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Ecosystem services, challenges of water bodies, a problem linked to climate change. A latent issue in Ethiopia

Servicios ecosistémicos, desafíos de los cuerpos de agua, un problema vinculado al cambio climático. Un tema latente en Etiopía

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Abstract

Lakes, rivers, and wetlands support livelihoods by providing numerous ecosystem services. They play crucial roles in human societies in drinking water provisioning, food production (via fisheries, aquaculture, and irrigation of agricultural lands), recreation, energy provision (via hydropower dams), wastewater treatment, and flood and drought control. Therefore, this study aimed to investigate the challenges facing the ecosystem services of Ethiopian water bodies. Freshwater lakes provide diverse consumptive and non-consumptive ecosystem services to people, such as water supply, fisheries, recreation, and natural enjoyment. Wetland systems provide humans with both intermediate and final ecosystem services, such as provisioning services (e.g., freshwater provision), regulating services (e.g., water purification, flood regulation, climatic regulation), supporting services (e.g., habitat for wildlife), and cultural services (e.g., recreation). Challenges include flow alteration, water pollution, destruction or degradation of natural habitats, invasive alien species, and climate change.

Resumen

Los lagos, ríos y humedales sustentan los medios de vida al proporcionar numerosos servicios eco-sistémicos. Desempeñan papeles cruciales en las sociedades humanas en el suministro de agua potable, la producción de alimentos (a través de la pesca, la acuicultura y el riego de tierras agrícolas), la recreación, el suministro de energía (a través de represas hidroeléctricas), el tratamiento de aguas residuales y el control de inundaciones y sequías. Por lo tanto, este estudio tuvo como objetivo investigar los desafíos que enfrentan los servicios eco-sistémicos de los cuerpos de agua de Etiopía. Los lagos de agua dulce brindan diversos servicios eco-sistémicos consuntivos y no consuntivos a las personas, como suministro de agua, pesca, recreación y disfrute de la naturaleza. Los sistemas de humedales brindan a los seres humanos servicios eco-sistémicos tanto intermedios como finales, como servicios de aprovisionamiento (por ejemplo, suministro de agua dulce), servicios de regulación (por ejemplo, purificación del agua, regulación de inundaciones, regulación climática), servicios de apoyo (por ejemplo, hábitat para la vida silvestre) y servicios culturales. servicios (por ejemplo, recreación). Los desafíos incluyen la alteración del flujo, la contaminación del agua, la destrucción o degradación de hábitats naturales, las especies exóticas invasoras y el cambio climático.

Palabras clave:

Retos,
consuntivo,
ecosistema,
Etiopía,
lagos,
aprovisionamiento,
servicios.

Introduction

Ecosystem services (ES) are ecological characteristics, functions, or processes that directly or indirectly contribute to human well-being, that is, the benefits that people receive from healthy ecosystems[1]. Aquatic ecosystems (rivers, lakes, groundwater coastal waters, and seas) help deliver critical ES, such as fish production, water provisioning, and recreation. Key ES such as water purification, water retention, and climate regulation are also linked to the hydrological cycle in the river basin[2].

Approximately 60 % (15 out of 24) of the ES examined during the Millennium Ecosystem Assessment are degraded or unsustainable, including freshwater, capture fisheries, air and water purification, regional and local climates, natural hazards, and pest control. Freshwater ecosystems are among the most endangered ecosystems on the planet, with a global decline of 64 % between (1997 and 2011)[3].

As a result, it is not surprising that river and lake ecosystems, as well as wetlands, have the highest estimated per ha value of ES supply for all inland ecosystems (12,512 × 10^{12} $/year and 25,681 * 10^{12} $/year for lakes/rivers and freshwater wetlands, respectively, compared to 3137-4166* 10^{12} $/year for temperate forests and grasslands) while having the smallest surface area (0.39 percent and 0.12 percent for lakes/rivers and freshwater wetlands, respectively)[4].

Many Africans rely on ES to provide wood for preparing food, poles for enclosures, wild animals for nutrition, and potable water[5]

Ethiopia’s 0.7 % was covered by water bodies. The spatiotemporal variability of water resources is characterized by multi-weather system rainfall in the country. Most river courses become full and flood their surroundings during the three main rainy months (June to August). The west-flowing rivers (Abay, Baro-Akobo, Omo-Gibe, and Tekeze) receive much rainfall, unlike the northeast- (Awash) and east-flowing rivers (Wabishebele and Genale-Dawa), which receive normal to low rainfall. According to current knowledge, the country has about 124.4 billion cubic meters (BCM) of river water and 70 BCM of lake water. Ethiopia's groundwater resource potential is around 40 billion cubic meters. It can potentially develop 3.8 million ha of irrigation and 45000 MW of hydropower production[6].

Lakes, rivers, and wetlands help to sustain livelihoods by providing a variety of ES. Potable water, sand, and soda ash mining, fishing, flood mitigation, waste treatment, habitat for flora and fauna, irrigation, navigation, electric power generation, and other ES are examples of these services[7].

Water influences every aspect of human society and sustains all ecosystems. Freshwater ecosystems meet many of our basic needs, including water for drinking and irrigation, food for fish and waterbirds, and reeds for craftsmanship. Healthy ecosystems also provide important regulating ES, such as flood prevention and drought relief.

Ecosystems are communities of plant, animal, and microorganism communities that interact as a functional unit. A specific environment's ES can be classified as provisioning, regulating, supporting, or cul-

tural. They provide a variety of direct and indirect benefits to human well-being, such as food, fiber, raw materials for industries, and water supply[8]

Water bodies (particularly wetlands and lakes) are critical environmental components of the terrestrial landscape, covering a significant portion of the country's total land area and providing important ES such as climate regulation, pollutant reduction, flood storage, drought control, water supply, and biodiversity conservation[9].

Despite the important ES, they provide, water bodies in Ethiopia are impacted by a variety of development activities aimed at improving socioeconomic conditions. Many development activities are established near waterbodies, where water is used in manufacturing processes and for dumping untreated waste. Unregulated agricultural activities near rivers and streams have an impact on aquatic ecosystems through sedimentation and associated limnological effects, as well as increased nutrient levels from fertilizer and pesticide use[10].

Therefore, the objectives of this review are (1) to identify the ES of Ethiopian water bodies and (2) to identify the challenges of Ethiopian water bodies.

Development

Table 1 Some of the selected studies conducted on ESs in water bodies of Ethiopia

References	Country of 1st author	Study area in Ethiopia	Ecosystem SPUs	ES categories studied (P, R, S, C)	Mode of ES assessment (Q/M/V)	Methodology
11	Ethiopia	Blue Nile basin	WE	P, R	Q	Soil and Water Assessment Tool (SWAT)
12	Ethiopia	Blue Nile basin	WE	P, R	Q, V	Residual value method and focus group Discussions
13	Ethiopia	Central Highlands	Mixed	P, R, C, S	Q, V	GIS Using LU/LC analysis method for ESV
14	Germany	southwestern Ethiopia	Mixed	C, S, R	QV	Focus group discussions
15	Ethiopia	Lake Tana	WE	P, C, S, R	Q, V	Focal Group Discussions (FGD)
7	Ethiopia	Upper Blue Nile Basin	WE	P, C, S, R	Q, M, V	GIS Using LU/LC
16	Ethiopia	Southern Ethiopia	WE	P, C, S, R	Q, V	Focal Group Discussions (FGD), Questionnaire, field observation
17	Ethiopia	Central Rift Valley	Mixed	P, C, S, R	Q, V	GIS Using LU/LC
9	Ethiopia	Central Rift Valley	WE	P, C, S, R	Q, V	GIS Using LU/LC
18	Ethiopia	Ethiopian Rift Valley	WE	P, C, S, R		Questionnaires, focus group discussion
19	Ethiopia	Lake Tana region	WE	P, R	Q	FGDs, key informant interview
20	Ethiopia	Jimma highlands	WE	P, R, S, C	Q	Questionnaires, key informant interviews (KIIs), FGDs
21	Ethiopia	Lake Ziway	WE	P, R, S, C	Q	Questionnaire and FGDs

ME mixed ecosystem, WE water ecosystem, P Provisioning, R Regulating, S Supporting, C Cultural services.

Methodology

A systematic review (SR) is useful for synthesizing trends and conceptualizing findings from large bodies of information.

For this SR, I developed a search strategy to identify relevant literature. This search strategy was tailored to three databases: Science Direct, Web of Science, and Google Scholar, and the search terms used were the following: ES, water bodies, Ethiopia, and challenges. I have also used Boolean searches such as "And" and "Or". All searches included journal articles, books, and book chapters. The search span was from the year 2000-2022 in English only. The search was mainly focused on Ethiopia. The search from-

any other country was considered accordingly.

Fifty-one papers were chosen for data extraction, and the following aspects were extracted: Articles must be published journal articles. Reports, dissertations, and unpublished documents were excluded. In total, 27 studies were considered in this review.

All data extraction and coding were performed using Microsoft Excel and Mendeley Reference Manager.

ES and challenges of Ethiopian water bodies

Status. Natural lakes and artificial reservoirs cover only about five million square kilometers of the Earth's surface; thus, 3.7 percent of the Earth's non-glaciated land surface has long been regarded as a minor component of the biosphere. However, due to widespread human exploitation, their situation has declined rapidly[22].

Effective and appropriate supplies of multiple ES are needed to sustain life, maintain livelihoods, and protect productivity. Africa, on the other hand, has a remarkable spatial variability of SPU.

The heterogeneity of ES supply corresponds to differing ES demand throughout African countries and regions[23].

Aquatic resources in Ethiopia are becoming increasingly stressed, owing primarily to anthropogenic activities. These anthropogenic stresses disrupted ecological integrity and jeopardized ES that could otherwise support millions of people's livelihoods[7].

Many reservoirs built for hydroelectricity, water systems, and irrigated agriculture accumulate significantly more sediment than predicted[24]. This accelerated sedimentation threatens reservoirs such as Koka, Angereb, Legedadi, Gilgel Gibe I, and others. Sedimentation results in the loss of storage capacity and its subsequent effects.

Agricultural production, urban growth, and industry that have expanded in Ethiopia in the last few decades are the primary causes of nutrient enrichment[25].

Ecosystem services. ES is all of the benefits that humans receive directly or indirectly from an ecological system, and they primarily include provisioning services, regulating services, supporting services, and cultural services[26].

Freshwater lakes provide people with a variety of consumptive and non-consumptive ESs like water supply and fisheries, recreation and nature enjoyment, and so on[21].

Freshwater ecosystems are among the most impacted in the world, with a global decrease of 64 % from 1997 to 2011, and 50 % in Europe from (1970 to 2008)[3].

Reservoirs hold about 10 % of the freshwater stored in lakes worldwide. These reservoirs are home to ‘reservoir ecosystems,' which are aquatic and non-aquatic interactive ecosystems linked with artificial lakes in which water is collected for human benefit, typically behind a dam[27].

Wetland systems also provide both living beings with intermediate and final ES, like providing (e.g., freshwater provision), regulating (e.g., water treatment, flood mitigation, climatic regulation), supporting (e.g., wildlife habitat), and cultural service (e.g., recreation)[28].

A study on the Andassa watershed in the Upper Blue Nile basin outlined the decrease and individual ES as a result of LULC changes It was discovered that the massive expansion of agricultural land and constructed area, as well as the decrease in the forest, shrubland, and grassland cover from (1985 to 2015)[7], and the expected changes in 2030 and 2045, diminished the overall ESV from US$ $26.83*10^6$ in 1985 to US$ $22.58*10^6$ in 2000 and to US$ $21.00*10^6$ in 2015, and expected to further reduce to US$ $17.94*10^6$ in 2030 and to US$ $15.25*10^6$ in 2045.

Wondie[15], according to the findings of his study wetlands in Lake Tana, reference and agricultural-affected wetlands presently offer greater provisioning and cultural services, whereas urban wetlands, preceded by benchmark wetlands, provide the majority of regulatory and supporting services, despite being highly impacted.

Another study by Eneyew & Assefa[19] on the Lake

Tana region Infranz wetland Exploitation of more than 15 billion cubic meters of water for public water supply and khat irrigation, farmland expansion, eucalyptus plantation within the wetland, overgrazing, and papyrus overuse were the primary causes of wetland degradation and biodiversity loss.

Moges[29] on their findings on Jimma highlands Furthermore, impacted agricultural and urban wetlands provide more provisioning and cultural services than forested wetlands. As a result, the agricultural and urban wetlands' regulatory and supporting services have gradually declined.

Lake Ziway's ESs contribute to local and national socioeconomic development. The lake provides all types of ES, including those that support, provision, regulate, and are cultural. However, the lake's ESs are primarily concerned with provisioning services[21].

Major pressures (challenges) on freshwater ecosystems. Natural ES and functions have a wide range of ecological, cultural, and economic significance. The major ecosystems and biodiversity that support them, however, are still being degraded and lost on an unprecedented scale. According to Davidson's review, the long-term loss of global natural wetlands averages between 54 and 57 percent, but losses since 1700 AD could be as high as 87 percent[30] recently claimed that in just 50 years, 60 percent of global ES have been degraded. Since 1990, it is estimated that 420 million hectares of forest have been lost due to conversion to other land uses, with the rate of deforestation expected to be 10 million hectares per year between (2015 and 2020)[17].

Land-use intensification, nutrient enrichment, hydrological modification, aquaculture, and fisheries are other major threats that are closely linked to anthropogenic pressures. In many inland water bodies, these pressures have resulted in habitat loss and degradation, eutrophication and pollution, food web disruption, and physical degradation. The human footprint is estimated to have significantly influenced more than 83 percent of the land surface surrounding freshwater systems[22].

The supply side spatial and temporal water-related challenges of water resources are: The quantitative water resource degradations are associated with over-abstraction of lakes (e.g., Lakes Haramya and Abjata), Diversion Rivers for irrigation, and groundwater over-abstraction. Quality degradations are mainly associated with pollution from untreated municipal and industrial wastes (e.g., Zeway, Hawassa, Koka, Akaki, Mojo (Awash), etc.) and off-site impacts that include soil erosion and nutrient transport. Catchment degradation due to deforestation and poor cultivation practices explains the substantial amount of suspended sediment load to river systems in the country[31].

In tropical countries like Ethiopia, water quality is strongly influenced by human factors in combination with the geology, warm climate, and physiographic factors such as rugged terrain, through effects on rates of mineralization, soil erosion, and transport of particulates and solutes. Climate changes, especially rainfall, during the last three decades have affected a large portion of sub-Saharan Africa including Ethiopia with several episodes of drought and famine. Such changes in rainfall could also have direct effects on the lakes. Furthermore, most of the Ethiopian rift-valley lakes are in the vicinity of fast-growing cities surrounded by agricultural land and exposed to water quality changes as a result of land use and modification, irrigation, waste disposal, and other practices associated with population growth[32].

For example, the water quality of the Awash Basin's rivers, lakes, and reservoirs is deteriorating. Rapid urbanization and industrialization have caused serious point source water contamination in the basin, threatening its socioeconomic and ecological values. Due to a lack of wastewater treatment facilities, the majority of the factories in the basin simply discharge their toxic wastewater into nearby rivers, lakes, and streams. Domestic discharge is also present. Waste from industries in the Akaki and Mojo sub-basins is

discharged into nearby rivers and streams. They have not constructed any treatment plants, nor have they established appropriate waste storage or discharge pathways[33].

Flow alteration. Diversion of inflows for irrigation purposes, as well as flushing from deforested and heavily grazed catchments, may have also contributed to the decrease in water level and increase in ion concentrations[34].

Most of Ethiopia's existing dams, including Gilgel Gibe I, Aba-Samuel, Koka, Angereb, MelkaWakena, Borkana, Adrako, Legedadi, Koga (in Amhara region), and many irrigations Micro-dams, have experienced heavy sedimentation (in Tigray region)[35].

Water diversion from Lake Tana for irrigation and floriculture, for example, harms the lake's and its inhabitants' ecological integrity, particularly indigenous and endemic fish species[7].

Excess water withdrawal for diverse reasons is now a serious problem along the Rift Valley lakes, from Lake Afdera in the north to Lake Turkana in the south. This is especially serious in the Zwai-Shala basin[31].

Water pollution (urbanization and pollution). Water quality degradation caused by anthropogenic activities and limited enforcement capacity is a rapidly growing threat to developing countries' water security and public health. The cumulative effects of declining water quality undoubtedly place a strain on public health and socioeconomic development. Many Ethiopian towns are located near waterways (for example, Bishoftu, Hawassa, Zwai (Batu), Bahir Dar, Hayq, Arba Minch, and others). The expanding development activities and infrastructures in towns/cities are harming these wetlands near urban centers (e.g., hotels, health centers, households, and factories). These urban areas discharge various solid and liquid effluents into nearby wetlands. Illegal settlements in and around wetlands have a significant impact on the health and size of the waterbodies[31].

In Ethiopia, for example, most industries discharge their effluent directly into freshwater systems without any treatment. The problem is especially severe for rivers that run through major cities, such as the Awash[33].

Human activities threaten freshwater ecosystems in Ethiopia in general, but poor agricultural practices and industries cause the most severe damage. Agricultural practices hurt the quality and quantity of nearby water bodies. Farmers use fertilizers and pesticides, which leads to eutrophication and toxic cyanobacteria. In many Ethiopian river basins, soil erosion fills aquatic ecosystems with sediment. Because of newly emerging industries, water bodies near cities have shown signs of severe pollution. Without prior treatment, industrial and municipal wastes are dumped directly into wetlands, lakes, and rivers[7].

Both physicochemical and biological results from the Jimma zone study rivers revealed ecological impairment of downstream sites due to the direct discharge of high organic waste from coffee processing industries into nearby rivers[36].

Mehari et al.[37] concluded that the textile factory poses a significant pollution load to the aquatic habitat at the head of the Blue Nile River, causing the water to become highly polluted. Most metrics' values followed a pollution gradient and revealed deteriorated water quality conditions at the Blue Nile River's head.

Destruction or degradation of habitats. It was studied that Abaya-chemo lake-wetland provides local people with fish, lumber, firewood, fodder, irrigation water, farmland, rainfall, recreation, tourism, aesthetics, carbon sinks, air quality, and climate regulation. The main causes of wetland degradation were farm expansion, sedimentation, irrigation, invasive plants (water hyacinth), open access and overuse of resources, a lack of a legal framework, and rapid population growth[38].

The study of Lake Hora revealed several hydromorphological and physicochemical changes that may impair the ecological status of lakes. Because benthic

invertebrates are much less mobile than fish and rely heavily on littoral habitat types, shoreline development is expected to have far more severe consequences for invertebrate communities[34].

Ethiopia's Central Rift Valley (CRV) is an important region due to its vast ES and enriched biodiversity. However, its ES and biodiversity are under tremendous strain as a result of rapid population growth, unsustainable development activities, unplanned urbanization, aggressive agricultural expansion, climate change, and the resulting changes in land use and land cover (LULC)[9].

Invasive alien species (introduction of non-native (exotic) plants and animals). In Ethiopia, invasive alien plant species (IAPS) are spreading at an alarming rate, wreaking havoc on agricultural lands, rangelands, national parks, waterways, lakes, rivers, power dams, roadsides, and urban green spaces[39].

The water hyacinth (*Eichhornia crassipes*) is an invasive plant species (IAPS) that was introduced to Ethiopian water bodies in the mid-twentieth century and has recently exacerbated devastating ecological and economic consequences[40].

Water hyacinth and other related species can quickly fill a wetland and pose a threat to water quality in some areas. Water hyacinth (*E. crassipes*) invasion has been observed in Lake Tana from the highland lakes, Koka Reservoir in the Rift Valley, and Lake Tata in Gambella. It appears that it is currently spreading to other bodies of water, including Lake Zwai in the Rift Valley[31].

From 2015 to 2019, the average annual expansion rate of the weed in Lake Tana was roughly doubled. From 2015 to 2019, the maximum infestation area of water hyacinth on the lake ranged between 278.3 ha and 2504.5 ha[41].

The Lake Koka study revealed that the effects of water hyacinth on the abundance and composition of zooplankton were manifested by a lower number of zooplankton and pollution-tolerant species in hyacinth-infested sites. This suggests that water hyacinth infestations of the magnitude seen in Koka Reservoir pose a serious threat to zooplankton communities and the overall food chain balance[42].

Carps are exotic fish that wreak havoc on wetlands. Carps, which have been introduced for a variety of reasons, are known to significantly increase the turbidity of water resources. These species, for example, have been introduced into Lakes Zwai and Langeno, as well as Koka Reservoir, and have taken over the fisheries[31].

Climate changes. The climate of the Earth is changing and will continue to change in the future, gradually transforming the Earth's ecosystems. The scale of climate change's impact on inland water bodies is global, but the effects can be seen locally and vary by location. Geographic location, elevation, and morphometry are all important factors in determining how climate change affects lakes and reservoirs. Small inland water bodies in tropical and arid regions experience changes in water level and conductivity as a result of changes in water balance and evaporation rate[22].

Parts of Ethiopia, including the Great Rift Valley, which contains the Lake Zwai watershed, are subject to increasing warming and declining rainfall, resulting in increased demand for wetland, water, and irrigated agriculture, driving people to the lake in search of fresh water for irrigation, indoor flower farming, and free-access fishing exercises. The Zwai area is specifically identified as one that is vulnerable to declining rainfall and rising temperatures, and thus designated as one of the country's most densely populated areas at high risk from climate change[31].

The fate of another lake called Haramaya in the eastern part of Ethiopia is just an excellent example of the consequences of climate change and the rising pressure for freshwater by continuing to increase populations. Lake Haramaya, which was once a flourishing freshwater source providing public water

to over 100000 people in the area, fish, animal watering source, bathing, and recreation, has gone from freshwater to a terrestrial ecosystem[31].

Climate change impacts have also been observed in Lakes Chelekleka, Abijata, Beseka, Kilole, and many other[31].

Habitat changes due to agricultural practices. Irrigation, which includes both small-scale open-field horticulture and large-scale greenhouse farmers, has recently grown greatly around the rift lakes of Zwai, Abijata, and Langeno. The discharge of agriculture-related agrochemicals into lakes poses a serious threat to the lakes' habitat and biota. On the outskirts of the wetlands, it is now popular to grow eucalyptus, banana, sugarcane, and 'chat'[31].

Floodplain deterioration is aggravated by unregulated intrusion by squatters, landless farmers, and the workless, who merely catch land segments and use them for planting crop production, pastureland, clearing vegetation for house construction, and so on, with too little impunity or oversight. As a consequence of overuse, numerous floodplains around the Omo Delta, Gilgel Abay Delta, Awash River delta near Lake Abe, and fringe wetlands such as Shesher and Welela wetlands are affected by disorganized settlements, landscape degradation, and loss of ESs such as fish, fertile soil, and habitats[31].

Watershed perturbation. In Ethiopia, land use land cover change is occurring at a rapid pace, with natural forests being converted to cultivated land and grazing lands holding the lion's share. Soil erosion is increasing over time as a result of unwise land use, deforestation, and overgrazing of watersheds, causing siltation of lakes, reservoirs, and rivers. Lake Haramaya, Hawassa, and the Koka Reservoir are all affected by siltation issues caused by wetlands degradation. The worst-case scenarios can be found in Lakes Abaya and Chamo[31]. Another issue caused by sedimentation is the deterioration of river channels. The Awash stretches in the lower valley, for example, are a prime example. As a result of these aggradations, the channels have lost their natural capacity to carry floods that are much lower than peak flows. As a result, flooding in these areas has become an annual occurrence.

Mining activities. In-stream sand and gravel dredging is an invasive process that can have an immediate and indirect impact on fish and habitat. It is especially important for migratory fish species and other aquatic organisms that deposit and protect their eggs and developing embryos in gravels and sand. For example, it is well known that the migratory Labeobarbus species of Lake Tana require a spawning/breeding area with gravel beds and clear, fast-flowing, well-oxygenated water. According to some reports, sand mining and irrigation canals could have a significant impact on these fishes' spawning grounds and migratory routes. By removing the sand and gravel bed from the main channel of the rivers and disrupting both the quantity and quality of water, sand mining may reduce suitable breeding grounds. In extreme cases, these activities can lead to species decrease and disappearance[31].

Salt mining is common in the Afar wetlands, and it will eventually cause the lakes to dry up completely. The deeper Lake Asal appears to be less vulnerable to such a crisis than Lakes Afdera and others. Soda ash extraction has been taking place in Lake Abijata, and as a result of increased abstraction from feeder rivers, the lake has lost so much water that it is on the verge of drying up totally. Phosphate mining in Lake Asal, for example, requires a large amount of freshwater from upland springs, affecting the water table and hydrology of the lowland wetlands[31].

Overexploitation of resources. This primarily refers to the overharvesting of fish stocks from bodies of water, as well as aquatic plants from lakes near shores. Overfishing occurs in many Ethiopian freshwater bodies, particularly highland lakes such as Lakes Tana and Hayq and Rift Valley lakes such as Lakes Zwai, Hawassa, Langeno, and Chamo, where a large percentage of the fish catch occurs. This is

primarily due to an increase in the number of fishermen, which has created pressures that exceed the lakes' sustainable production level[31].

Neo-tectonism (seismic events). The Ethiopian Rift is subject to frequent tectonic activity manifested as earthquakes and, on rare occasions, volcanism. As evidenced by the Main Ethiopian Rift, new ground fractures are being created, resulting in the extinction and/or reduction of the sizes of wetlands. Tendaho Reservoir in the Awash Valley is an excellent example of the effects of seismic activity on the nature of waterbodies[31].

Absence of appropriate policy and institutional arrangement. Wetland concepts are incorporated into various policies and strategies in Ethiopia (for example, Ethiopian Water Resources, Agriculture, and Environmental policies). Wetland issues have also been mentioned in Ethiopia's Conservation Strategy, which serves as the foundation for the country's Environmental Policy. In contrast to the national environmental strategy, the Gambella region's Conservation Strategy includes a separate section on waterbodies. However, Ethiopia lacks a clear policy on waterbodies[31].

Ownership of land tenure. This aspect also contributes more to the destruction of natural resources, such as wetlands, as farmers seek short-term, albeit destructive, advantages rather than lengthy returns due to a lack of ownership security. As a result, there is rigorous cultivation by depleting the wetlands, particularly among those with little understanding of wetland management[31].

Conclusion

Water bodies (lakes, reservoirs, wetlands, and rivers) have been used for a variety of purposes, including flood control, biodiversity, climate change mitigation, river flow regulation, hydropower supply, and water purification and storage, from ancient times to the present. As a result, they are critical to social development, economic growth, and human health. However, their future is jeopardized due to human overexploitation and emerging global threats such as biological invasions, climate change, land-use intensification, and water depletion. Eutrophication has resulted in the degradation of lake ecosystems and biodiversity in approximately 40% of the world's lakes, while 83 percent of freshwater species have disappeared since 1970.

Furthermore, as a result of industrialization and intensive agriculture, eutrophication and heavy metals have emerged as two of the most serious issues confronting lakes and reservoirs.

Eutrophication has resulted in turbid and toxic water from algal and cyanobacterial blooms, resulting in the degradation of lake ecosystems and biodiversity in approximately 40% of the world's lakes. This contamination is becoming more common in developing countries, such as Ethiopia, where rapid agricultural and industrial development has resulted in untreated wastewater discharges into lakes and rivers. Similarly, anthropogenic heavy metal sources such as floriculture, agriculture, and industrial discharge are becoming major sources of heavy metal contamination in lakes and reservoirs. Heavy metals such as Pb, Cd, Cr, Hg, and as are toxic, persistent, and accumulative in the food chain, posing a serious threat to ecosystems as well as human health. Directly discharged wastewater effluent, as well as diffuse sources from agricultural run-off, are both potential sources of high pathogen levels in these receiving waterbodies.

As a result, given the dramatic increase in human pressures on the lake and the anticipated future impacts of these pressures on the lake's ESs and sustainability, conservation measures should be considered by a variety of stakeholders, including local government institutions and decision-making bodies, local communities living around the lake, companies invested along the lake's shorelines, and other development partners such as NGOs.

They should all be involved in the planning and implementation of conservation activities to ensure the lake's and its ESs' long-term use. Therefore, Ethiopia must develop and implement integrated catchment-based ecological protection, restoration, management, and sustainable use of wetlands, as well as ratify the Ramsar Convention and develop a wetland policy. Planning conservation awareness programs among the people about the importance of wetlands and their conservation, involving local stakeholders in any wetland's conservation plan, and optimizing food yield per unit area by conserving wetlands and protecting their functions should also be considered.

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Conflicts of interest

There is no conflict of interest in this investigation.

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Ethical considerations

The authors declare that the article's writing was developed carefully using previous studies in the literature and acknowledge them through the respective authors and sources cited.

Authors' contribution

Tensay Teshome Adane and Tadesse Fetahi contributed to the conception and design of the study, search for information, discussion of results, drafting of the manuscript, and approval of the final version of the manuscript.

Research limitations

This review focuses on the major water bodies of Ethiopia regardless of the minor water bodies found in Ethiopia.

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