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Local Perceptions of Ecosystem Services, Degradation Causes, and Conservation Strategies: Denbiq Wetland, West Gojam, Ethiopia

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ABSTRACT

Wetlands are vital ecosystems that offer various ecological and socio-economic benefits. However, in Ethiopia, wetland degradation has been increasingly prevalent. This study focused on Denbiq Wetland in the West Gojam district, Bure Wereda, to assess its ecosystem services and the factors driving its degradation. Data were collected through structured questionnaires, interviews, group discussions, and field observations. A random sample of 202 households was surveyed, and data were analyzed using descriptive statistics (mean, percentage, frequency distribution) and binary logistic regression. The study found that Denbiq Wetland provides essential services, including provisioning services (e.g., fresh water, fodder, fruit), regulating services (e.g., water purification, temperature regulation), cultural services (e.g., recreation, tourism), and supporting services (e.g., habitat, organic matter accumulation). The leading causes of wetland degradation identified by respondents were the shortage of cropland, grazing land, declining upland crop productivity, and increasing agricultural demands. Logistic regression analysis revealed that household size negatively impacted the wetland, while landholding size and age had a positive effect. Respondents were aware of strategies to address the issues, including raising awareness, establishing buffer zones, and limiting grazing. The study emphasized the importance of legal support, proper planning, and sustainable management practices to protect wetlands and enhance upland agricultural productivity.

Keywords: *Deriving force, Denbiq, Ecosystem services, Sustainable use, Wetland management*

INTRODUCTION

Wetlands are among the most valuable and fragile ecosystems on earth, playing a crucial role in aquatic environments (Xu *et al.*, 2019). Their significant ecological and socio-economic benefits have led to a growing interest in the expansion of artificial wetlands to replicate the functions of natural ones. A study by *et al.* (2015) simulated the functions of natural wetlands in supporting human activities, aligning with earlier findings by Ghermandi et al. (2010). From a conservation and sustainable management perspective, wetlands are vital due to their rich biodiversity of plant and animal species (Wondie, 2018). These ecosystems offer both tangible and intangible resources, including fodder, fish, fuelwood, non-timber forest products, ecotourism opportunities, and flood regulation, all of which have traditionally contributed to human livelihoods (Lamsal *et al.*, 2015). The ecological and economic importance of wetlands is immense, as they provide essential services to local communities who rely on them. However, the environmental health and integrity of wetlands in Ethiopia remain largely unexplored (Tareke, 2023;Gebresllassie *et al.*, 2014).

Over the past thirty years, perceptions of wetlands have shifted significantly (Douglas, 2015). In the past, they were often regarded as unproductive "wastelands" due to the difficulties they posed for land development. However, in Ethiopia, wetlands have supported local communities for centuries, offering essential

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benefits crosswise the country. Their economic, social, and cultural contributions remain substantial, with many people depending on them for their livelihoods (Kakuru *et al.*, 2013; De Haan, 2012). Wetlands serve as transitional zones between land and water systems, making them highly productive and ecologically diverse. Despite their importance, they are among the most threatened ecosystems (Asnakew and Seyoum, 2022). These ecosystems provide a variety of ecosystem services, including provisioning services such as food, fresh water, biochemicals, genetic materials, fiber, and fuel. They also offer regulating services, including climate regulation, water purification, waste treatment, erosion prevention, and flood control. Additionally, wetlands contribute to supporting services like primary production, nutrient cycling, and soil formation, as well as cultural services that encompass recreation, aesthetic value, education, and spiritual significance (Junk *et al*., 2013). The benefits humans derive from ecosystems are collectively referred to as ecosystem services, as described by Junk *et al.* (2013).

Despite their immense value, wetlands in Ethiopia are opposite severe threats formerly are rapidly deteriorating due to widespread land use changes driven by agricultural expansion and the construction of water resource infrastructure (Gebresllassie *et al*., 2014). The capacity of these ecosystems to provide essential services has been undergoing unprecedented shifts, potentially at a rate unmatched in history. Research, including that of Wondie (2018), highlights a significant decline in the country's wetlands and their associated resources in recent years, mainly due to human-induced activities exacerbated by climate change. Contributing factors include economic imbalances, income inequality, inadequate cost accounting, policy shortcomings, market failures (such as unpriced ecosystem services), unclear property rights, and rapid population growth and urbanization, all of which have led to increased encroachment (Hoe and Lian, 2021). Although awareness of the importance of wetland conservation has grown, degradation continues to persist. The failure to acknowledge their factual value has motivated severe consequences for biodiversity, water quality, and climate regulation.

The perception of wetlands as "wastelands" or unproductive areas has influenced policies that permit their exploitation or conversion for other purposes, often overlooking the long-term environmental consequences (Russi *et al*., 2012; De Haan, 2012; Hollis, 1990). Simply designating wetlands as protected areas may not be adequate to counteract this trend. A more holistic approach that includes economic valuation, increased awareness, and active community participation in conservation efforts is necessary to safeguard these ecosystems (Lamsal et al., 2015). Moreover, promoting sustainable practices that balance conservation with development is crucial. The responsible use of wetland resources should be a key component of any comprehensive and effective policy. To ensure the sustainable management and protection of wetlands, it is essential to gather and analyze data on ecosystem services, factors driving change, and the resulting impacts at regional and local levels (Mmopelwa, 2006).

In Ethiopia, many wetlands are undergoing significant shrinkage and transformation, mainly due to limited knowledge and a general lack of awareness (Giweta and Worku, 2019). The primary drivers of wetland degradation include inadequate hydrological understanding,

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insufficient monitoring, poor watershed management, and the abandonment of highland-lowland interactions. These factors have led to drastic ecological changes, such as biodiversity loss, declining water quality, increased sedimentation, and reduced vegetation cover, all of which have been further exacerbated by human activities (Mengistu, 2020). Foremost threats to wetlands, especially in riparian and shoreline areas, include agricultural expansion, industrial pollution, drainage projects, and excessive resource extraction (Wondie, 2018). Despite their crucial role in supporting ecosystems and human livelihoods, wetlands are often overlooked Gupta & Tiwari, 2020).

For instance, in the Denbiq Wetland, issues such as agricultural encroachment, land degradation, pollution, excessive nutrient loading, intensive land use, and the loss of vegetation retention capacity have been identified. To mitigate these adverse impacts, the tender of ecohydrology is essential, emphasizing practical implementation and knowledge dissemination transfer (Zalewski *et al.*, 2022). While initiatives focused on ecosystem services have been introduced in this area, their ecological and socio-economic effects have yet to be totally evaluated. Therefore, this study seeks to analyze the ecosystem services of the Denbiq Wetland, identify the primary factors contributing to its degradation, and propose a comprehensive management plan to prevent further decline.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Denbiq Wetland, located in Bure Woreda, within the West Gojjam Zone of the Amhara Region, North West Ethiopia. Bure is approximately 415 km northwest of Addis Ababa and 150 km southwest of Bahir Dar, with geographic coordinates of 10°42'N and 37°4'E. The area receives substantial rainfall, with an annual mean ranging from 1386 to 1757 mm, and a balanced distribution pattern throughout the year (Erkihun *et al*., 2018). The western and northern regions of Bure experience higher rainfall than other parts; the region follows a mono-modal rainfall pattern, typically from May to September. Rainfall scarcity is not a key constraint on crop and livestock production in the area.

Agriculturally, Bure is distinctive within the Amhara Region due to its unique rainfall patterns, which significantly influence farming practices. Agro-ecologically, the area is classified into moist and wet lowland (10%), wet Woina-Dega (82%), and wet Dega (8%) zones. The altitude varies from 713 to 2604 meters above sea level (masl), with the highest elevations found in the northern part and the lowest in the southern part near the Nile Gorge (Adamu, 2019). Bure's long-term annual mean temperature ranges from 14°C to 24°C. The area's diverse climate and altitude enable farmers to cultivate a diverse variety of crops suited to different agro-ecological zones. The chief water source for Denbiq Wetland is the Denbiq spring, along with runoff and precipitation from the upper catchment. The wetland spans about 3123 hectares and originates from Tiya Tiya Kebeles, one of the areas assessed in this study (Figure 1). Vegetation cover in the wetland varies, with the northern region showing degradation due to intensive agriculture and grazing, while the eastern part retains natural shrubs and grasslands.

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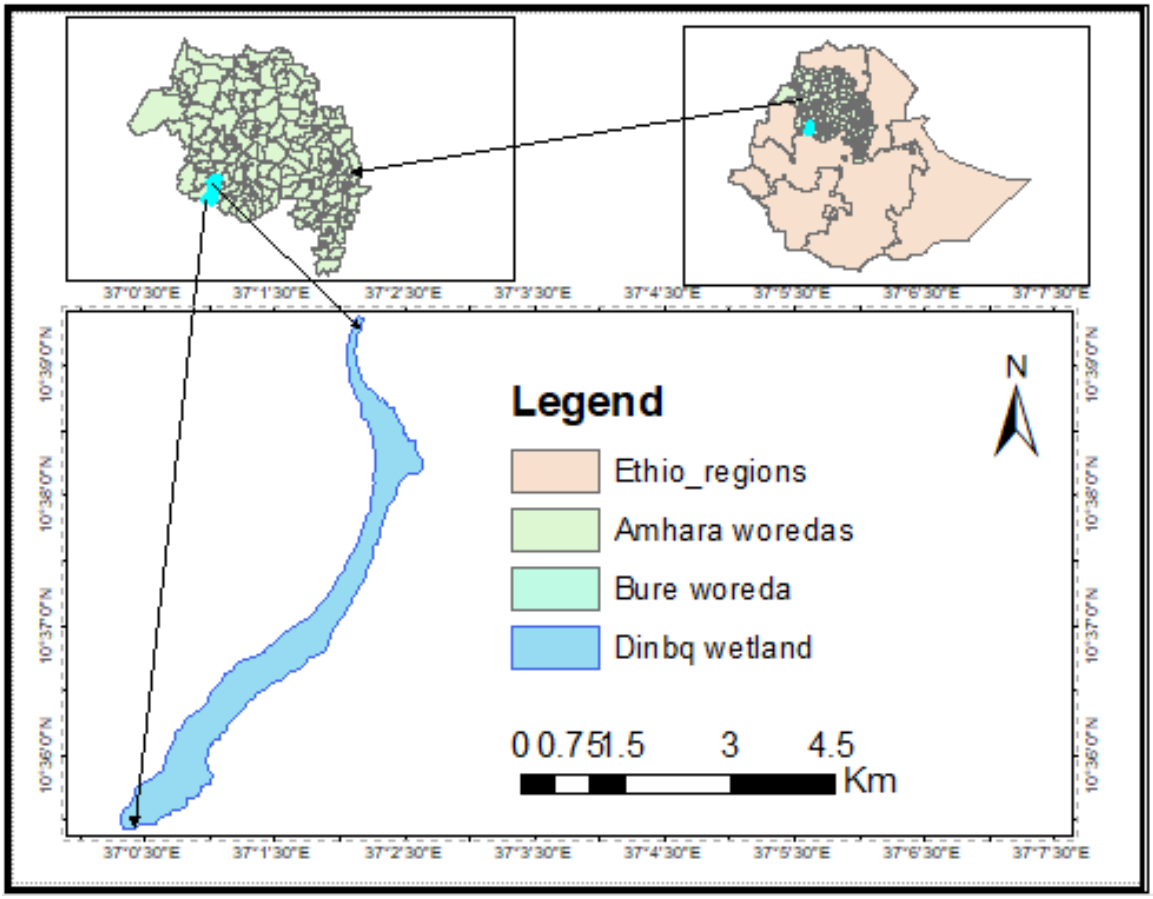

Figure 1: Map of the study area

Research Methods

The study was carried out in four selected kebeles: Wadera, Denbun, Tiya Tiya, and Alfa, chosen deliberately from a total of seven kebeles based on the extent of wetland coverage and its utilization. The research employed the ecosystem service classification proposed by Wallace (2007), which divides services into provisioning, supporting, regulating, and cultural categories. The methodology incorporated stakeholder consultations and direct field observations. Households served as the primary sampling unit for interviews, and a random sampling approach was used to ensure proportional representation from each kebele according to household numbers. Data collection involved structured questionnaires administered during household interviews and focus group discussions. The household survey aimed to assess community perspectives on wetland benefits and the effects of conservation interventions on their livelihoods. The questionnaire was designed to explore the community-wetland relationship, focusing on

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ecosystem services and the impact of environmental measures. This research is vital for understanding both the ecological and socio-economic implications of wetland conservation and restoration efforts. The interviews sought to capture individual and collective viewpoints on how people benefit from or are influenced by wetland functions, particularly in areas such as agriculture, fishing, and tourism. The study offers valuable insights into how ecosystem transformations affect local livelihoods.

The questionnaire used in this research was adapted from previous studies, particularly the work of (Anderson *et al*., 2013). It consisted of over 30 questions with multiple response options, structured into six sections. The first section gathered demographic and socio-economic details about household heads. The subsequent sections covered topics such as livelihood sources, awareness and perceptions of the wetland, and opinions on its sustainability and conservation efforts. Other sections examined the benefits derived from ecosystem services and identified the main factors driving changes in the wetland. To ensure clarity and cultural relevance, the questionnaire was translated into the local language, and structural improvements were performed before administration. A preliminary reconnaissance survey was conducted before data collection to test the questionnaire's validity and reliability. This pre-survey helped evaluate whether the questions generated the intended responses, confirmed that interview durations were appropriate, and revealed emerging patterns. The questionnaire was developed in alignment with the ecosystem service framework outlined by Mitsch and Gossilink (2000), with modifications tailored to the study area's specific context.

A combination of data collection methods was employed. Focus group discussions were conducted in each kebele, with six to eight participants chosen based on their reliance on wetland resources. Local leaders and development agents assisted in participant selection. Focus group discussions followed a structured checklist to examine ecosystem services, trends, and drivers of change. Additionally, 12 key informant interviews were held with individuals identified through Focus group discussions and local leadership. Field observations were carried out in two stages: the first phase took place during the pilot study to evaluate the physical environment and accessibility, while the second, more detailed phase occurred during the primary data collection period. This involved traversing the wetland and engaging in informal discussions with residents to gain further insights into their interactions with the ecosystem.

Sample Frame and Sampling Techniques

Four sample Kebeles surrounding the Denbiq wetland were identified randomly, and the numbers of household respondents from the four selected kebeles were determined based on the proportional sample size formula, which was adopted from Yamane (1976) method with a ±7% level of precision.

$$n = \frac{N}{[1+N(e2)]} \qquad (1)$$

Where n is the required total sample size of respondents, N is the total household (22771) in all sample Kebeles, and e is the minimum level of precision (0.07), where the confidence level is 95% at $P = \pm 5$ (maximum variability).

$$n = \frac{22771}{[1+22771(0.0049)]} = 202$$

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Accordingly, a total of 202 households, 50 (24%) from Alefa kebele, 44 (21.5%) from Tiya Tiya, 60 (32%) from Denbun, and 47 (22.5%) from Wadera kebele were randomly selected for interview (Table 1). In addition, 12 key informants and four Focus group discussions (each group consisting of 6 individuals) were involved and participated in the study. Members of the Focus group discussions were selected purposively.

Table 1. Total Household Heads (HHH) and Sample Size of HHH

		Sample HHH		
Kebeles	Total HHH	Males	Females	Total Percentage (%)
Alefa	5,563	46	4	24
Tiya Tiya	4,575	38	6	21.5
Wadera	5,326	42	5	22.5
Denbun	7,307	54	6	32
Total	22,771	181	21	100

Data Analysis

The data collected from the household survey were analyzed using the Statistical Package for Social Scientists, version 26.0. The analysis involved both descriptive statistics and logistic regression to interpret the findings effectively. Descriptive statistics were used to summarize general trends, while a binary logistic regression model was applied to explore relationships between variables. This approach provided a comprehensive understanding of both broad patterns and deeper variable interactions. The regression model utilized was based on the linear regression framework outlined by (Gujarat, 2004);

$$Y = a + B1X1 + B2X2 + B3X3 + B4X4 + B5X5 + B6X6 + B7X7 + B8X8 + \mu \quad (2)$$

where: Y = dependent variable (degradation/loss of wetlands), α = constant, X1 – X8 are independent variables; that is, X1 = Location, and, X2 = age of the respondents, X3 = gender of the respondents, X4 = family size, X5= educational level, X6= Occupation, X7= land size, X8= Tropical livestock unit (TLU) and μ = error term (residual).Values β1 – β8 are the parameters estimated (i.e., the respective coefficients of the independent variables X1 – X8. Focusing on statistical significance and effect size allows us to identify which household factors or socio-economic characteristics played a key role in wetland degradation. Thus, a procedure was performed to test the null hypothesis, β1 = β2 = β3 = β = n, against the alternative hypothesis, which is that the null hypothesis is not true in at least one case. The data obtained from the focus group discussion

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and field observation were written in the form of verbal/narrative information.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics and Livelihood Conditions of Sampled Households

Understanding the demographic structure of local communities is essential for effective policy-making, strategic planning, and sustainable natural resource management, particularly in wetland conservation and restoration. The findings from the structured questionnaires administered to 202 household heads (Table 2) reveal a predominance of male-headed households (89.6%), with female-headed households accounting for only 10.4%. The average age of respondents was 40 years, ranging between 25 and 61 years. Education levels varied significantly, with 17.8% of respondents being illiterate, 26.7% having completed primary education, 36.8% attaining secondary education, and 16.8% pursuing college-level studies. The dominance of agriculture as the primary occupation (83.7%) underscores the crucial role wetlands play in supporting local livelihoods, with other professions, such as government employment and self-employment, contributing to a lesser extent. These trends highlight the direct dependence of communities on wetland resources for economic stability and sustenance.

Wetlands are dynamic socio-ecological systems that provide provisioning, regulating, and cultural services to local communities (Crul *et al*., 2011). For the past four decades, Denbiq Wetland has been a significant source of livelihood, offering essential resources for agricultural activities and ecosystem benefits. The study findings indicate that 94.5% of respondents engage in crop farming, while others participate in livestock rearing (32.4%), vegetable farming (59.7%), small-scale trade (4.5%), and the harvesting of wetland resources such as reeds, thatching grass, and wild fruits (Table 2). These multiple livelihood activities underscore the wetlands' role as a critical economic asset for the region, reinforcing their significance in community well-being and food security. Similar trends have been observed in other studies emphasizing the economic and ecological importance of wetland ecosystem services (Yilma, 2019a; Zekarias *et al*., 2021; Camacho-Valdez *et al*., 2022).

However, human activities have also contributed to wetland degradation, as evidenced by the varying conditions across the studied wetlands. Dembun and Tiya Tiya wetlands have been significantly affected by agricultural expansion, livestock grazing, drainage, and seasonal farming, particularly during the dry season. Notably, the Tiya Tiya wetland lacks buffer vegetation, making it more vulnerable to degradation, whereas the Debun Kebele wetland retains some ecological integrity with Nile grass (Berbeza) coverage. In contrast, the Alefa and Wadera wetlands exhibit a relatively intact ecological structure, dominated by Typha lotifolia and Cyperus papyrus reed species, which are crucial for maintaining biodiversity and hydrological stability. These variations in vegetation cover demonstrate the differing degrees of human impact on wetland sustainability and the need for targeted conservation strategies.

The economic reliance on wetlands, as shown by the significant proportion of household

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income derived from wetland-related activities, highlights the necessity of sustainable management practices. Farming, livestock husbandry, land leasing, and the agriculture of fruits, vegetables, and papyrus reeds are vital economic activities that sustain local communities (Table 2). These findings align with global research emphasizing the universal role of wetlands in delivering essential ecosystem services (Thapa *et al*., 2020). Given their fundamental importance in mutually human livelihoods and environmental well-being, balancing resource utilization with conservation efforts is imperative. Applying sustainable wetland management strategies will be crucial in mitigating degradation while ensuring continued socio-economic benefits for the local communities.

Table 2. Socio-demographic information of respondents (n=202)

		Participated respondents	
		Number	(%)
Sociodemographic variable	Category		
Gender	Male	181	89.6
	Female	21	10.4
Age	<40	92	45.5
	41-50	68	33.7
	>51	42	20.8
Education	Can't read and write	36	17.8
	Primary education	54	26.7
	Secondary education	78	38.6
	College	34	16.8
Residence	Born	180	89.1
	Immigrants	22	10.9
Occupation	Farmer	169	83.7
	Gov't employed	6	3
	Merchant and farmer	27	13.4
Source of income	Crop production	192	94.5
	Vegetables and fruits	108	59.7
	Livestock	45	32.4
	Trade	9	4.5

Respondent's Livestock Population and Land Holding in Hectare

Land ownership and access to income vary significantly among households in the study area, influencing their dependence on wetlands for

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sustenance. The maximum land holdings recorded were 4 ha for cultivated land, 5 ha for grazing land, and 1.75 ha for homesteads, while some households had no land at all (Table 3). With an average family size of 5.19 members, limited land availability, and increasing population pressure near wetlands, many households remain reliant on these ecosystems for food and income, particularly in the absence of alternative livelihood options. Previous research has highlighted that such dependence is exacerbated by changing weather patterns, which further limit agricultural productivity and push communities toward wetland resource exploitation (Turyahabwe *et al*., 2013).

Livestock ownership also plays a crucial role in shaping wetland dependence. While some households own up to 19 livestock, others have none. Wetland-based grazing primarily supports commercial beef cattle from local grazers, making wetlands essential for livestock production. Households with large herds are mainly dependent on wetlands for fodder and water, while those without livestock still utilize wetland resources, such as grasses (cheff) for sale and wetland water for vegetable farming and domestic use. However, increased livestock grazing exerts pressure on wetland ecosystems, contributing to soil compaction, which accelerates water runoff and increases flood risks. Additionally, livestock activities may lead to nutrient overload and fecal coliform contamination in water bodies, posing environmental and public health risks (Fisher *et al.*, 2011). These findings underscore the need for sustainable grazing management and alternative livelihood strategies to mitigate wetland degradation while ensuring economic resilience for local communities.

Table 3. Household characteristics, livestock population, and landholding in hectares

Variables	Minimum	**Maximum**	**Mean ±S.d**
Family size	1	12	5.19±1.9
Number of livestock	0	19	7.2±5.1
Cultivated land (ha)	0.15	4	1.38±0.89
Grazing land (ha)	0.1	5	0.59±0.38
Homestead (ha)	0	0.5	0.15±0.12
Woodlot (ha)	0	1.75	0.44±0.22

Ecosystem Service in Denbiq Wetland

The recognition of the Denbiq wetland's importance in supporting livelihoods is a positive indication of its perceived value among local communities. Wetlands provide essential ecosystem services, contributing to both socio-economic well-being and ecological balance (Erwin, 2009). In this study, these services were classified into provisioning, regulating, cultural,

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and supporting categories, ensuring a comprehensive assessment through field observations, household surveys, key informant interviews, and focus group discussions. However, despite the wetland's crucial role, a significant proportion of respondents (36.6%) lacked awareness of its ecological and socio-economic benefits (Table 4). The study found that awareness levels were significantly associated with education and locality ($p<0.01$; Table 4), with more formally educated individuals demonstrating a better understanding of wetland ecosystem services.

Education has long been recognized as a key factor in fostering environmental awareness and conservation attitudes (Hnatyuk *et al*., 2024). Variations in educational attainment across the sampled kebeles likely contributed to differences in respondents' understanding of wetland benefits. Higher levels of education generally equip individuals with the knowledge and skills necessary to manage natural resources effectively, promoting sustainable practices and influencing others toward conservation efforts (Law *et al*., 2017). Moreover, education not only enhances environmental stewardship but also empowers communities to explore alternative livelihoods, reducing direct dependence on wetlands and alleviating pressure on these fragile ecosystems. Educated communities may also be more receptive to discussions on population management, which plays a critical role in minimizing long-term environmental strain (Bandura, 2002). These findings highlight the need for targeted educational programs and awareness campaigns to bridge knowledge gaps and encourage sustainable wetland management practices.

Table 4. Respondents' level of awareness of ecosystem services from Denbiq Wetland

Response	Frequency	%	Chi-square ($\chi2$) educational level	Respondent locality
Fully Informed	23	11.4	26.6*	24.4*
Informed	48	23.8		
Moderately Informed	57	28.2		
Not informed	74	36.6		

*$\chi2$ significant at $p<0.01$

Provisioning Services

The high reliance on the Denbiq wetland for livelihood is evident from the strong recognition of its provisioning services among respondents. This wetland serves as a crucial resource hub, supplying water for livestock (70.9%), irrigation (40%), and household needs (60.4%). Additionally, many households depend on it for grazing and fodder (65.3%), wood for construction, fuel, and agriculture (30.5%), thatching grass (48.5%), and medicinal plant collection (10.2%) (Table 7). These findings align with previous research on rural Ethiopian communities, where wetlands significantly contribute to local livelihoods (Mulatu et al., 2014). Most respondents rely on the wetland for cattle grazing, and many also harvest reeds for sale or use in crafting traditional items

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such as boats, baskets, mattresses, and ceremonial decorations. Similar studies in Uganda (Turyahabwe *et al.*, 2013). highlight how wetlands enhance food security by providing marketable resources that generate income. Among the various uses, livestock grazing emerged as the most widespread, reinforcing the wetland's role in supporting pastoral communities.

Beyond providing essential resources for sustenance and income, the Denbiq wetland also supports cultural traditions by offering materials like ceremonial reeds and thatching grass (Table 7). Comparable trends have been observed in other Ethiopian wetland-dependent communities, where 59% of farmers collect grass for fodder and 20% utilize vegetation for livestock feed (Yilma, 2019b) This reliance underscores the wetland's multifunctional importance, not only as an economic asset but also as a cornerstone of cultural and ecological practices.

Agriculture is the primary source of income for many households, particularly in Alefa and Wadera, where nutrient-rich soils facilitate crop cultivation due to sediment accumulation from periodic flooding (Verhoeven & Setter, 2010). Many view farming as a more lucrative option compared to other economic activities. However, while wetlands boost agricultural productivity, excessive fertilizer and pesticide use pose serious environmental threats, contributing to water contamination and loss of biodiversity. Human-induced pollution continues to degrade these ecosystems, with declining water quality severely impacting wetland flora and fauna (Porte & Gupta, 2017). These findings highlight the urgent need for sustainable agricultural practices that preserve wetland integrity while supporting livelihoods, ensuring long-term ecological and economic benefits.

Regulating Services

Denbiq Wetland provides vital regulating services that contribute to environmental stability, including carbon sequestration (50.5%) for temperature regulation, water purification (61.6%), erosion control (70.5%), and sediment retention (47.4%) (Table 7). These functions are crucial for managing water resources and enhancing climate resilience. By storing excess water during the wet season and gradually releasing it in drier periods, the wetland helps maintain a steady water supply for local communities, supporting their adaptation to changing climatic conditions. Additionally, its natural filtration process improves water quality by removing pollutants and recycling nutrients (Demissie *et al*., 2015). Research by Zalewski *et al*. (2022) also highlights the importance of wetlands in maintaining water stability and purity. Similarly, studies on Geray Wetland emphasize its role in regulating local temperatures, as differences in air pressure between land and water create cooling breezes (Tareke,2023: Zhang *et al*., 2022).

Community awareness of these ecological benefits varies, with more than half of respondents recognizing the wetland's role in flood mitigation, water purification, and sediment retention (Table 7). Among these services, erosion control received the highest level of acknowledgment (70.5%), whereas sediment retention was less widely understood (47.4%). Field assessments and expert insights suggest that wetlands in more urbanized areas tend to provide stronger pollution control services, likely due to their function in filtering contaminants from surface runoff. These findings highlight the importance of increasing public awareness of wetland benefits and promoting

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sustainable conservation efforts to ensure their long-term ecological and economic contributions.

Cultural Services

Denbiq Wetland offers valuable cultural services, with local households recognizing its importance for various purposes, including recreation (60.4%), spiritual activities (35.6%), and educational or research activities (4%) (Table 7). The degree of connection to the wetland's cultural value was influenced by the length of time respondents had lived in the area, with long-term residents expressing a deeper attachment to the land ($P<0.05$; Table 5). Cultural Ecosystem Services refer to the intangible benefits people receive from ecosystems, such as spiritual enrichment, intellectual development, recreation, and aesthetic enjoyment (Martínez Pastur *et al*., 2016). Many respondents emphasized the wetland's role in providing recreational opportunities, highlighting its contribution to local well-being. The wetland, with its diverse wildlife and unique landscapes, not only supplies crucial resources like water and food but also offers significant cultural and recreational value. This finding is supported by Zekarias *et al.* (2021), who observed that wetlands contribute to cultural practices, tourism, aesthetic appreciation, and recreational activities, including swimming, as well as ceremonial events such as weddings.

Interestingly, those who had lived near the wetland for longer periods showed a stronger cultural and spiritual connection, which influenced how they perceived the wetland's value. However, in recent years, there has been a noticeable decline in the spiritual and cultural practices linked to Denbiq Wetland. This shift could reflect changing societal values, evolving local customs, or the effects of external factors such as environmental degradation or modernization. A weakening of these cultural ties can undermine community-led conservation efforts, as these practices are often integral to the sustainable management of natural resources (Moges *et al*., 2016). Therefore, maintaining the cultural significance of the wetland is essential for both its ecological preservation and its role in supporting the local community.

Table 5. Respondents' perception of cultural ecosystem services as influenced by duration of residence in Denbiq wetland

	Cultural Service					
Age categories (Years)	Spiritual and religious values	Recreational	Aesthetic	Educational	Total	Chi-square ($\chi2$
<40	8	29	5	11	53	25.504*
41-50	10	9	8	13	40	
>51	25	32	23	29	109	
Total	43	70	55	53	202	

*$\chi2$ significant at $p<0.05$

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Supporting Services

A considerable number of respondents acknowledge the ecological value of Denbiq Wetland, recognizing its role in supporting various bird species and other wildlife. This emphasizes the wetland's broader environmental significance, extending beyond its direct benefits to humans to include critical support for local biodiversity. The wetland provides several essential supporting services, such as serving as breeding grounds (45.4%) and habitats (50.2%) for a wide variety of wetland plants and animals, aiding soil formation through organic matter accumulation (45.2%), and contributing to nutrient cycling (57.2%) (Table 7). These services sustain a diverse range of species, with Denbiq Wetland home to about 65 bird species, including the common crane, great white pelican, yellow-billed duck, Egyptian goose, African jacana, wattled crane, and crowned crane. The wetland also supports various fish populations. Focus Group Discussions (FGDs) and interviews highlighted the wetland's importance as a habitat for numerous bird and wildlife species, underscoring its role in biodiversity conservation (Anderson *et al*., 2013). Ethiopia has 73 important bird areas, 43 of which are wetlands that provide sanctuaries for endemic, endangered, and vulnerable species (Tamrat & Bekele, 2014). While these supporting services are vital, they tend to impact the local population indirectly and require some ecological knowledge to fully appreciate. The age of respondents was found to significantly affect their recognition of these services significantly ($P<0.05$; Table 6). This may be because individuals with higher education levels, such as those who have completed secondary education or attended college (typically between the ages of 30 and 51), are more likely to understand and recognize the supporting services provided by the wetland. This highlights the role of education in fostering a deeper awareness and appreciation of the ecological importance of wetlands.

Perception of Driving Forces of the Degradation of Denbiq Wetlands

The degradation and loss of Denbiq Wetland can primarily be attributed to human activities, particularly the local community's heavy reliance on the wetland's resources and services (Mohammed and & Mengist, 2018; Ballut-Dajud *et al*., 2022). Several factors have been identified as contributing to the deterioration of the wetland, including farmland scarcity (22.3%), inadequate grazing land (86%), lack of awareness (77%),

Table 6. Perception of supporting ecosystem services as influenced by respondents' age

	supporting ecosystem service				
Age categories (Years)	Primary production	nutrient cycling	Soil formation	Total	Chi-square ($\chi 2$)
<40	18	6	33	57	
41-50	27	12	27	65	
>51	38	8	33	80	21.564*
Total	83	26	93	202	

*$\chi 2$ significant at $p<0.05$

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Table 7. Main ecosystem services (ESs) of Denbiq wetland based on household perception

Ecosystem service provided			
1. Provisioning	N	%	Ranks
Water for domestic use	13	60.4	3
Water for irrigation	8	40	6
Water for livestock drinking	123	70.9	1
Fodder and grazing service	35	65.3	2
Wood for fuel	7	30.5	7
Medicinal plants	11	10.2	4
Hatching grass	9	48.5	5
2. Regulating service			
Temperature regulation	42	50.5	3
Water purification	44	61.6	2
Sediment retention	34	47.4	4
Erosion control	82	70.5	1
3. Cultural services			
Recreational services	122	60.4	1
Spiritual services	72	35.6	2
Educational and research services	8	4	3
4. Supporting services			
Habitat	61	50.2	2
Nursery	15	45.4	4
Accumulation of organic matter	51	45.2	3
Nutrient cycling	75	57.2	1

unclear boundaries (70.3%), youth unemployment (58.1%), lack of alternative livelihoods (51.9%), low productivity of nearby land (30.2%), deforestation (11.2%), sedimentation (47%), and settlement expansion (13.7%) (Fig. 2). These factors are consistent with findings from other studies, which have recognized similar drivers of wetland degradation and the subsequent loss of ecosystem services (Bedo, 2022).

According to household surveys and focus group discussions, significant changes have occurred in the region over the past 10 to 20 years, with agricultural expansion, particularly through irrigation near wetland areas, exacerbating the degradation. The use of agrochemicals, such as pesticides, herbicides, and fertilizers, has led to pollution and nutrient overload, further stressing the wetland ecosystem (Jing *et al*., 2008). Research by Noriko *et al*. (2012) also identified the scarcity of cropland as a major cause of wetland degradation, accounting for 73% of wetland loss in developing countries. Similarly, Jogo & Hassan (2010) highlighted that improper practices, such as overuse of wetland resources and waste discharge, have long-term negative effects on wetland ecosystems.

Local focus group participants and key informants observed a gradual reduction in the size and water levels of Denbiq Wetland, linking this

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decline to increased agricultural activities, sedimentation, heavy grazing, and unsustainable resource extraction. Long-term residents noted visible environmental changes over the past five to ten years, emphasizing the persistence of these issues. This localized knowledge is crucial for monitoring the health of the wetland; however, it also highlights the urgent need for formalized monitoring systems and enhanced conservation efforts. Additionally, key informants pointed out the lack of clear regulations and enforcement, as well as the insufficient commitment from local authorities, creating a governance gap that exacerbates the pressure on the wetland. Without strong governance structures, the wetland remains highly susceptible to overexploitation and further depletion.

Variables such as household size, landholding size, livestock population, and age significantly influence the Denbiq wetland ecosystem, with a 99% confidence level (Table 8). Among these variables, household size showed a notable negative effect, with a beta coefficient of -0.873 and a significance value of 0.006. Conversely, the age of the household head, landholding size, and livestock population had positive impacts, with beta coefficients of 1.93, 3.02, and 0.31, respectively, and significance values of 0.009, 0.009, and 0.008, all indicating statistically significant positive relationships with the wetland ecosystem at a 99% confidence level (Table 8). This suggests that larger household sizes are associated with a higher likelihood of utilizing wetland resources and contributing to its degradation. As family sizes grow, the demand for food increases, leading to greater pressure on the wetland, often resulting in its conversion for agricultural use (Van Asselen *et al*., 2013). Consequently, larger households may negatively affect the sustainable management of the wetland.

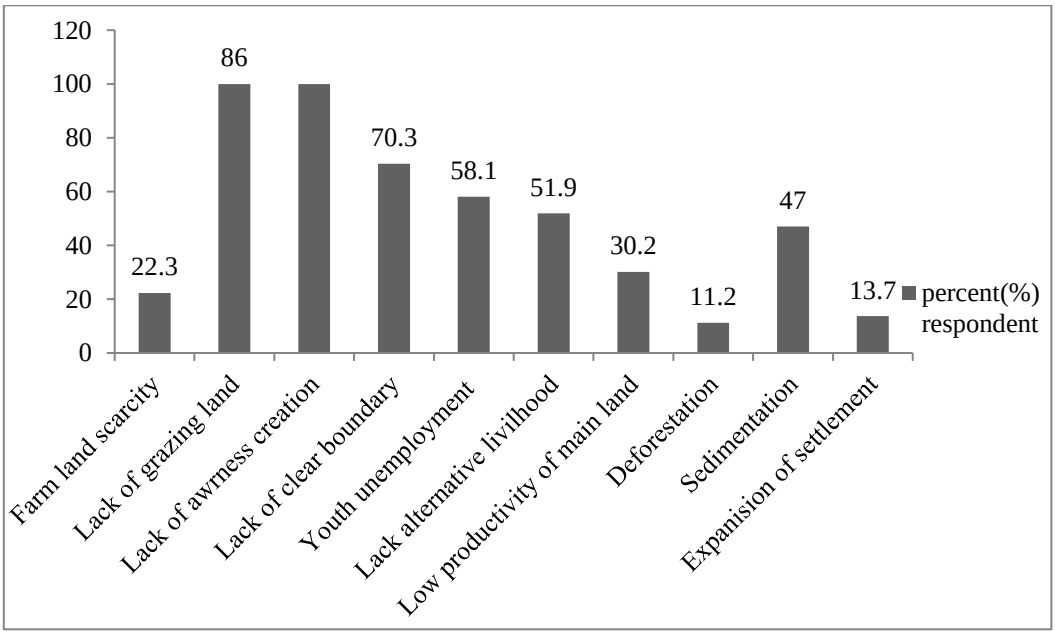

Figure 2: Major driving forces for the degradation/loss of Denbiq wetland based on the proportion (%) of respondents.

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Table 8. Binomial logistic regression for determining factors affecting wetland sustenance

	Beta coefficient			statistics	95% C.I for EXP(B)		
Variables	B	SE	df	Sg	EXP(B)	Lower	Upper
Location	-0.209	0.873	1	0.658	0.82	0.183	3.519
Sex	1.578	0.981	1	0.217	3.91	0.735	24.35
Age	1.932	0.808	1	0.009	5.254	1.845	14.95
Family size	-0.873	0.364	1	0.006	0.597	0.358	0.893
Educational level	1.298	1.349	1	0.023	3.852	0.326	42.463
Occupation	-2.147	1.812	1	0.324	0.219	0.009	4.102
Landholding(ha)	3.025	0.903	1	0.009	8.813	1.876	40.703
Number of livestock	0.312	0.092	1	0.008	1.522	1.321	1.928
Constant	0.237	2.917	1	0.987	1.892		

a. Dependent variable: Wetland sustenance/degradation)

Actions Recommended by the Local Community

A large portion of respondents displayed varying degrees of awareness regarding the challenges faced by Denbiq Wetland and potential solutions with 11.4% being well-informed, 23.8% informed, and 28.2% moderately informed (Table 4). To address the wetland's degradation, several conservation strategies were suggested, including raising awareness (64%), reducing grazing in the wetland area (41%), creating buffer zones (38.39%), preventing deforestation (12.42%), installing shoreline fencing (49.23%), and regulating the use of wetland water for irrigation (3%) (Table 9). A consistent theme among respondents was the importance of educating both residents and the broader public on the various benefits of wetlands, such as water purification, flood regulation, biodiversity support, and carbon sequestration. Education initiatives could play a crucial role in changing public attitudes and minimizing harmful practices that endanger wetland ecosystems (Marambanyika *et al*., 2021).

Beyond raising awareness, many respondents pointed out the need for alternative grazing land to reduce pressure on the wetland, helping to prevent overgrazing and soil erosion. Recommended measures include the implementation of managed grazing programs, rotational grazing, and the creation of community grazing reserves

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(Marambanyika et al., 2021; Briske et al., 2011; Donaghy *et al*., 2021). Additionally, to reduce the overuse of wetland resources like grazing areas and water extraction, respondents suggested promoting alternative livelihoods, such as sustainable farming, eco-tourism, and small-scale businesses that have a lower environmental impact. They also recommended addressing sedimentation through erosion control methods and sediment traps to help maintain the wetland's health and depth. By integrating these conservation strategies, the community could contribute significantly to preserving the ecological integrity and sustainability of Denbiq Wetland.

Table 9: Wetland conservation measures suggested by respondents

wetland conservation measure	Frequency	Percent
Awareness creation	75	64
Reducing grazing around the Wetland	53	41
Develop buffer zones	44	38.39
Avoid deforestation	24	12.42
Shoreline fencing	64	49.23
Controlling the use of wetland water for irrigation	12	3

CONCLUSION AND RECOMMENDATIONS

Denbiq Wetland is a crucial provider of ecosystem services that sustain the livelihoods and well-being of local communities, offering provisioning, regulating, cultural, and supporting functions. However, the wetland is undergoing significant degradation due to unsustainable practices such as overgrazing, agricultural encroachment, sedimentation, and excessive resource use. These activities are undermining the wetland's capacity to maintain biodiversity and support critical ecosystem functions, endangering essential resources. While the wetland supplies valuable goods like grazing land, water, and firewood, improper management and overuse are leading to long-term environmental damage. Fortunately, 82.59% of surveyed households expressed strong support for wetland rehabilitation, reflecting the community's keen interest in restoring its health. Effective rehabilitation will require active community engagement and addressing the socio-

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economic and institutional factors influencing households' willingness to participate. Proposed conservation measures include improving upland agricultural productivity, creating alternative livelihoods, raising awareness, installing shoreline fencing, and conserving the wetland. A holistic approach combining restoration, sustainable management, and community-driven initiatives is crucial for safeguarding Denbiq Wetland and ensuring the continued delivery of its ecosystem services.

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REFERENCE

Adamu, H. (2019). *Monitoring Dairy Production , Marketing and Milk Quality in and Around Burie Town : Case of Dairy Cooperatives*. *December 2016*.

Anderson, T., J., Davis, & A., C. (2013). Wetland techniques: Volume 3: Applications and management. In *Wetland Techniques: Volume 3: Applications and Management*. https://doi.org/10.1007/978-94-007-6907-6

Asnakew, E., & Seyoum, A. (2022). Ecological Impacts of Ecohydrological Intervention on the Wetlands Along the Southeastern Shore of Lake Tana, Ethiopia. *Journal of Global Ecology and Environment*, *16*(1), 1–13. https://doi.org/10.56557/jogee/2022/v16i17618

Ballut-Dajud, G. A., Herazo, L. C. S., Fernández-Lambert, G., Marín-Muñiz, J. L., Méndez, M. C. L., & Betanzo-Torres, E. A. (2022). Factors Affecting Wetland Loss: A Review. *Land*, *11*(3). https://doi.org/10.3390/land11030434

Bandura, A. (2002). Environmental Sustainabiltiy by Sociocognitive Deceleration of Population Growth. *Psychology of Sustainable Development*, *2002*, 209–238. https://doi.org/10.1007/978-1-4615-0995-0_11

Bedo, D. (2022). *Perception-based Assessment of Ecosystem Services of Wetlands in Abijata-Shalla National Park in the Central Rift Valley of Ethiopia*. https://doi.org/10.4172/2157-7625.1000334

Briske, D. D., Derner, J. D., Milchunas, D. G., & Tate, K. W. (2011). An Evidence-Based Assessment of Prescribed Grazing Practices. *Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps*, 21–74.

Camacho-Valdez, V., Rodiles-Hernández, R., Navarrete-Gutiérrez, D. A., & Valencia-Barrera, E. (2022). Tropical wetlands and land use changes: The case of oil palm in neotropical riverine floodplains. *PLoS ONE*, *17*(5 May), 1–23. https://doi.org/10.1371/journal.pone.0266677

Crul, M. R. J., Schneider, J. ;, & Lelie, F. (2011). VU Research Portal Super-diversité. *Springer Netherlands*, *1*, 323–333. https://doi.org/https://doi.org/10.1007/978-90-481-9659-3_66

De Haan, L. J. (2012). The livelihood approach: A critical exploration. *Erdkunde*, *66*(4), 345–357. https://doi.org/10.3112/erdkunde.2012.04.05

Demissie, F., Ab, T., Addis, M., & Bc, D. (2015). Human Development and Wetland Conservation Policy. *CRDEEPJournals International Journal of Environmental Sciences Fikirte & Mare*, *4*(3), 126–138. www.crdeep.com

Donaghy, D., Bryant, R., Cranston, L., Egan, M., Griffiths, W., Kay, J., Pembleton, K., &

ISSN: 2354-5844(Print)
ISSN: 2477-5223 (Online)

Tozer, K. (2021). Will current rotational grazing management recommendations suit future intensive pastoral systems? *NZGA: Research and Practice Series*, *17*, 205–222. https://doi.org/10.33584/rps.17.2021.3464

Douglas, I. (2015). Ecosystems and Human Well-Being. In *Reference Module in Earth Systems and Environmental Sciences*. Elsevier. https://doi.org/10.1016/b978-0-12-409548-9.09206-x

Erkihun, Getaneh, & Assaye. (2018). *Prevalence of Bovine Trypanosomosis in Bure and College of Veterinary Medicine and Agriculture ,. 6*(3), 164–173. https://doi.org/10.5829/idosi.apg.2015.6.3.95146

Erwin, K. L. (2009). Wetlands and global climate change: The role of wetland restoration in a changing world. *Wetlands Ecology and Management*, *17*(1), 71–84. https://doi.org/10.1007/s11273-008-9119-1

Fisher, B., Bradbury, R. B., Andrews, J. E., Ausden, M., Bentham-Green, S., White, S. M., & Gill, J. A. (2011). Impacts of species-led conservation on ecosystem services of wetlands: Understanding co-benefits and tradeoffs. *Biodiversity and Conservation*, *20*(11), 2461–2481. https://doi.org/10.1007/s10531-011-9998-y

Gebresllassie, H., Gashaw, T., & Mehari, A. (2014). *Wetland Degradation in Ethiopia: Causes, Consequences and Remedies*. *4*(11). www.iiste.org

Ghermandi, A., Van Den Bergh, J. C. J. M., Brander, L. M., De Groot, H. L. F., & Nunes, P. A. L. D. (2010). Values of natural and human-made wetlands: A meta-analysis. *Water Resources Research*, *46*(12), 1–12. https://doi.org/10.1029/2010WR009071

Giweta, M., & Worku, Y. (2019). *" Reversing the Degradation of Ethiopian Wetlands ": Is it Unachievable Phrase " Reversing the Degradation of Ethiopian Wetlands ": Is it Unachievable Phrase or A Call to Effective Action ? October*. https://doi.org/10.19080/IJESNR.2018.14.555898

Gujarat, D. (2004). *Basic economtrics 4TH ed.* (pp. 169–217.). Report of the Evaluative Committee for Econometrica," Econometrica.

Hnatyuk, V., Pshenychna, N., Kara, S., Kolodii, V., & Yaroshchuk, L. (2024). Education's role in fostering environmental awareness and advancing sustainable development within a holistic framework. *Multidisciplinary Reviews*, *7*(Special Issue). https://doi.org/10.31893/multirev.2024spe012

Hoe, L. I., & Lian, C. J. (2021). Legal Framework on the Conservation Issue of Pulau Kukup National Park in Johor, Malaysia. *Journal of Sustainability Science and Management*, *16*(5), 115–123. https://doi.org/10.46754/JSSM.2021.07.009

Hollis, G. E. (1990). Les effets sur l'environnement de la mise en valeur des zones humides dans Ses regions arides et semi arides. *Hydrological Sciences Journal*, *35*(4), 411–428. https://doi.org/10.1080/02626669009492443

Ibrahim Mohammed and, & Minwyelet Mengist. (2018). Status, Threats and Management of Wetlands in the Lake Tana Sub-basin: A Review. *J. Agric. Environ. Sci*, *3*(2), 15–29.

Jing, Qi, Bouman, Bas, Keulen, V., Herman, Hengsdijk, Huib, Cao, Weixing, Dai, & Tingbo. (2008). Disentangling the effect of environmental factors on yield and nitrogen uptake of irrigated rice in Asia. *Agricultural Systems*, *98*(3), 177–188. https://doi.org/10.1016/j.agsy.2008.06.005

Jogo, W., & Hassan, R. (2010). Balancing the use of wetlands for economic well-being and ecological security: The case of the Limpopo wetland in southern Africa. *Ecological Economics*, *69*(7), 1569–1579. https://doi.org/10.1016/j.ecolecon.2010.02.021

Junk, W. J., An, S., Finlayson, C. M., Gopal, B.,

ISSN: 2354-5844(Print)
ISSN: 2477-5223 (Online)

Květ, J., Mitchell, S. A., Mitsch, W. J., & Robarts, R. D. (2013). Current state of knowledge regarding the world's wetlands and their future under global climate change: A synthesis. In *Aquatic Sciences* (Vol. 75, Issue 1, pp. 151–167). https://doi.org/10.1007/s00027-012-0278-z

Kakuru, W., Turyahabwe, N., & Mugisha, J. (2013). Total economic value of wetlands products and services in Uganda. *The Scientific World Journal*, *2013*. https://doi.org/10.1155/2013/192656

Lamsal, P., Pant, K. P., Kumar, L., & Atreya, K. (2015). Sustainable livelihoods through conservation of wetland resources: A case of economic benefits from Ghodaghodi Lake, western Nepal. *Ecology and Society*, *20*(1). https://doi.org/10.5751/ES-07172-200110

Law, M. M. S., Hills, P., & Hau, B. C. H. (2017). Engaging Employees in Sustainable Development – a Case Study of Environmental Education and Awareness Training in Hong Kong. *Business Strategy and the Environment*, *26*(1), 84–97. https://doi.org/10.1002/bse.1903

Marambanyika, T., Mupfiga, U. N., Musasa, T., & Ngwenya, K. (2021). Local perceptions on the impact of drought on wetland ecosystem services and associated household livelihood benefits: The case of the driefontein ramsar site in Zimbabwe. *Land*, *10*(6). https://doi.org/10.3390/land10060587

Martínez Pastur, G., Peri, P. L., Lencinas, M. V., Soler, R., Bahamonde, H. A., Valenzuela, A. E. J., Cabello, J. L., & Anderson, C. B. (2016). Investigación socio-ecológica a largo plazo en la Patagonia Austral: Estrategias interdisciplinarias para lograr la conservación de los recursos naturales a través de un manejo sustentable bajo escenarios de cambio global. *Ecosistemas*, *25*(1), 49–57. https://doi.org/10.7818/ECOS.2016.25-1.06

Mengistu, E. A. (2020). *ADDIS ABABA UNIVERSITY AFRICA CENTER OF EXCELLENCE FOR WATER MANAGEMENT Ecological and Socio-economic Impacts of Ecohydrological Interventions on the Wetlands along the Southeastern Shore of Lake Tana, Ethiopia Addis Ababa, Ethiopia*.

Mitsch, W. J., & Gossilink, J. G. (2000). The value of wetlands: Importance of scale and landscape setting. *Ecological Economics*, *35*(1), 25–33. https://doi.org/10.1016/S0921-8009(00)00165-8

Mmopelwa, G. (2006). T He O Kavango D Elta : the Value of Tourism. *Delta*, *9*(1), 113–127.

Moges, M. A., Zemale, F. A., Alemu, M. L., Ayele, G. K., Dagnew, D. C., Tilahun, S. A., & Steenhuis, T. S. (2016). Sediment concentration rating curves for a monsoonal climate: Upper Blue Nile. *Soil*, *2*(3), 337–349. https://doi.org/10.5194/soil-2-337-2016

Mulatu, D. W., van der Veen, A., & van Oel, P. R. (2014). Farm households' preferences for collective and individual actions to improve water-related ecosystem services: The Lake Naivasha basin, Kenya. *Ecosystem Services*, *7*, 22–33. https://doi.org/10.1016/j.ecoser.2013.12.001

Noriko, N., Elfidasari, D., Perdana, A. T., Wulandari, N., & Wijayanti, W. (2012). Analisis Penggunaan dan Syarat Mutu Minyak Goreng pada Penjaja Makanan di Food Court UAI. *JURNAL Al-AZHAR INDONESIA SERI SAINS DAN TEKNOLOGI*, *1*(3), 147. https://doi.org/10.36722/sst.v1i3.52

Porte, D. S., & Gupta, S. (2017). Nesting behaviour of Indian Pond Heron , Ardeola grayii (Sykes , 1832) at Ratanpur , District Bilaspur , Chhattisgarh , India. *Indian J. Applied & Pure Bio*, *32*(1), 31–42.

Russi, D., Brink, P. ten, Farmer, A., Badura, T., Coates, D., Förster, J., Kumar, R., & Davidson, N. (2012). The Economics of Ecosystems and Biodiversity for Water and Wetlands. Final Consultation Draft.IUCN. *The Economics of Ecosystems and*

ISSN: 2354-5844(Print)
ISSN: 2477-5223 (Online)

Biodiversity for Water and Wetlands, *7*(1), 84. http://medcontent.metapress.com/index/A65RM03P4874243N.pdf%5Cnwww.teebweb.org

Tamrat, M., & Bekele, A. (2014). Species Composition, Distribution, Relative Abundance and Habitat Association of Bird Species from Aba Asrat Monastery, East Gojam Zone, Ethiopia. *International Journal of Ecology and Environmental Sciences*, *40*(3), 111–121.

Tareke, A. T. (2023). Ecosystem Service Reason to Save Wetlands: A Case of Geray Wetland, North Western Ethiopia. *East African Journal of Environment and Natural Resources*, *6*(1), 459–472. https://doi.org/10.37284/eajenr.6.1.1630

Thapa, S., Wang, L., Koirala, A., Shrestha, S., Bhattarai, S., & Aye, W. N. (2020). Valuation of Ecosystem Services from an Important Wetland of Nepal: A Study from Begnas Watershed System. *Wetlands*, *40*(5), 1071–1083. https://doi.org/10.1007/s13157-020-01303-7

Turyahabwe, N., Kakuru, W., Tweheyo, M., & Tumusiime, D. M. (2013). Contribution of wetland resources to household food security in uganda. *Agriculture and Food Security*, *2*(1), 1–12. https://doi.org/10.1186/2048-7010-2-5

Under, B., Wieder, K., & Vile, M. A. (2022). *By The Nature Conservancy and the Pennsylvania Department of Conservation and Natural*.

Van Asselen, S., Verburg, P. H., Vermaat, J. E., & Janse, J. H. (2013). Drivers of wetland conversion: A global meta-analysis. *PLoS ONE*, *8*(11), 1–13. https://doi.org/10.1371/journal.pone.0081292

Verhoeven, J. T. A., & Setter, T. L. (2010). Agricultural use of wetlands: Opportunities and limitations. *Annals of Botany*, *105*(1), 155–163. https://doi.org/10.1093/aob/mcp172

Wallace, K. J. (2007). Classification of ecosystem services: Problems and solutions. *Biological Conservation*, *139*(3–4), 235–246. https://doi.org/10.1016/j.biocon.2007.07.015

Wondie, A. (2018). Ecological conditions and ecosystem services of wetlands in the Lake Tana Area, Ethiopia. *Ecohydrology and Hydrobiology*, *18*(2), 231–244. https://doi.org/10.1016/j.ecohyd.2018.02.002

Xu, T., Weng, B., Yan, D., Wang, K., Li, X., Bi, W., Li, M., Cheng, X., & Liu, Y. (2019). Wetlands of international importance: Status, threats, and future protection. *International Journal of Environmental Research and Public Health*, *16*(10). https://doi.org/10.3390/ijerph16101818

Yamane, S. (1976). Morphological and taxonomic studies on the Vespine larvae, with reference to the phylogeny of the subfamily Vespinae (Hymenoptera: Vespidae). *Insecta Matsumurana New Series*, *8*(January 1976), 1–45.

Yilma, G. (2019a). Socio-Economic Contribution of Rift Value Aquatic and Wetlands to the Local Community and the National Economy: The Case of Lake Hawassa and Associated Wetlands, in the Southern Part of Ethiopia. *International Journal of Environmental Sciences & Natural Resources*, *22*(5). https://doi.org/10.19080/ijesnr.2019.22.556096

Yilma, G. (2019b). Wetlands ecosystem service in terms of economic values : A case of Lake Hawassa, southern Ethiopia. *Current Information and Technologies on the Environment and Forest: Proceedings of the 4th Annual Research Outputs Dissemination Workshop*, *1*(2), 89–96.

Zalewski, M., Guo, J., & Breil, P. (2022). *Proceedings of the 5th International Symposium of Healthy Rivers and Sustainable Water Resources Management : ECOHYDROLOGY FOR WATER SECURITY. June 2022*. https://hal.inrae.fr/hal-03792186

Zekarias, T., Govindu, V., Kebede, Y., & Gelaw, A. (2021). Geospatial Analysis of Wetland

ISSN: 2354-5844(Print)
ISSN: 2477-5223 (Online)

Dynamics on Lake Abaya-Chamo, The Main Rift Valley of Ethiopia. *Heliyon*, *7*(9), e07943. https://doi.org/10.1016/j.heliyon.2021.e07943

Zhang, Z., Chen, F., Barlage, M., Bortolotti, L. E., Famiglietti, J., Li, Z., Ma, X., & Li, Y. (2022). Cooling Effects Revealed by Modeling of Wetlands and Land-Atmosphere Interactions. *Water Resources Research*, *58*(3), 1–18. https://doi.org/10.1029/2021WR030573