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Research Article

Assessment of Major Wetlands' Current Situation and Their Contribution To Livelihood Improvement, South Wollo, Ethiopia

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The wetland ecosystem is among the most important ecosystems globally. It is a source of ecosystem services that can contribute to the income and means of livelihood for communities living near the vicinity of wetlands especially in developing countries. Ethiopia is among the least developing countries in Africa where many communities around the wetlands depend on ecosystem services for their livelihoods. However, these wetlands are being degraded both by anthropogenic and natural factors. The objectives of the study were to assess the status of the major wetlands and their contribution to the livelihoods of communities in South Wollo Zone of Amhara Regional State located in North-Eastern Ethiopia. Districts in South Wollo with wetland potential were selected purposely in collaboration with Zonal Agricultural Office experts. A multistage sampling technique was used to select 114 respondents living around the wetlands for the interview. In addition to this, three focus group discussions and key informant interviews were conducted to gather data focused on types of wetlands, major provisioning ecosystem services, and major threats to wetlands. In the study area, 9 natural and 3 manmade major wetlands were identified. These wetlands have provisioning ecosystem services such as food production; source of grasses for animal feed; ceremonial activities; roof making and handicrafts; and water for drinking, livestock watering, and irrigation which are the major sources of livelihoods. Though these wetlands have important roles in livelihood, they are highly affected by settlement, conversion for agriculture, overgrazing, excessive water abstraction, deforestation, sand mining, pollution, invasive species, and climate change. Therefore, wetland management intervention plan should be prepared and implemented through a community-based restoration approach.

1. Introduction

The wetland ecosystem is among the crucial ecosystems in the world that harbour huge biodiversity and provide key ecosystem services to societies [1, 2]. Wetlands are the source of ecosystem services that play an important role in the well-being of the people living in and around them [3, 4]. Wetlands have four common ecosystem services, provisioning, regulating, supporting, and cultural services that benefit people around the globe.

African wetlands are important for their global contribution to ecosystem services on which hundreds of millions of rural communities depend directly for their livelihoods [5]. Increasingly, the essential role of wetlands in climate change mitigation is recognized [6], and African countries have a made remarkable progress in developing policies for wetland conservation and management.

Though wetlands are very crucial ecosystems that provide ecosystem services to people and biodiversity, their coverage is being reduced globally due to more pressure than other ecosystems [7]. They have been affected by land-use change, water abstraction, pollution, and invasive species [3, 8–12].

Wetlands in Africa are also expected to have a similar reduction trend due to increasing pressure on wetlands [13]. Major threats to wetlands in Africa include the increasing development of reservoirs for energy purposes in sub-Saharan Africa [14], an increase in population growth, and

agricultural activities and urbanization [5] and land use system, considering wetlands as communal land and open access [15].

In the past few years, African countries have been interested to design sustainable utilization of wetland ecosystems considering the biodiversity values of wetlands [16]. However, the knowledge and skill gap in the design and implementation of sustainable utilization of wetland ecosystem services is a challenge in most African countries [17].

Ethiopia is one the African countries located in Eastern Africa that has about 1.13 million km^2 total areas and is endowed with several inland water bodies consisting mainly of swamps, rivers, lakes, ponds, reservoirs, and other wetlands (bogs and marshes), which are generally termed as wetlands [18]. The coverage of these wetlands was estimated to be 2% or 22,500 km^2 [19]. Though Ethiopia has no recent central database or wetland inventory system [20], the country has important wetlands distributed unevenly from lowland to highland areas. Lakes Tana, Hayq, Ardibo, and Ashengie-associated wetlands are some of the major wetlands located in the highlands of Ethiopia. On the other hand, highland lakes, Lake Abe, and Afdera are wetlands located in lowland areas of Ethiopia. The country has also bigger wetlands around big rivers such as Awash (Cheffa wetland) and Baro (flood plains of Gambella) and rift valley lakes such as Hawassa, Abaya, and Chamo-associated wetlands [21, 22].

In addition to natural wetlands, many microdams (artificial wetlands) have been built for irrigation. The highest number of microdams (>60) were constructed in Tigray Region due to the severe shortage of water in the region. In addition to these microdams, bigger dams such as Koka (1900 million m^3), Tekeze (9000 million m^3), and Gilgel Gibe II (14000 million m^3) have been constructed [23]. The underconstruction Grand Ethiopian Renaissance Dam (GERD) when completed will have 79,000 million m^3 which is more than twice the size of Lake Tana, the largest lake in Ethiopia.

In Ethiopia, different-sized wetlands have a very important role in livelihoods. Wetlands provide water and food security through their provisional services for the poor. They are also the source of income and livelihood for other people living in the vicinity and even far from wetlands [24].

However, wetlands in Ethiopia are affected by factors such as excessive water abstraction, due to less efficient agricultural water utilization and less coordination among stakeholders [22] and wrong perception of wetlands considering them as wasteland [25].

Amhara Region, one of the regional administrative states in Ethiopia, is known for its wetland potential. The coverage of wetlands in the region is estimated to be around 1.4%. Bigger wetlands like Lake Tana and its associated wetlands are located in the region [26].

Though some larger wetlands in South Gonder (Fogera flood plain), West Gojjam (Lake Tana-associated wetlands), Awi (Dinbanko), and Oromia zone (Cheffa wetland) have been studied in Amhara Regional State in Ethiopia [26–28]; still small and medium-sized wetlands that have important contributions for communities are not studied and documented in other zones of Amhara Region. The wetlands of the south zone are among them. Therefore, this study is aimed to assess the types of wetlands, major provisioning ecosystem services used for livelihoods, and common threats and recommended sustainable utilization of major wetlands in South Wollo Zone.

2. Materials and Methods

2.1. Study Area. South Wollo is one of the eleven administrative zones of the Amhara National Regional State which is located between 10010′N and 110 41′N latitudes and 380 28′E and 4005′E longitudes. It has about 18,157.48 km^2, which is divided into 19 rural districts and four administrative towns, Dessie, Kombolcha, Haik, and Mekaneselam [29].

The common land use of the zone is arable land (36.3%), forest and bushland (13.5%), grazing land (18%), and others, bare land, buildings, and water bodies (31.9%) [30]. South Wollo Zone has a diversified topography with many steep slopes with elevations ranging from 927 m to 4261 m (Little et al. 2006 [30]). Since 2010, agricultural land, settlement, grazing land, and bare land are being increased. On the other hand, forest land and closure are being decreased [31, 32].

The major soil type in South Wollo Zone is sandy, sandy clay, and sandy loam with moderate fertility [32]. The zone is known for its bimodal rainfall pattern, the big rainy season usually extending from June to September, and the small rainy season extending from February to May [33]. Based on the population statistics of ANRSPC [29], the total population in South Wollo was estimated nearly 3.1 million of whom 49.5% were males and 50.5% were females. The zone is among the most densely populated areas of the country with 171 persons per km^2. The zone has many small, medium, and larger rivers with huge irrigation potential. About 82% and 18% of these rivers located in Abay and Awash basins [30]. Some of the major wetlands located in South Wollo are shown in Figure 1.

2.2. Methods. Both primary and secondary data were used for the study. Primary data about demographic characteristics, types of wetlands, major provisioning ecosystem services and their contribution to livelihood, and major threats of wetlands located in South Wollo were collected through a questionnaire, focus group discussion (FGD), key informant interviews (KII), and field observations. To strengthen the quality of the data, secondary data were obtained from published and unpublished sources. Though wetlands have four kinds of ecosystem services, provisioning, supporting, regulating, and cultural [3], this study focused on provisioning ecosystem services that have a direct role in the livelihoods of communities that are highly dependent on wetlands for survival.

2.2.1. Sampling Procedure and Sample Size. From the 23 districts of the South Wollo Zone, their districts, Dessie from towns, and Tehulederie and Kalu from rural districts were selected purposely based on the presence of more wetland

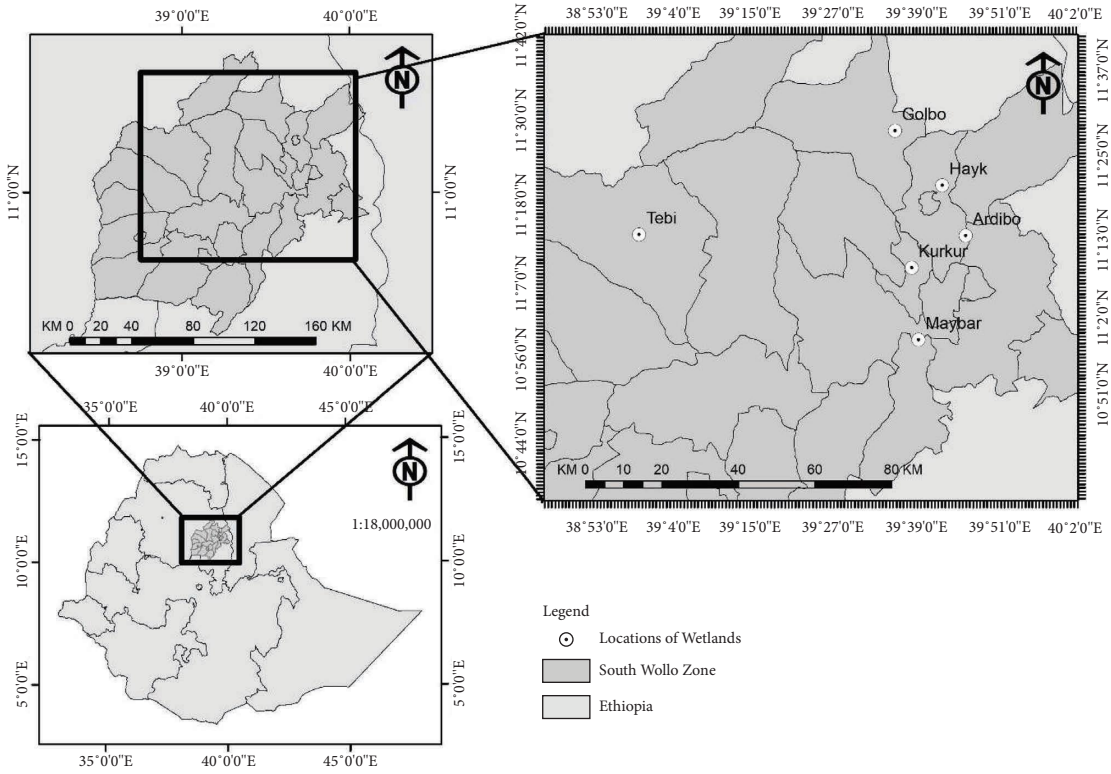

Figure 1: Some wetlands of South Wollo Zone produced by GIS and Google Earth (source: own).

areas, greater interaction of communities with wetlands, accessibility, and security. After the selection of the districts, kebeles with more wetland coverage and greater interaction of communities with wetlands were selected in collaboration with concerned district officials and a literature review.

The percentage of community dependency on the nearby wetlands was determined by Bhatta et al. [34]. An initial rapid assessment was carried out in three districts, Kalu, Tehulederie, and Dessie. From these districts, 10 kebeles bordering wetlands were selected to determine household dependency on wetland resources. About 30% of the total households were found to depend directly on wetland resources. Of these households, about 10%, 114 were randomly selected for the household survey.

A multistage sampling procedure was applied to select the households. First, the three districts were purposefully selected by involving key informants and knowledgeable persons from the office of the Agricultural and Rural Development of South Wollo Zone. The selection of districts considered wetland potential, the interaction of communities with wetlands, diversity, accessibility, and representativeness. Second, 10 kebeles were selected purposefully within selected districts in such a way that samples were drawn from kebeles adjacent to significant wetland occurrences. Third, sample respondents were randomly selected from the households registered as residents of the selected kebeles, since they are homogenous in their ethnicity, socioeconomic characteristics, and educational backgrounds. Accordingly, 10% of the household sample size from each selected three kebeles was drawn and a total of 114 heads of households were randomly selected to be used as respondents for the prepared questionnaires. The selection considered the percentage of wetland-dependent communities from an initial assessment made before the actual detailed survey conducted for this study.

2.2.2. Data Collection Tools

(1) Focus Group Discussions (FGDs). The data, the types of wetlands, major ecosystem services, common threats of wetlands, and existing wetland management efforts in South Wollo Zone obtained from the respondents using questionnaires were validated during focus group discussions. Three focus group discussions, one per district was conducted on-site with more wetland-dependent communities ranged 9–12 participants in each group. The members of the focus group were selected based on their major livelihood type and the level of dependency on the adjacent wetland. Major types of wetlands, kinds of ecosystem services used in livelihoods, major threats to wetlands, and efforts for the management of wetlands were thoroughly discussed with the group members one by one.

(2) Key Informant Interviews. Representatives of the government authorities, Haik Fisheries and Other Aquatic Life Research Sub-Center, Fisheries and Livestock Agency, Environmental Protection and Land Use and Administration, Agriculture and Rural Development Office of Kalu, Tehulederie and Dessie Districts, and Lake Hayq and Ardibo

Protection and Development Association were consulted about the type of wetlands, major ecosystem services and their role in livelihoods, common threats of wetlands, and methods of wetland management if any in South Wollo. The most important questions asked during interviews were focused on the types of ecosystems generated from the wetlands, the level of dependency of communities on the wetlands, major threats of wetlands and any effort made for the management of the wetland, presence/absence of policy, and regulation and leading organization responsible for the management of wetlands. A total of 11 representatives from the aforementioned organizations were consulted as key informants. The criteria for the selection of the key informants were knowledge about the wetland resources, their close interaction with those people highly depended on wetland resources, and involvement in the conservation and restoration of the wetlands [34].

2.3. Data Analysis. The data collected using primary and secondary sources were summarized using descriptive (tables, mean, percentage, and figures) statistics through the application of SPSS version 20 software.

3. Results and Discussion

3.1. Characteristics of Households

3.1.1. Age of Respondents. The average age of respondents was 37.3 ± 5.5, 49.5 ± 8.9, and 41.27 ± 10.3 in Dessie, Kalu, and Tehulederie, respectively (Table 1). The average age of the respondents in the three districts was in the active age range (<65 years). Being in the active range of communities has an impact on intensive wetland resource extraction.

3.1.2. Family Size. The average family size of respondents was almost similar in the three districts, 6, 6, and 5 in Dessie, Kalu, and Tehulederie, respectively, as shown in Table 2. The family size of the three districts was proportional to 4–6 family members of Amhara Regional State [26, 35] resulting in high population growth. These communities have large families which contribute to more demand for wetland resources which means more pressure on the ecosystem functions and services of wetlands. In the study area, the wetland user communities had a higher population dominated by a young age which might have contributed to the excessive extraction of resources.

3.2. Types and Distribution of Major Wetlands in South Wollo Zone. The current version of the Ramsar typology recognizes three broad groups of wetlands: marine and coastal, inland, and manmade [7]. In South Wollo Zone, there are no marine and coastal wetlands since Ethiopia lacks these kinds of wetlands. However, there are inland wetland types (lacustrine, riverine, and marshes) and manmade types (water harvesting small ponds and reservoirs), as shown in Table 3. In South Wollo Zone, three manmade and nine natural wetlands were reported from seven districts (Table 3). The natural wetland area coverage is decreasing due to climate change, conversion to agricultural land, and land sold for investments. However, the manmade wetlands increased both in number and area coverage due to the high demand for water harvesting for irrigation purposes. After ELINO which happened in 2015, many newly dams were constructed by GOs and NGOs in South Wollo for irrigation and cattle watering purposes [36]. For instance, more than 100 water harvesting ponds were constructed in Azigo Village located in Kalu district. The ponds were being used for horticultural crop production mainly chat farming.

Table 1: Average age of respondents in Dessie, Kalu, and Tehulederie districts.

Districts	Kebele	Mean	Std. deviation	Number of respondents
Dessie	016	37.33	5.553	24
Kalu	01	49.80	8.521	15
	032	45.38	10.309	8
	033	53.57	6.997	7
Tehulederie	05	41.07	8.730	15
	010	39.60	7.872	15
	011	39.27	10.833	15
	012	45.13	13.271	15

Table 2: Average family size of respondents in Dessie, Kalu, and Tehulederie districts.

Districts	Kebele	Mean	Std. deviation	Number of respondents
Dessie	016	5.08	1.998	24
Kalu	01	5.27	1.624	15
	032	5.25	1.982	8
	033	6.57	1.512	7
Tehulederie	05	4.67	1.718	15
	010	5.07	1.751	15
	011	4.33	2.526	15
	012	4.93	2.187	15

3.3. Importance of Wetlands for Livelihoods. All of the respondents reported that communities living around the wetlands are using one or more provisions of ecosystem services of wetlands for different purposes. The communities having low income are using ecosystem services such as grasses, fisheries, and sand mining as a source of livelihood.

From all wetlands of the study area, *Cyperus latofolia* is the common commercial wetland plant used for cultural and religious activities. This grass species is sold in the market at least once a week because many members of the communities used the grass for cultural activities in the area. In Ethiopia, both Muslim and orthodox followers practice using wetland grasses during their religious festivals. In the study area, Ethiopian Orthodox Church followers celebrate boldly their annual festivals (Epiphany, Good Friday, Easter, and Ethiopian New Year) using *Cyperus latofolia*. In addition to these holidays, they celebrate weekly and monthly

Table 3: Major natural and manmade wetlands in South Wollo.

No.	Wetland names	Wetland types	Location
1	Alansha	Permanent freshwater marsh	Kutaber
2	Borumeda	Permanent freshwater marsh	Dessie
3	Gerado	Permanent river	Dessie
4	Borkena/Cheffa	Permanent river	Kalu
5	Tebi	Manmade reservoir	Mekidela
6	Legemara	Manmade reservoir	Mekaneselam
7	Azigo ponds	Manmade ponds	Kalu
8	Lake Logo	Natural, permanent freshwater lake	Tehulederie, Worebabo
9	Lake Ardibo	Natural, permanent freshwater lake	Kalu, Tehulederie
10	Lake Maybar	Natural, permanent freshwater lake	Albuko
11	Lake Golbo	Natural, permanent freshwater lake	Ambasel
12	Kurkur/Bahirshesh	Seasonal/intermittent freshwater lake	Dessie Zuria

Note: There are many small-sized numerous waters harvesting ponds in each district which can be considered as manmade seasonal wetlands [36].

religious holidays using the plant. This is a good market opportunity and livelihood means for the plant collectors.

Other wetland plants, *Cyperus* species and *Typha latofolia* are used for handicraft making (mattresses and pillow) and roof making purposes especially in Borkena wetland/part of Cheffa wetland located in Kalu District. Many of the low-income communities cover their roof with *Typha latofolia* species. Moreover, wetlands are the source of many kinds of grasses used for feed for animals especially during the dry season when the shortage of feed for livestock occurs.

Fisheries from Lakes Hayq and Ardibo are also the source of income and means of livelihood for many fishermen living in the vicinity of those lakes. Sand mining especially from Borkena and Gerado wetlands is another important source of income and means of livelihood directly for unemployed youths and indirectly for those involved in construction activities. Wetlands are also used for crop production since they are the source of land and of water for irrigation either from the surface water (lakes, rivers, reservoirs, and ponds) or groundwater (marshes), as indicated in Table 3.

The respondents said that they have different types of livelihoods such as crop farming, livestock production, livestock trading, fuelwood selling, fishery, *Catha edulis* production, and wetland grass selling. Most of the respondents (25%) of Gerado wetlands have mixed farming (crop and livestock production). Grass selling for ceremonial purposes from Gerado wetland for Dessie inhabitants is also an important livelihood for some farmers. Most (58%) of the respondents from Borkena (Cheffa) Wetland have mixed farming as a livelihood similar to Gerado.

All respondents (100%) of them confirmed that wetlands located in their surroundings contribute to the food security effort of the local government. Even in bad years like 2015, the people and their animals living around wetlands have been less affected by drought than those living far from the wetlands. South Wollo wetlands have significant importance for livelihood from the components, water, vegetation, and soil as stated in Table 4.

In agreement with the present study, the role of wetlands for income and livelihoods improvement for riparian communities was reported in different countries in Africa,

Table 4: Benefits of South Wollo wetlands for the local people.

S. no.	Benefits	%
1	Cattle watering	100
2	Drinking water source	50
3	The source of land for farming	100
4	Feed for cattle	100
5	Irrigation water	75
6	Grass for ceremonial purposes	100
7	Grass for roofing	10
8	Medicinal plants	0
9	Fuelwood	5
10	The source of fish	75

Katonga Wetland in Uganda [37], Savelugu Municipality in Ghana [38], and Nyando Wetland in Kenya [11]. Wetlands in Arica have an important role in the survival of people through provisioning water and nutrients for biological productivity [11, 39–43]. The finding of this study also agrees with other studies conducted in different wetlands found in Ethiopia, wetlands of Lake Tana [26, 27], and wetlands around Jimma [44].

Lake-associated wetlands (Logo and Ardibo) are also important wetlands in South Wollo Zone. Mixed farming and fishery are the dominant livelihoods for people living around Lake Logo, and mixed farming and *Catha edulis* selling are the dominant livelihood for the people living around Lake Ardibo. A similar study was reported for lake-associated wetlands in other areas in Ethiopia (Shesher and Welela) in Lake Tana [45, 46]. The contribution of fisheries in the wetlands of Ethiopia was reported by Hailu [47], Abebe et al. [48], JERBE (Ethio Russian Biological Expedition) [49], Berihun et al. [50]; Assefa et al. et al. [28], Deng [51], and Zekarias et al. [52].

In agreement with the present study, the role of wetland plants for animal feed, ceremonial and cultural activities, and roof making and handicrafts were reported for wetlands of Cheffa, Abaya-Chamo, Western Wollega, and Illubador zones in Ethiopia [28, 47, 52].

The ecosystem services of wetlands support a significant population that depends on wetland ecosystem services in Africa, especially the poor who are very vulnerable to climate change and have the low adaptive capacity [42]. According to

Figure 2: Excessive water abstraction of Lake Ardibo, flooding irrigation for chat (*Catha edulis*) farming (source: own picture).

(a) (b) (c)

Figure 3: Invasive macrophyte species in Lake Hayq: *Ceratophylum demesum* (a), *Ceratophylum muricatum* (b), and *Potamogeton pectinatus* (c) (from Girum et al., 2016).

Stephen [42], flood recession cultivation of crops, livestock grazing, and fisheries are the three common livelihood activities in Africa. Wetlands have a very important contribution to livelihood in Africa where inland wetlands are used largely for agriculture as farmland and water sources [53].

3.4. Status of Major Wetlands of South Wollo Zone. Like other Ethiopian wetlands, the wetlands of South Wollo are degraded from time to time due to less attention given by the federal and regional governments. Major threats to South Wollo Zone wetlands are overfishing (Lake Hayq), overextraction of macrophytes (Borkena/Cheffa in Kalu District), climate change (all wetlands), conversion into agricultural land (all natural wetlands), pollution (Borkena and Logo), excessive abstraction of water (Borkena and Ardibo), illegal settlement (Logo, Borkena, and Ardibo), invasive plant species (Lake Maybar and Lake Hayq), and sand mining (Borkena and Gerado).

There are about 200 motorized water pump taking water excessively from Lake Ardibo during the dry season. This excessive water abstraction using flooding type of irrigation (Figure 2) affects other ecosystem services such as fisheries and wetland plants. Another major threat observed around lakes Hayq and Maybar is the expansion of invasive aquatic plants (Figures 3 and 4) which might have occurred due to more nutrient enrichment from fertilizer residuals, cloth washing, and siltation. Overfishing especially on *Oreochromis niloticus* species in Lake Hayq happened due to illegal fishing activities and was also one of the major threats.

Since 2017, the expansion of industrial development around wetlands and the degradation mentioned above have affected the livelihoods of vulnerable groups (landless widows, old people, and orphans) in South Wollo Zone.

Figure 4: Excessive growth of water lily, Lake Maybar, South Wollo (source: own picture).

South Wollo Zone is among the highly affected zones by the recent conflict that happened (from August to December 2021) between the federal government of Ethiopia and its alliance and Tigray People's Liberation Front (TPLF). During the war, there was heavy fire exchange between the fighters that have been degraded most of the wetland's ecosystem. Consequently, the diversity and abundance of fauna and flora are expected to be reduced highly, especially in Alasha, Boru Meda,and Cheffa wetlands.

Despite the very important contribution of wetlands for livelihoods, government and nongovernmental organizations have not emphasized the conservation and restoration of wetlands in Ethiopia, in general, and in South Wollo, in particular. There is no independent policy and organization for this crucial and fragile ecosystem in Ethiopia.

In line with the findings of the present study, *Oreochromis niloticus* fish species overfishing was reported in Lake Hayq due to illegal fishing activities [54]. In agreement with the present study, extraction of macrophytes/wetland plants was reported in Cheffa Wetland located in Oromiya Zone in Amhara Region [28, 55]. Similar to the findings of the present study, the effect of climate change on vulnerable communities was reported in other studies conducted in sub-Sahara Africa [5], southern wetlands of Bangladesh [56] and Vembanad Lake in India [57].

In agreement with the present study, most of the wetlands of Ethiopia have been affected by human activities except those wetlands found in remote areas where human and cattle populations are less. The major threat comes from overgrazing, excessive extraction of water, settlement, catchment degradation, pollution, unsustainable agriculture, invasive species, excessive mining, Eucalyptus tree plantation, and climate change [28, 58–63].

In alignment with the present study, similar results were reported about major threats to wetlands globally. For instance, climate change [5, 56, 57], conversion for agriculture [40], higher dependency and the gender imbalance of the wetlands [11, 15], population pressure leading to encroachment of wetlands [64], less understanding about the role of wetlands [38, 60], shortage of cropland and upland degradation [65], and change in land use and land cover [66].

The results of the present study were similar to most African countries such as South Africa that pollution and invasive plants are among the major threats to wetlands affecting ecosystem services. These threats often happen due to less emphasis given to wetland protection [67].

4. Conclusion and Recommendation

South Wollo Zone is one of the 11 zones found in Amhara Regional Administrative State in Ethiopia. It has many natural (rivers, marshes, and lakes) and manmade (ponds and reservoirs) wetlands. However, for this study, 12 major wetlands (9 natural and 3 manmade) were considered. Based on the Millennium Ecosystem Service Assessment [3], wetlands have four ecosystem services: provisioning, regulating, supporting, and cultural. But this study was focused on provisioning ecosystem services that have a direct role in livelihoods.

The wetlands of South Wollo have very important provisioning ecosystem services; fishery, commercial grasses for cultural and religious activities, roof making, handicraft, and animal feed; water for drinking, livestock and irrigation, and crop production. These ecosystem services are playing a very important role in the livelihoods of the poor living around the wetlands in the zone. Hence, both the natural and manmade wetlands of South Wollo Zone can contribute to a job opportunity for many jobless youths of the zone if sustainable wetland resource management is applied. Recently, these wetlands are being degraded highly due to less attention given to this fragile ecosystem by the local communities, government, and nongovernmental organizations. Therefore, stakeholders like Wollo University should be actively involved in the implementation of integrated wetland management in collaboration with other wetland

stakeholders. Full data on the impact of the current war (which happened between August and November, 2021) on the ecosystem functions and services of the wetlands of South Wollo is limited. Therefore, a well-designed study should be conducted to prepare and implement a restoration plan for these wetlands.

Data Availability

The data have been included in the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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