeskel et al., 2019).

d) **Implications for Biodiversity and Ecosystem Services**

i. The decline in NDVI signals **loss of wetland biodiversity**, as habitats for fish, birds, and amphibians are shrinking.
ii. Reduced vegetation cover leads to **soil erosion and sedimentation**, lowering the wetland's capacity for water purification and carbon sequestration.
iii. Socioeconomically, degradation threatens pastoral livelihoods dependent on wetland grazing and water access.

Comparison with Other Studies

The observed NDVI trends in Meteka Wetland align with other studies in Ethiopia's Rift Valley wetlands and river basins:

1. Lake Ziway Wetlands showed declining NDVI due to agricultural encroachment and water abstraction (Kebede et al., 2019).
2. Awash Basin Studies confirmed consistent NDVI decline linked to large-scale irrigation projects (Moges et al., 2020).

3. National-Level NDVI Analysis (2000–2020) revealed declining vegetation productivity in wetlands, especially in arid and semi-arid zones, due to climate and anthropogenic pressures (Tolessa et al., 2017).

These findings strengthen the interpretation that the Meteka Wetland has undergone sustained degradation between 2000 and 2023, consistent with regional patterns of land use and ecological stress.

Flora State (Ecosystem Degradation)

The vegetation structure is undergoing type-conversion, moving from a dynamic savanna/wetland mosaic to a rigid, simplified woodland structure.

1) Dominance of Invasive Species: The state is defined by dense, mono-specific thickets of *Prosopis juliflora*, which is dominating over 60% of vegetation cover in some areas, forming impenetrable stands that exclude almost all native understory species (Linders et al., 2020).
2) Native Species under Stress: While native trees and shrubs like *Acacia senegal, Acacia commiphora*, *Acacia oerfota*, *Salvadora persica*, and the multipurpose *Balanites aegyptiaca* persist, they are increasingly marginalized.
3) Functional Loss of Forage: Palatable native herbaceous grasses (*Chrysopogon*, *Sporobolus*, *Cynodon*) show a critical reduction in cover and biomass, indicating a significant drop in the primary productive capacity of the rangeland due to invasive encroachment and overgrazing.

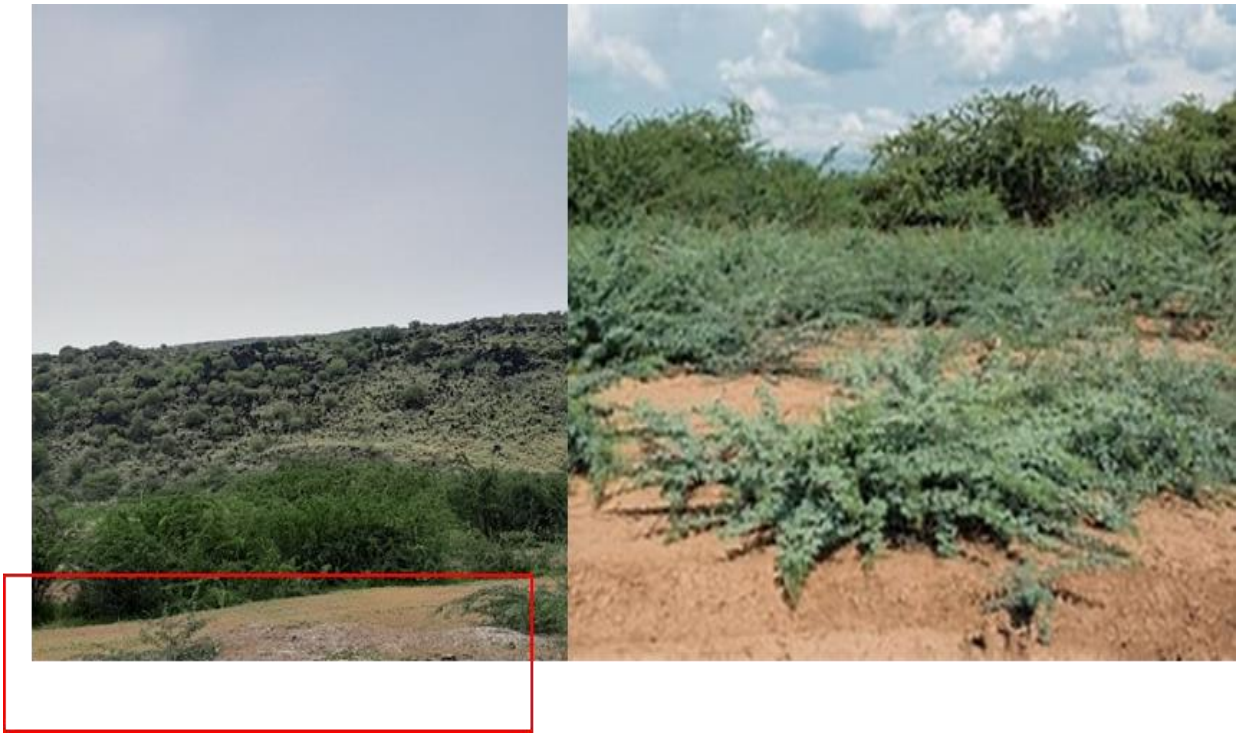


Figure 14 A -Prosopis juliflora invaded land (PJIL)

Table 11: **Major Plant Species of Meteka Wetland Ecosystem**

Category	Dominant Species	Status/Remarks
Invasive	*Prosopis juliflora*	Aggressive, dominates wetlands
Trees/Shrubs	*Acacia senegal*, *Acacia commiphora*	Semi-desert woodland
	Acacia oerfota, *Salvadora persica*	Drought tolerant
	Balanites aegyptiaca	Multipurpose species
Herbaceous grasses	*Chrysopogon*, *Sporobolus*, *Cynodon*	Declining due to grazing and invasion

Fauna State (Vulnerability of Keystone Species)

The faunal community is highly threatened, with the wetland serving as a last bastion for several threatened species. The presence of large carnivores (lions, cheetahs, leopards) indicates the wetland is still a functional ecosystem, but these populations are dependent on dwindling prey species.

Table 12:- Category, Species (Common / Scientific), Conservation Status (IUCN 2024), and Ecological Status in Meteka.

Category	Species (Common / Scientific)	Conservation Status (IUCN 2024)	Ecological Status in Meteka
Critically Endangered	Somali wild ass (*Equus africanus somaliensis*)	CR	Isolated, highly resource-stressed population, subject to human-wildlife conflict.
Endangered	Grevy's zebra (*Equus grevyi*)	EN	Peripheral population, severely impacted by habitat fragmentation and loss of forage.
Vulnerable	Beisa oryx (*Oryx beisa*)	VU	Population declining due to habitat loss and competitive exclusion by livestock.
Vulnerable	Soemmerring's gazelle (*Nanger soemmerringii*)	VU	Key prey species, facing population pressure.
Large Carnivores	Lion, Cheetah, Leopard, Hyenas	Mixed	Dependent on the viability of ungulate prey base.
Indicator Avian	Lesser flamingo (*Phoeniconaias minor*)	NT (Near Threatened)	Population health is an indicator of water quality and aquatic invertebrate abundance.

Medicinal Plants and Biodiversity in Meteka Wetland Ecosystem

Medicinal Plant Diversity

The Meteka Wetland and its surrounding dry savanna–wetland mosaic host numerous traditional medicinal plants that are integral to local pastoralist and agro-pastoralist livelihoods. Field observations and community interviews (FGD 2025) revealed the continued use of native species such as Balanites aegyptiaca, Salvadora persica, Acacia senegal, Acacia oerfota, and Acacia commiphora for ethnomedicinal purposes.

- *Balanites aegyptiaca* (Desert date): used for treating digestive disorders and skin diseases; provides edible fruits and oil.
- *Salvadora persica* ("Toothbrush tree"): used for oral hygiene and as an antibacterial agent.
- *Acacia senegal* and *A. oerfota*: used for wound healing and respiratory infections; also supply gum arabic with commercial value.
- *Commiphora africana*: source of aromatic resin used in traditional medicine for inflammation and respiratory ailments.

However, several medicinal species are declining due to habitat degradation, overgrazing, and the expansion of **Prosopis juliflora**, which suppresses native flora through allelopathy (Ayanu et al., 2015). The reduction in medicinal plant diversity directly undermines traditional health care practices and household resilience (Mwangi & Swallow, 2008).

Endangered and Extinct Plant Species

Field data indicate significant biodiversity loss, with several native trees and shrubs now **endangered or locally extinct** due to land-use change, salinization, and invasive species pressure (Kassahun et al., 2022). Endangered and extinct flora identified in the wetland catchment include:

- **Acacia (Meanto)**
- **Shewshwea (Sagayto)**
- **Kella Zafe**, **Sulla**, **Keselto**, **Tikurea**, **Tedecha**, **Kusera**, **Kunkura**, **Adaytoo**, **Felfelea**, **Aurento**, **Rabrabayto**, **Hidayto**, and **Garssaa**

These species historically contributed to soil stabilization, microclimate regulation, and herbal medicine, but their decline signals a collapse of native ecosystem functions. The encroachment of *Prosopis juliflora*, *EMBOCH* (floating invasive), and *Adey Abeba* (seasonal colonizer) continues to displace native vegetation (Shiferaw et al., 2020; Bekele et al., 2018b).

Biodiversity: Domestic and Wild Animal Composition

The Meteka Wetland remains a critical habitat for **wildlife and domestic species**, though under increasing pressure. According to the ecological assessment (2023):

Wildlife (Key Species):

The wildlife diversity of the region includes several species under varying conservation categories according to the IUCN (2024) Red List. Among the **Critically Endangered** species is the *Somali wild ass* (*Equus africanus somaliensis*), which exists in small, isolated populations often affected by habitat fragmentation and human–wildlife conflict. The **Endangered** category includes *Grevy's zebra* (*Equus grevyi*), whose population continues to decline due to habitat loss, fragmentation, and competition with livestock for forage and water. Two species listed as **Vulnerable** are the *Beisa oryx* (*Oryx beisa*), facing population decline due to competition with domestic animals, and *Soemmerring's gazelle* (*Nanger soemmerringii*), affected by reduced access to water and diminishing prey resources. The **Near Threatened** *Lesser flamingo* (*Phoeniconaias minor*) serves as a vital indicator of aquatic ecosystem health, reflecting the condition of wetland habitats. Other notable fauna in the ecosystem include apex predators such as the *lion* (*Panthera leo*), *cheetah* (*Acinonyx jubatus*), *leopard* (*Panthera pardus*), and *spotted hyena* (*Crocuta crocuta*), all of which depend on an increasingly shrinking prey base and fragmented habitats, emphasizing the urgent need for integrated conservation and management strategies.

Domestic Species (Dominant Livestock):

1. **Cattle, camels, goats, and sheep** constitute the primary domestic animals.
2. Their population growth and concentration around the wetland are contributing to **overgrazing, soil compaction, and water competition** with wildlife (Kebede, 2013).
3. Seasonal migration from neighboring *Woredas* exacerbates forage scarcity and accelerates degradati

Overall Trend

The system is trending toward a low-diversity, low-resilience state. If the current trajectory continues, the Meteka Wetland will cease to function as a viable dry-season refuge for Critically Endangered equids within the next decade. Wildlife populations are shrinking due to habitat fragmentation, overgrazing, and escalating human–wildlife conflict.

2.3.2. Drivers for loss of Biodiversity on the Meteka Wetland

Underlying Socio-economic and Institutional Forces

The primary forces driving biodiversity loss in Meteka Wetland are fundamental socio-economic and institutional shifts, many of which are characteristic of transitional pastoralist systems in the Horn of Africa.

Demographic Growth and Livelihood Diversification:

Rapid population growth among the Afar pastoralists is the core driver, intensifying pressure on fixed, arid land resources. This growth accompanied by the marginalization of traditional mobile herding in favor of **sedentary settlement and opportunistic cultivation** near permanent water sources, including the wetland area, increasing resource demand per unit area (Mohamed, 2019; Tschopp et al., 2024).

Policy and Economic Rationale for IAS Introduction:

The initial introduction of *Prosopis juliflora* in the late 1970s and 1980s was a top-down response driven by the demand for rapid afforestation, fuelwood, and fodder in drought-prone areas, reflecting a policy failure to anticipate the ecological costs of invasive alien species (Bekele et al., 2018b; Reaser et al., 2021).

Weak Institutional Capacity and Law Enforcement:

A significant governance driver is the **limited capacity to enforce conservation laws** in managing protected areas and restricting settlement/grazing within sensitive wetland zones. This institutional gap allows unsustainable resource use to continue unchecked.

Climate Change and Variability:

Increased frequency and intensity of drought events exacerbate resource scarcity. This is an external, systemic driver that forces pastoralists to concentrate livestock near the remaining wet season grazing areas, overriding traditional resource governance mechanisms.

2.3.3. Pressures for loss of Biodiversity on the Meteka Wetland

The drivers translate into several immediate and destructive pressures on the Meteka Wetland ecosystem.

Aggressive Invasion by Prosopis juliflora:

The widespread and unchecked proliferation of *P. juliflora* is the dominant ecological pressure. Its success is rooted in its high water use efficiency, resilience to grazing, prolific seed production, and efficient spread via livestock (endozoochory), leading to a rapid **loss of native habitat** (Shiferaw et al., 2020).

Hydro-ecological and Allelopathic Stress:



Figure 15:- Aline invasive specious Pressure on wetland's and water body

Source:- Filed survey 2018

P. juliflora is a phreatophyte, placing significant pressure on the wetland's water balance by drawing down the water table, thereby altering the hydro-ecological regime necessary for native wetland flora. Furthermore, its chemical exudates (**allelopathy**) actively inhibit the germination and growth of competing native grasses and woody species (Ayanu et al., 2015).

Overgrazing and Resource Competition:

High concentrations of domestic livestock, especially cattle and camels, around the wetland—a critical dry-season refuge—result in severe localized **overgrazing from expanding herds**. This pressure leads to soil compaction, reduced infiltration, and direct competition for limited forage and water resources with indigenous wild equids like the Somali wild ass (Kebede, 2013).

Agricultural Expansion:

Direct **encroachment of wetlands and riparian zones for crops and settlements** is a critical pressure, physically reducing the wetland area and fragmenting the remaining ecological corridors.

2.3.4. Impacts for loss of Biodiversity on the Meteka Wetland

The loss of ecological integrity has profound consequences across the human and natural systems.

Socio-economic Impact: Increased Poverty and Conflict:

The direct loss of grazing capacity for native grasses and the resulting reduction in livestock productivity lead to increased household poverty. This heightened resource scarcity drives greater competition for remaining resources, increasing the frequency and intensity of pastoralist-wildlife and inter-pastoralist conflict (Mwangi & Swallow, 2008). Furthermore, there is a reduction in availability of medicinal plants and a decline in ecotourism potential.





Figure 16: **Somali wild ass / Grevy's zebra in Afar landscape**

Source: Lucasuvu 27 October 2012

Ecological Impact: Irreversible Loss of Ecosystem Services:

The dense canopy and root structure of *P. juliflora* prevent hydrological recharge and lead to soil salinization in low-lying areas. This results in **reduced wetland water regulation capacity**. The primary ecosystem services including forage provision, water purification, and climate regulation are severely compromise, locking the ecosystem into a degraded state.

Conservation Impact: Genetic Bottle-necking and Extinction Risk:

The fragmentation of habitat due to invasive species creates small, isolated populations of Somali wild ass and Grevy's zebra.



Figure 17:- Grevy's zebra

This isolation leads to genetic bottlenecking, reduces adaptive capacity, and increases the overall risk of local extinction (Moehlman et al., 2015).



Figure 18 : Flamingos in Meteka or nearby Rift Valley wetlands

Source: YPRECRVLYouth Power in Restoring Ethiopia's Central Rift Valley Lakes September 9, 2020

2.3.5. Strategic Response for loss of Biodiversity on the Meteka Wetland

The response framework aligns the DPSIR analysis with a strategic, integrated, and sustainable development approach, targeting the reversal of negative trends in the Meteka Wetland.

2.3.6. Outlook

Current projections suggest a

Conservation Outlook

The Meteka Wetland is approaching a low-diversity, low-resilience state (He et al., 2022; Liu et al., 2023). Without urgent restoration focused on invasive species management, habitat restoration, and sustainable grazing the ecosystem risks the local extinction of several keystone species. Community-led reforestation and protection of medicinal plant zones are essential for maintaining ecological and cultural resilience.

Business-as-Usual (BAU) scenario

Will lead to continued *Prosopis* spread, severe wildlife decline, and possible local extinction of the Somali wild ass and Grevy's zebra, exacerbating resource conflict and increasing pastoralist vulnerability to drought.

Optimistic Scenario

An **Optimistic Scenario** proposes a strategic reversal of this trend, grounded in the successful implementation of the Response Framework:

- **Optimistic Scenario (2030 Vision):** The Meteka Wetland is a model of socio-ecological resilience, characterized by three key shifts:

1. Ecological Stability (State): The rate of *P. juliflora* encroachment is halted and reversed in core conservation zones (e.g., 20% habitat restored by 2030). Native grass biomass increases, supporting a stabilizing and possibly increasing population of the Somali wild ass and Grevy's zebra, thereby securing the viability of Meteka as a regional biodiversity hotspot.
2. Enhanced Livelihoods (Impact): Pastoralist households near the wetland derive supplementary income (e.g., 15% of annual income) from diversified sources including *Prosopis* utilization (charcoal, fodder) and community-led eco-tourism ventures. This reduces their exclusive reliance on competitive grazing and consequently mitigates resource-based conflict by 30%.
3. Effective Governance (Driver/Response): Customary land-use practices are formally recognized and integrated into Woreda-level policy, resulting in clearly enforced land-use zones that guarantee seasonal access for livestock while protecting critical wildlife refuge areas and buffer zones.

The following strategic pillars are design to achieve this optimistic outcome.

Theory of Change and Intervention Strategy

Goal: To reverse biodiversity decline and enhance the socio-ecological resilience of the Meteka Wetland by 2030.

Core Intervention Logic: If the spread of *P. juliflora* is control through community-led utilization, and if local governance capacity for resource sharing is, strengthen, then the state of native rangeland biodiversity will improve, reducing resource conflict and ensuring the long-term survival of threatened species.

Response Pillar 1: Integrated Invasive Species Management and Utilization

This pillar targets the **Pressure** (IAS) while converting the pest into an economic **Driver** for removal.

i. **Integrated Control Methods:** Implement a phased control program combining mechanical clearing of dense thickets with strategic chemical application for stump treatment, focusing initially on buffer zones around critical watering points and core wild ass habitat.

ii. **Economic Utilization:** Establish community-based enterprises focused on *Prosopis* resource use. This includes:

a) **Charcoal and Fencing Production:** Converting the cleared biomass into high-quality charcoal for sale in regional markets and utilization for **fencing materials**, providing an economic incentive for removal (Dube et al., 2019).

b) **Livestock Feed:** Processing *Prosopis* pods into palatable, high-protein supplemental feed for livestock, shifting the tree's perception from an ecological problem to a commercial solution for dry-season feeding (Tibebe et al., 2021).

iii. **Ecological Restoration:** Following removal, implement active restoration of native plant species (*Acacia, Balanites*) and reseeding of critical native grasses to restore rangeland function.

Response Pillar 2: Rangeland Governance and Conflict Mitigation

This pillar addresses the **Drivers** (Population/Livelihood, Weak Enforcement) and **Impacts** (Conflict) through improved local institutions.

i. **Strengthening Customary Governance:** Formally recognize and empower traditional Afar resource management institutions (e.g., *dasa* system) in collaboration with Woreda-level administrations. This ensures local ownership and adherence to resource use rules (Homewood et al., 2012). This includes promoting and expanding existing **controlled grazing trials** in sensitive wetland zones.

ii. **Establishment of Shared Resource Zones:** Facilitate the development of community-agreed land-use plans that map and demarcate three zones: 1) Core Wildlife Sanctuary (exclusive), 2) Shared Dry-Season Grazing (time-bound access), and 3) Settlement/Cultivation Zones.

iii. **Mitigation of Competition:** Implement water point management strategies (e.g., temporary closure or rotational access) to reduce competition between domestic livestock and wild equids, particularly during periods of extreme drought (Tschopp et al., 2024). Traditional conservation practices should be documented and integrated into formal management plans.

Response Pillar 3: Policy Alignment and Climate Resilience

This pillar ensures the local interventions are sustainable and aligned with national and international development frameworks (UNDP style).

i. **Mainstreaming Biodiversity into Regional Planning:** Integrate the Meteka Wetland Conservation Plan into the Semera Zone's regional development policy, ensuring allocation of budget and human resources. This aligns the project with the Federal Democratic Republic of Ethiopia's Climate Resilient Green Economy (CRGE) Strategy (2017).
ii. **Disease Surveillance:** Establish a joint Veterinary/Wildlife Health monitoring system to prevent the transmission of zoonotic and livestock diseases (e.g., anthrax, trypanosomiasis) to the susceptible wild ass and Grevy's zebra populations (IUCN, 2024).
iii. **Knowledge Management and Policy Outreach:** Document the success and failures of the *Prosopis* utilization program to create a best-practice knowledge product that can be shared across the Afar, Somali, and Oromia regions, contributing to national invasive species management policy. This includes sharing findings with partners like **Youth Power in Restoring Ethiopia's Central Rift Valley Lakes (YPRECRVL)**.

2.4. Climate

Climate, Climate Change and Forest Ecosystem

Climate

Climate is the "average weather" or more specifically the statistical aspects of the atmosphere-hydrosphere-land surface system that varies over time ranging from months to decades of years. The classical period for averaging climatic variables as defined by the World Meteorological Organization is 30 years.

The Atlantic Ocean and the wind blow across Equatorial Africa have a marked seasonal effect on much of Ethiopia Climate and weather. These inter tropical convergence zone has great influence on Ethiopian Kiremt seasons which is one of the main rainy seasons. Such weather pattern provides the highlands with most of its rainfall during a period that generally lasts from mid-June to mid-

September. Due to difference in elevation and seasonal change in atmospheric pressure, that causes Variations in precipitation throughout the country and several regions receive rainfall throughout most of the year, but in other areas, precipitation is seasonal.

According to the Ethiopian National Meteorological Service Agency (NMSA) Ethiopia Climate is characterized of having has three seasons of Kiremt, Bega and Belg.

Kiremt (summer) it is starting from mid-June up to mid-September during this season's long and heavy rainfall occurs.

Bega (winter) is the dry season that occurs during the month of October up to January and little cooler season

Belg seasons on the month of February, March, April and May were short or moderate rainfall occurs.

Climate Change

Climate change refers to a statistically significant variation either in the main state of the climate or in its variability, persisting for an extended period, typically for decades or longer. The change may be due to natural process or anthropogenic forces in the composition of the atmosphere. The Climate Change is any significant change in measures of climate (such as temperature or precipitation) lasting for an extended period (typically three decades). United Nations Framework Convention on Climate Change (UNFCCC) defines Climate Change as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere'. Increasing GHGs in the atmosphere_ that is the Issue! According to the International Panel on Climate Change (IPCC fifth assessment report, 2014) the global surface temperature increase by the end of the 21st century is likely to exceed 1.5 °C relative to the 1850 to 1900 period for most scenarios, and is likely to exceed 2.0 °C for many scenarios Climate conditions change with elevation, the average temperature drops 0.6°C for every 100m increase in elevation.

Wetland Ecosystems

Wetlands are the ecosystems that are found on the interface between land and water. It is also areas of marsh and swamps, whether natural or artificial, permanent or temporary, with water, that is static or flowing, fresh, brackish or salty, including areas of marine water, the depth of which at low tide, does not exceed six meters. (Ramssar Convention)

Ethiopia exhibits a wide range of geologic formations and climatic conditions, which create numerous wetland ecosystems including 12 rivers, eight major lakes and many swamps and floodplains.

The total wetlands coverage of Ethiopia is approximately 2% (22,600 km2). These, wetlands provide natural resources and services for humanity. They are a source of food, tourism, cultural resources, flood control and improved water quality. They are also important for biodiversity and wildlife conservation

According to EPA GIS analysis, Wetland coverage of the country also shows an inclination from 32,547 km2 in the year 2017 to 27,142.5 km2 in the year 2022 whereas cropland, degraded land and settlement built areas shows an increasing trend and they are the main driving factors for wetland ecosystem degradation in Ethiopia.

2.4.1. State and Trends of Climate of Meteka Wet Land Ecosystem (1990 – 2020)

State and Trend of Rainfall

The Central part of the country experience a bimodal rainfall pattern, receiving the majority of their rainfall from the Atlantic and some derives from the Indian Ocean. The main rains from June to September come mainly from the Atlantic, while the light spring rains between February and May come from the Indian Ocean

Monthly

According to the national Meteorology agency (NMA) rainfall the wetland grid data obtained for the past 30 years (1991 – 2022) , Meteka wet land ecosystem gets the l from Jully to September and the shorter rain from March to May. The data’s are analyzed and described as follow

Month	Am RF
January	20.84
feburary	13.3
Martch	38.68
April	35.37
May	26.2
June	15.17
July	118.33
August	123.31
September	44.75
October	21.33
November	21.27
December	12.61
Sum	**491.15**

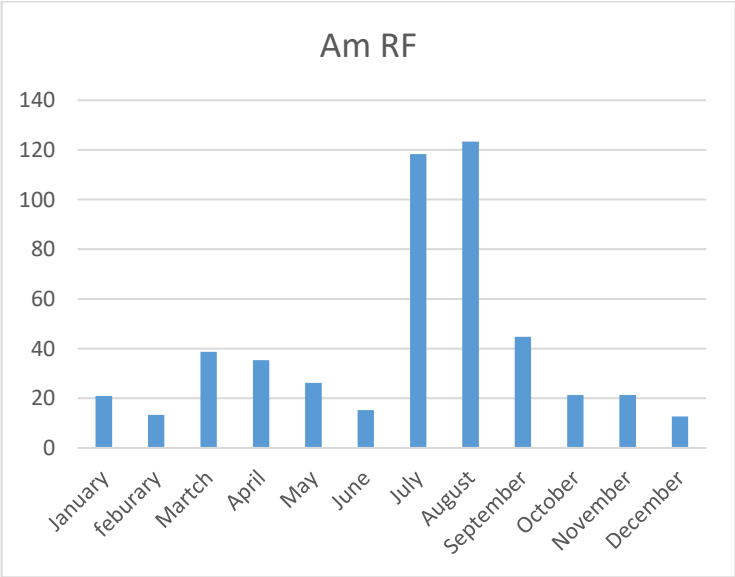


Figure 19: **Meteka wet land ecosystem average rainfall trend in months from the year 1991-2022**

Yearly

In Meteka Wetland Ecosystem the maximum rainfall was recorded in 1997 around 687.77 mm. comparatively minimum rainfall was recorded around 373.7 mm in 2022. One can observe the variation and erratic nature of the rainfall. The rainfall trends shows it is decreasing.

Year	RF
1991	381.388
1992	571.01
1993	641.918
1994	557.166
1995	557.629
1996	600.675
1997	686.705
1998	532.11
1999	675.26
2000	507.067
2001	456.506
2002	471.696
2003	514.634
2004	616.44
2005	443.953
2006	624.106
2007	497.47
2008	464.46
2009	413.859
2010	398.554
2011	265.561
2012	553.582
2013	534.881
2014	413.123
2015	314.284
2016	431.152
2017	418.601
2018	483.867
2019	499.962

2020	412.958
2021	402.361
2022	373.704
Avr	491.1450625

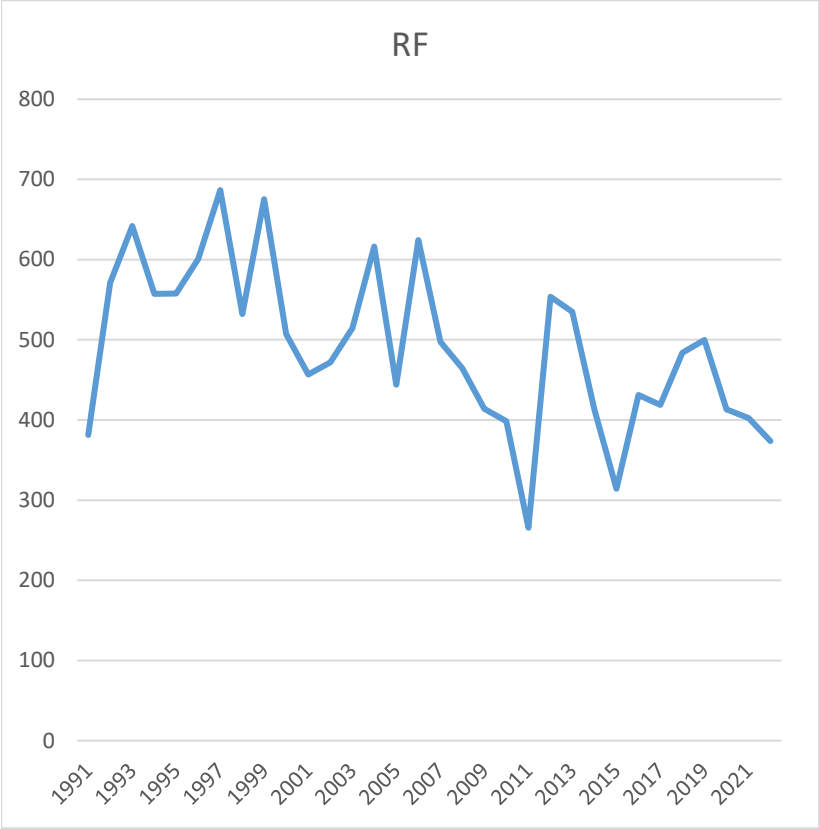


Figure 20 : ***Meteka annual rainfalls from 1990 to 2020***

State and Trend of Temperature for Meteka wetland

Maximum Temperature - Month

Meteka wetland ecosystem has been experienced a warm pattern from May and June and relatively cooler December and January.

The hottest month for the 1991 - 2022 period was the months of June with an average maximum temperature of 39.29 °C, relatively cool month was the months of December with a maximum temperature of 32.53 °C while the normal reference of 36.17 °C.

Month	**Max T**
January	33.95597
February	35.38713
March	36.55791
April	37.21638
May	38.55534
June	39.29641
July	37.85841
August	36.44606
September	36.56466
October	34.97384
November	34.69556
December	32.53353
Avr Max T	**36.1701**

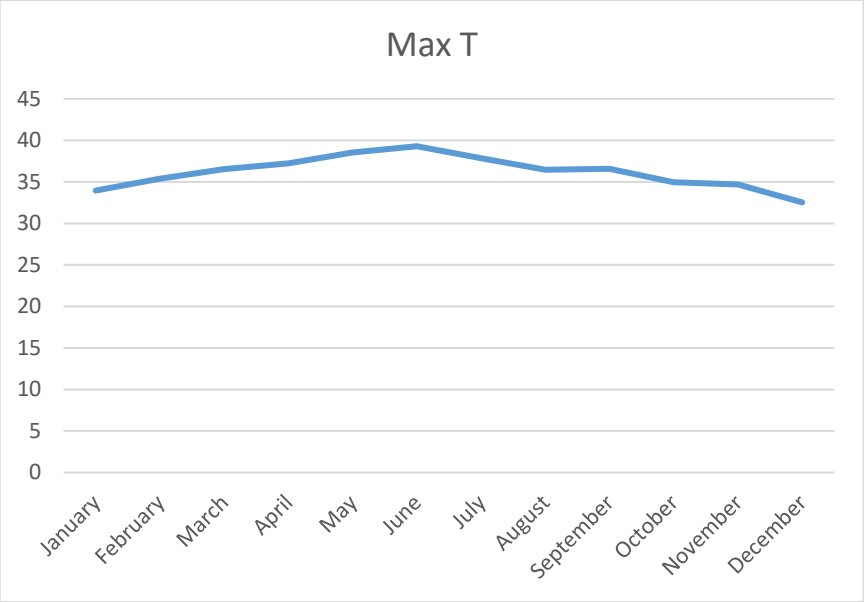


Figure 21: *Meteka Mounthly Average Maximum Temperatures*

Maximum Temperature - Year

Considering the reference normal of 36.17 °C the average annual maximum temperature recorded

- Highest recorded was 38.03 °C in 2011 with anomaly +1.86 . While
- Lowest recorded was 34.09 °C in 1994 with anomaly of -2.08 °C.

From the data one can observe the Maximum Temperature is range or variance is increasing and getting erratic.

Year	Max T
1991	34.85308
1992	34.50725
1993	34.67417
1994	36.0125
1995	35.94425
1996	35.56842
1997	34.95692
1998	34.94575
1999	36.23342
2000	36.18458
2001	35.25275
2002	36.4155
2003	35.795
2004	35.78175
2005	35.68717
2006	36.90342
2007	36.54667
2008	36.72792
2009	35.80583
2010	36.19183
2011	38.032
2012	37.34967
2013	37.3895
2014	35.42167
2015	36.48358
2016	37.07667
2017	36.73683
2018	37.41092
2019	37.90275
2020	34.0855
2021	37.84725
2022	36.71867
Avr Max T	**36.1701**

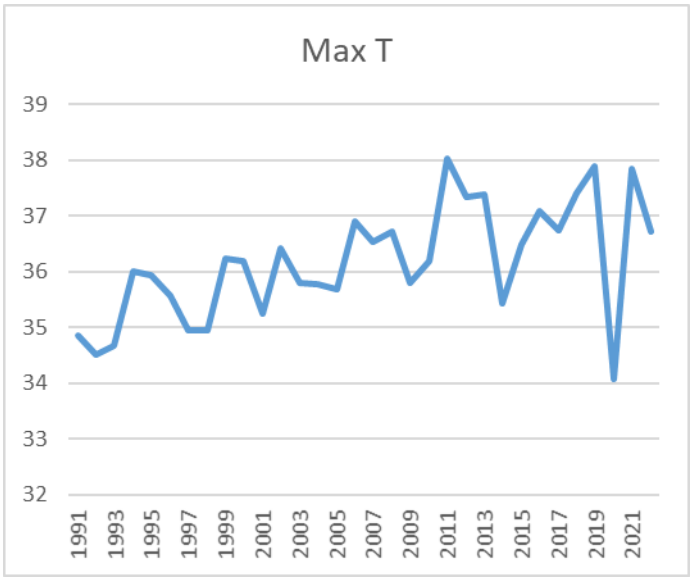


Figure 22: *Meteka Annual Average Maximum Temperatures*

Minimum Temperature - Month

Meteka wetland ecosystem has been experienced a warm pattern from May and June and relatively cooler December and January.

The cool month for the 1991 - 2022 period was the months of December with an minimum coolest temperature of 15.97 °C, relatively June is maximum cool temperature of 23.27 °C while the normal reference of 19.49 °C

Month	Min T
January	16.43416
February	17.51156
March	19.45416
April	19.542
May	21.64509
June	23.26563
July	22.42428
August	21.281
September	20.21459
October	18.38559
November	17.697
December	15.96566
Avr Min T	**19.48506**

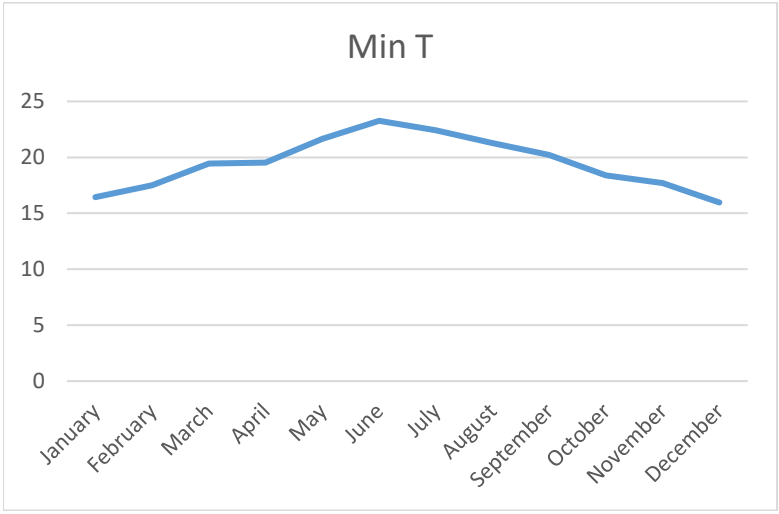


Figure 23: Meteka Monthly average minimum temperatures

Minimum Temperature – Year

Considering the reference normal of 19.49 °C the average annual **minimum** temperature recorded

- Coolest temperature recorded was 17.28 °C in 2012 with anomaly - 2.21 . While
- Relatively cool recorded was 22.17 °C in 2017 with anomaly +2.68 . While

From the data one can observe the Minimum Temperature is range or variance is increasing and getting erratic.

Year	Min T
1991	18.88783
1992	19.14925
1993	18.80575
1994	18.90675
1995	19.39217
1996	19.13858
1997	19.29308
1998	19.52708
1999	19.20242
2000	18.87517
2001	18.72592
2002	19.46358
2003	19.2625
2004	19.16292
2005	18.98092
2006	21.60483
2007	19.25408
2008	18.68758
2009	19.76033
2010	20.44242
2011	21.56558
2012	17.28383
2013	19.80217
2014	18.88867
2015	20.51917
2016	19.72358
2017	22.17858
2018	21.45825
2019	19.969
2020	16.93392
2021	19.45592
2022	19.22008
Avr Min T	**19.48506**

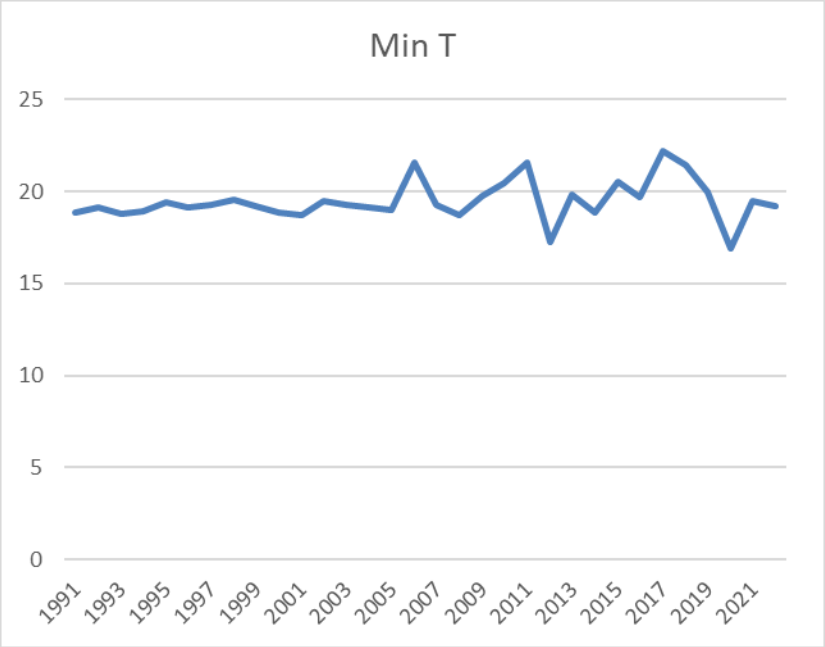


Figure Meteka Annual average minimum temperatures

2.4.2. Climate Change Driver and pressure

Animal Population

Grazing and browsing animal population growth and animals coming from near nearby Wereda/Tribes cause over grazing and natural vegetation degradation creating favorable condition to invasive species pioneering the degraded environment.

Land Degradation and Invasive spp

As the result of the catchment area degradation and favorable environment created for the invasive species mainly the *Prosodies Julifelerea* and ADEY ABEBA make the indigenous and native trees and shrubs as well as wild animals are extinction or endanger condition. The composition of the forest and the ecosystem is changing

2.4.3. Impact of climate change

Loss of livelihood income

Siltation/Salinity as well as pollution mainly from the irrigation agricultural imputes of fertilizer and pesticides and oil and lubricant released from the LAVAJO service are causing to wetland ecosystem degradation that affect the capacity of lakes to provide livelihood ecosystem incomes.

Salinity

Due to land use, cover changes the catchment area is expose to erosion causing siltation and salinization to the wetland. Because of the salinity, it creates a favorable environment to the development of invasive water floating EMBOCH species

Biodiversity degradation

Endangered / extinct trees and shrubs from the wetland catchment area

- Acacia (Meanto), Shewshwea (Sagayto) , Kella Zafe, Sulla , Keselto, Tikurea, Tedecha, Kusera, Kunkura , Adaytoo, Felfelea, Aurento, Rabrabayto, Hidayto, Garssaa

Endangered / extinct wild animalsfrom the wetland catchment area

- Wild Ass, Ostrich, Geraph, Buffalo, Anthelion , Lion , Apes

Expansion of invasive species

- Prosopis julifelrea
- EMBOCH
- ADEY ABEBA

2.4.4. Response to climate change

Policy Response

Ethiopia is endowed with vast wetlands, however, efforts towards their conservation and sustainable utilization are very limited, and no clear policy and legislative framework have been designed. However, some ministries like ministry of water and EPA promote policies of

- To recognize that natural ecosystems, particularly wetlands and upstream forests, are fundamental in regulating water quality and quantity and to integrate their rehabilitation and protection into the conservation, development and management of water resources;
- To ensure that any proposed introduction of exotic species into water ecosystems be subject to detailed ecological studies and environmental impact assessment;
- To promote the protection of the interface between water bodies and land

Whereas Ministry of agriculture were promoting to farm wetlands by draining

Environmental policy

It formulated Ambient Surface and Groundwater Quality Standards for different water uses and ambient water quality, development of water pollution prevention and control strategies. It states that all citizens shall have the right to an acceptable quality of water to satisfy their basic needs and should be supplied with strong environmental confirmation to meet the WHO and MoWR standards for quality and safety.

Draft Legal Framework

Draft proclamation on conservation and protecting wetland and their buffer zone has been formulated and it is on the process of approval in the parliament.

2.4.5. Projected Climate Change Scenarios

Rainfall Projection

IPCC (report 2008) forecast on the level of precipitation shows a long-term increase in rainfall in Ethiopia despite the short- and medium-term observation of frequent dry periods with extreme rainfall levels. The average change in rainfall is projected to be in the range of 1.4 to 4.5 percent, 3.1 to 8.4 percent, and 5.1 to 13.8 percent over 20, 30, and 50 years, respectively, compared to the 1961 to 1990 normal .

Temperature Projection

Future temperature projections of the IPCC mid-range scenario show that the mean annual temperature will increase in the range of 0.9 to 1.1ºC by 2030, in the range of 1.7 to 2.1ºC by 2050, and in the range of 2.7 to 3.4ºC by 2080 in Ethiopia compared to the 1961 to 1990 normal, posing a sustained threat to the economy.

2.4.6. Outlook

If those problem continued without any solution the benefit get from Meteka wetland like environmental benefit and economic benefit will be diminish. So, to reduce the negative impact different adaptation options needed. Adaptation options should focus on increasing sustainable management of livelihood, climate and the wetland ecosystem.

The following sustainable development activities has to be carried out:-

- Watershed based integrated water resources Management should be the core part of the adaptation options.
- Prevented the run off siltation and salinity pollutants,
- Undertake soil conservation measures that help to reduce soil erosion & siltation and also protect the pollution of water sources

- Protect the invasive species based on creative local researcher of problem solving
- Needs effective state involvement by policy and legislative framework

2.5 Water

2.5.1 State and trend of Water availability Meteka wetland ecosystem

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

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

Although the increase in water demand in agricultural production has been of great concern worldwide in recent years, the provision of water for energy production is ignored by water professionals and development experts. Sustainable development and advanced economic growth, sanitation, wastewater treatment, and water supply cannot be achieved without adequate energy

resources, especially in developing countries. Similarly, it is not possible to produce electricity on a large scale without large quantities of water (Asit, 2008).

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

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

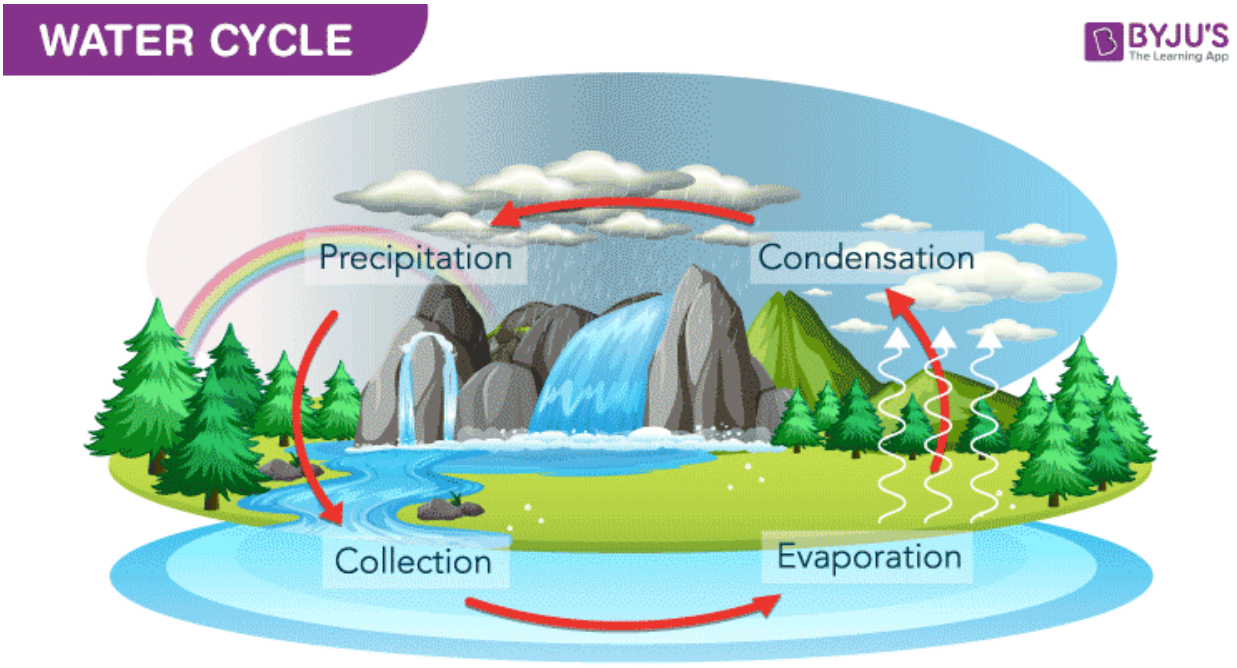
Lack of safe water remains one of the world’s most urgent health issues. People in developing countries have no access to safe and adequate drinking water despite access to safe drinking water is

a global priority agenda. In 2015, it was estimated that 56% of the world's population had an unsafe water source.

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

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

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



Stages of Water Cycle

The complete water cycle is carried into four stages, which are as follows: Evaporation, Condensation, Precipitation and Collection.

Evaporation

This is the initial stage of the water cycle.

The process by which water from its liquid state changes to vapor, a gaseous state, is termed as evaporation. During the water cycle, water in the water bodies get heat up and evaporates in the form of vapor, mixes with the air and disappears.

Condensation

When the evaporated water vapor loses its thermal energy, it becomes liquid through the process of condensation. Formation of clouds are examples of condensation.

Precipitation

Rain, snow, sleet, or hail are all examples of Precipitation. After the condensation, atmospheric water vapor forms sufficiently large water droplets and falls back to the earth with the help of gravity.

Deposition or Collection

This is the final stage of the water cycle. Deposition occurs when evaporated water vapor falls back to earth as precipitation. This water may fall back into the different water bodies, including oceans, rivers, ponds, lakes and even end up on the land, which in turn becomes a part of the groundwater.

Overall, the water cycle process describes how water is balance in the atmosphere. It also plays an important role in ensuring the availability of water for all living organisms and it has a great impact on our environment.

For more information about Water Cycle, its steps, facts and other related topics, visit us at BYJU'S Biology.

According to the Assessment Report of afar region

- Out of 386,371 people assessed, 183,885 (48%) were directly affected by the drought, with 102,408 (56% of the affected) urgently needing emergency food assistance.
- A total of 73,326 people urgently needed emergency water trucking to prevent the humanitarian situation from worsening further.
- A total of 4,826 individuals have been reported as internally displaced due to the ongoing drought conditions.
- Approximately 397,172 livestock have migrated across 40 Kebeles in search of water and pasture, with many dying from exhaustion and lack of resources. Several diseases, including PPR, CCPP, and trypanosomiasis, causing 1,956 deaths. The migration of infected animals has also led to the spread of transboundary diseases, threatening local animal health and veterinary systems. this shows that Afar region is suffering with water shortage

The study was conduct in Afar region, Gwane Woreda Meteka wetland ecosystem. The regional state has been striving to provide equal access to safe and affordable drinking water supply for all inhabitants. the regional pure water access coverage in urban is 41 % The major sources of potable water supply for rural and urban community are awash river and Meteka wetland. According to the Woreda water and energy office, people are suffering with water shortage so they travel long distance to fetch water. Due to this reason, rural women's are more vulnerable to water shortage.
The participant in the FGD explained that the only source of water for Woreda are the Awash river and Meteka wetland

2.4.2. Driver and Pressures of Water Resource Degradation in the Study Area

Overexploitation of freshwater resources jeopardizes human wellbeing and the environment. Wetlands, critical ecosystems for biodiversity, water purification and flood control, are increasingly under threat from a complex interplay of socio-economic and environmental hazards. The multi-hazard context of wetland loss and degradation involves a combination of natural and anthropogenic factors that exacerbate their vulnerability.

Human activities are a primary driver of wetland loss, in particular land use change and agriculture. Agricultural expansion results in direct habitat loss and fragmentation. Agricultural practices represent a significant driver of wetland loss, primarily through conversion for agricultural land, water extraction and pollution. The expansion of agricultural land often necessitates the drainage and infilling of wetlands, disrupting their natural hydrology and ecological functions. Furthermore, agricultural activities can lead to increased nutrient pollution, sedimentation and habitat fragmentation, further degrading wetland ecosystems. These impacts can have severe consequences for biodiversity, water quality and the provision of ecosystem services (Convention on Wetlands, 2022).

Climate change also contributes to wetland loss, manifesting through rising temperatures, altered precipitation patterns and increased frequency of extreme weather events such as storms and droughts. These climatic shifts disrupt hydrological regimes, leading to either prolonged inundation or excessive drying, both detrimental to wetland health. For instance, intensified storms can cause physical damage and increase sedimentation rates, while droughts can reduce water availability, impacting the flora and fauna dependent on wetland habitats (Humpenöder et al., 2020; Gitay et al., 2011).

Moreover, socio-economic factors such as poverty and inadequate environmental governance can exacerbate wetland degradation. In many regions, wetlands are exploited for their resources-such as timber, fish and water-without sustainable management practices, leading to over-extraction and habitat destruction (Ghosh et al., 2023).

Wetland loss/degradation is a negative trend in wetland condition, caused by physical or direct/indirect human-induced processes, expressed as a long-term reduction or loss of at least one of the following: biological productivity, ecological role or value to humans (Olsson et al., 2019). Wetlands are defined as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Convention on Wetlands, 1971: Article 1.1). Wetlands may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands (Convention on Wetlands, 1971: Article 2.1).

1. **Population Growth**

According to Gwane Woreda water mineral and energy office, the amount of wastewater generated from urban area is residences and other households waste increasing from time to time. One of the major causes for massive wastewater disposal and sever water degradation in the ecosystem.is, car washing or laybajo

2. Overexploitation of Resources

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

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

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

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

Overfishing and Aquatic Resource Harvesting

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

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

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

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

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

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

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

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

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

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

6. Invasive Species

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

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

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

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

3.4.3 The main pressures on water in wetland ecosystem degradation include:

1. Hydrological Alterations

Water Diversion: Changing natural water flow for agricultural or urban use can lead to reduced water levels, affecting wetland habitats.

2. Pollution

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

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

3. Sedimentation

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

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

4. Climate Change

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

5. Invasive Species

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

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

6. Overexploitation

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

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

7. Infrastructure Development

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

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

8. Recreational Pressure

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

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

2.4.3. Impact of Water Resource Degradation on the Local Community

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

Due to the degradation of Meteka wetland ecosystems can have significant and far-reaching impacts. Here are some key effects:

1. Water quality decline and reduced source of clean water availability -. Poor water quality can lead to health issues for communities relying on surface water sources, increasing healthcare costs.

2. 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.

3. 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.

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

2.4.4. Responses to protect water in the Meteka wetland ecosystem

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

2.4.5. Outlook

The outlook for water degradation in Gwanee Woreda is increasingly concerning due to rapid population growth, water demand for car wash, and drinking, 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, rely on these resources, face discriminating vulnerability due to health risks and reduced agricultural productivity. Despite these challenges, there is potential for positive change through heightened awareness, community-led conservation, and government initiatives focused on sustainable water management. Strengthening policies and infrastructure, along with fostering community engagement, is vital for reversing degradation trends and enhancing resilience in Ethiopia's water ecosystems.

2.4.6. Conclusion

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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