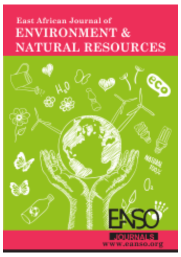


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*Original Article*

# Ecosystem Service Reason to Save Wetlands: A Case of Geray Wetland, North Western Ethiopia

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*Deriving Force, Ecosystem Services, Geray, Sustainable Use, Wetland Management*

## ABSTRACT

Efforts to conserve wetland ecosystems depend on the recognition of ecosystem services they provide. Hence, the study was conducted to analyze the ecosystem services of the Geray wetland and the driving force of its degradation. Structured questionnaires, personal interviews, focused group discussions, and field observations were used in data collection. Questionnaires were administered to 114 respondents obtained through random sampling of households. Data were analyzed using descriptive statistics and regression. Descriptive statistics like mean, percentage and frequency distribution were used to analyze quantitative data. The binary logistic regression model was applied to evaluate the impact of household-related independent variables on the dependent variable. Results showed that Geray wetland provides provisioning services (fish, fresh water, fodder and grazing services, firewood, crop, and fruit), regulating services (temperature regulation, water purification, sediment retention and erosion control), cultural services (recreation, tourism, and aesthetic) and supporting services (nursery, habitat, and accumulation of organic matter). Farm expansion, sedimentation, overgrazing, uncontrolled irrigation practices and deforestation of wetland vegetation, which are rooted in rapid population growth, open access to wetland resources, lack of awareness, lack of clear boundaries and weak institutional framework, were the main causes of the wetland degradation. Predictor variables like household size have a negative, and landholding size and age have positive significant impacts on the Geray wetland ecosystem. A high number of respondents were also aware of the measures (planting trees, trace building as a controlling method of erosion and conservation education to the community) to be taken to overcome the problems that face the Geray wetland. Thus, participatory sustainable wetland management is recommended to obtain more benefits from the wetland and minimize its destruction.

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## INTRODUCTION

Natural resources must be sustainably planned, managed, and wisely utilized today and conserved for future generations to come. As one of the natural resources, wetland provides various ecosystem services, which are essential to sustain life (MEA, 2005). Ecosystem services (ES) are defined as benefits that people obtain directly or indirectly from ecosystems, which are usually classified as provisioning, regulating, cultural, and supporting (MEA, 2005). In this sense, wetlands provide a wide range of ES that contribute to human well-being (Fischer et al., 2009). Understanding ecosystem services of wetlands and traditional mechanisms of managing natural resources forms the basis for conserving those (Nonga et al., 2010). They are required to satisfy domestic, agricultural, and industrial needs. In addition, they offer nonmaterial benefits through spiritual enrichment, cognitive development, recreation, and aesthetic experiences.

Though wetlands occupy only 1.5% of the Earth's surface (Rolon & Maltchik, 2006), they provide a disproportionately high 40% of global ecosystem services (Zedler & Kercher, 2005). From an ecological point of view, wetlands provide habitat to large numbers of species, such as diverse flora, fish, amphibians, and birds, among other varieties of fauna (Macharia *et al.*, 2010). They also offer various ecosystem services such as providing water for drinking, domestic use, and irrigation, providing fish for consumption and commercial purpose, maintaining water quality and supply, regulating atmospheric gases, sequestering carbon, protecting shorelines, sustaining unique indigenous biota, and providing medicinal plants, fuel wood, materials for building and handcrafts, recreational and educational resources (Terer & Githuki, 2001; Thenya, 2001; Dise, 2009).

Despite their ecosystem services, wetland ecosystems are increasingly threatened (Andrew et al., 2015; Strayer & Dudgeon et al., 2006), and their biodiversity has declined (Pelicice et al., 2017; Turka et al., 2017). Studies have shown that about 50% of the world's wetlands have disappeared in the last century due to agriculture and urban development (Shine & Klemm, 1999). Wetlands that remain are also under increasing pressure from both direct and indirect human activities since they have been used frequently only for short-term economic gains that destroy their ecological values and environmental services in the long term (Nonga et al., 2010). Threats are also often driven by economic reasons associated with population growth, urbanization, industrialization, and chemical-based intensive agriculture (Hooper et al., 2005; Pelicice et al., 2017).

Wetlands in Ethiopia contribute about 2% of its total area (1125000 $km^2$) (EWNRA, 2008) and provide vast ecosystem services to people and support their livelihood. However, rapid population growth triggers the expansion of agricultural areas, resettlement of landless people, and exploitation activities in wetland areas (Shewaye, 2008). Consequently, several wetlands either disappear or are on the verge of drying out, while others rapidly decline in size. Therefore, sustainable management of wetlands is timely needed. Efforts to conserve wetland ecosystems also depend on the recognition of ecosystem services they provide (Cohen et al., 2014). However, information related to the status of the wetlands and the ecosystem services they provide is very little in Ethiopia and is completely lacking,

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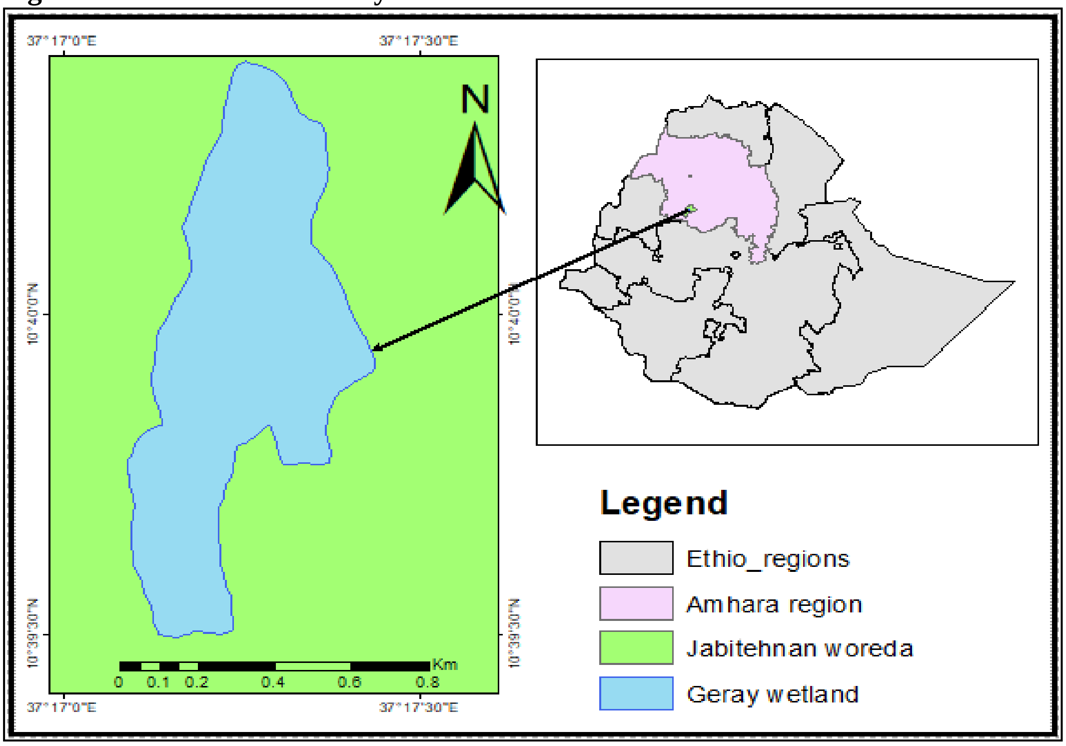
particularly in Geray wetlands. To this end, the present study is conducted to identify the ecosystem services of Geray wetland by accounting for the respondents' perceptions toward wetland management and their associated challenges. The study will provide baseline information on the socio-economic values of the wetland resources and environmental threats around the wetland, which are important for the sustainable management of the Geray wetland.

## MATERIALS AND METHODS

### Study Area

Geray wetland is in Amhara National Regional State, West Gojjam administrative zone, Jabitehnan Woreda, bordering Shemibekuma-Yedafas and Arbaitu-Insesa kebeles (Figure 1). The absolute geographical position of Geray reservoir is 10° 39' 59.7"N, 37° 17.9' 2.8"E, and it is a shallow (had a mean depth of 4 m) artificial water body primarily used for irrigation of surrounding farmland (Goshu, 2007). The main source of water for the wetland is through precipitation and run-off from the upper catchment. The wetland covers about 50 ha with 106 m$^3$ of water with the potential to irrigate 618 ha of arable land (Miheret, 2015). The vegetation coverage differs between the eastern and the northern part of the watershed; the western area is devoid of natural cover due to intensified agricultural activities, and the eastern area is covered with natural shrubs (Miheret, 2015). The total annual rainfall recorded in the watershed was about 1 350 mm, and most rain was observed to be from June to October. The average annual temperature is about 25 °C, and the topography of the Geray wetland watershed consists of 97% plain, 3% mountainous and valley (Miheret, 2015).

**Figure 1: Location of the study area**




### Research Methods

This study adopts the typology and nomenclature of ecosystem services proposed by the Millennium Ecosystem Assessment (Darradi et al., 2006), which classified them into provisioning, supporting, regulating, and cultural services, and using the discussions with stakeholders and field observation. Both primary and secondary data were used for the study, and quantitative and qualitative data collection methods were also used to obtain the primary data. The standardized questionnaire, with structured and semi-structured questions, was the main

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instrument, which involved face-to-face interviews with one respondent from each of the selected households. The interview was focused on each household's demographic and socio-economic characteristics, their understanding of the importance of the wetland ESs, challenges on the wetland, and their attitude toward wetlands management. In addition to local community interviews (HHDs), Focus Group Discussions (FGD) and Key Informant Interviews (KII) were used to collect data on Ecosystem services (ESs) of the wetland and the driving force of its degradation. Secondary data were obtained from books, journals/articles, internet sources, and research reports and were used to gather information on the climatic conditions, water resources and environmental conservation practices. The data obtained from FGD, key informant interview and observation were written in the form of narrative information.

### Sampling Techniques

Two (2) sample Kebeles surrounding the Geray wetland were identified purposely, and the numbers of household respondents from the two selected kebeles were determined based on the proportional sample size formula, which was adopted from Yamane (1976) method with a 9% level of precision.

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

Where n is the required total sample size of respondents, N is the total household (1499) in all sample Kebeles, e is the minimum level of precision (0.09), where the confidence level is 95% at *P* = ± 5 (maximum variability).

$$n = \frac{1499}{[1+1499(0.0081)]} = 114$$

Accordingly, a total of 114 households, 69 (60.6%) from Arbaitu-Insesa kebele and 45 (39.4%) households from Shemibekuma-Yedafas, were randomly selected for interview (Table 1). In addition, 10 key informants (KI) and two groups, Focus Group Discussions (FGD) (each group consisting of 8 individuals), were involved and participated in the study. Members of the FGD were selected purposively, and each group consisted of elders, development agents, women, and youth. Ten (10) key informants (4 members of Fishery Cooperatives, 4 experts in Natural Resource Protection, and 2 local elders) were selected purposively on their experience with Geray wetland.

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

| Kebeles | Total HHH | sample HHH | | | |
|---|---|---|---|---|---|
| | | Males | Females | Total | % |
| Arbaitu-Insesa | 909 | 59 | 10 | 69 | 60.6 |
| Shemibekuma-Yedafas | 590 | 40 | 5 | 45 | 39.4 |
| Total | 1499 | 99 | 15 | 114 | 100 |

### Statistical Analysis

The Statistical Package for Social Scientists (SPSS) version 20.0 software was employed to analyze data drawn from the household survey. The data were analyzed using descriptive statistics and logistic regression. Descriptive statistics like mean, percentage and frequency distribution were used to analyze quantitative data. The binary logistic regression model was applied to evaluate the impact of household-related independent variables on the dependent variable, 'wetland ecosystem' (about which data from respondents were gathered using binary response-options); that is, the linear regression model used is (Gujarati, 2004): $Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \beta 8X8 + \mu$ 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. Our purpose was to examine whether there are any significant

 

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effects of the explanatory variables on wetland degradation or not. Thus, a procedure was performed to test the null hypothesis, $\beta 1 = \beta 2 = \beta 3 = \beta = n$, against the alternative hypothesis, which is that the null hypothesis is not true in at least one case.

## RESULTS AND DISCUSSION

### Socio-Demographic Characteristics and Livelihood Conditions of the Households

It is important information to know the demographic characteristics of the local community for policymakers, planer, and natural resource managers to manage sustainable utilization and restoration of the wetland at local, regional, and national levels. About 13.2% of respondent households were female-headed while the remaining 86.8% were male-headed households (Table 2). In terms of educational levels, a higher number of respondents interviewed had primary education (41.2%), followed by those who had no education (39.5%). Then those with secondary education (14%), preparatory education (4.38%) and the least had a bachelor's degree (0.87%). A high number of respondents aged between 41-50 years (37.7%), followed by those with years 18-40 (25.5%) and then those with above 50 years (36.8%) (Table 2). Households in the studied wetland areas have livelihood activities that are mainly natural resource-based, and most respondents interviewed were crop farmers (95%). A number of them combine crop farming with other economic activities, for instance, livestock keeping (48%), vegetable production (34%), fishing (21.4%), petty trades (11.7%) and collection of wetland products (such as reeds, thatching grass, wild fruits, etc.) (*Table 2*).

**Table 2: Socio-demographic information of respondents (n=114)**

| Socio-demographic variable | Category | Participated respondents Number | (%) |
|---|---|---|---|
| Gender | Male | 90 | 86.8 |
| | Female | 12 | 13.2 |
| Age | 18-40 | 29 | 25.5 |
| | 41-50 | 43 | 37.7 |
| | Over 50 | 42 | 36.8 |
| Education | Cannot read and write | 45 | 39.5 |
| | Primary education | 48 | 41.2 |
| | Secondary education | 16 | 14 |
| | Preparatory education | 5 | 4.38 |
| | Degree | 1 | 0.87 |
| Residence | Born | 103 | 90.3 |
| | Immigrant | 11 | 9.7 |
| Occupation | Farmer | 82 | 71.9 |
| | Farmer and petty trade | 21 | 18.4 |
| | Fishermen | 2 | 1.75 |
| | Farmer and fishermen | 11 | 9.6 |
| | Car driver | 2 | 1.75 |
| Source of income | Crop production | 108 | 94.7 |
| | Livestock rearing | 55 | 48.2 |
| | Vegetable production | 39 | 34.2 |
| | Fishing | 32 | 28 |
| | Trade | 13 | 11.4 |

### Respondent's Livestock Population and Land Holding in Hectare

The average family size in these wetland areas is about 5.7 members (*Table 3*), which lies in the range of the regional average of 4–6 members (NABU, 2014). Even though about 13% of the households were landless, the average land holding size per head is 1.34 ha, and it is better as compared to the average landholdings in Ethiopia as a whole, where the land carrying capacity has

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already surpassed the threshold level of one ha per family (*Table 3*).

**Table 3: Household characteristics, livestock population and land holding in hectares**

| Household characteristics | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|
| Family size (NO) | 2 | 11 | 5.7 | 1.64 |
| No of livestock (TLU) | 0 | 23 | 7.47 | 6 |
| Cultivated land (ha) | 0 | 3.5 | 1.34 | 0.57 |
| Grazing land (ha) | 0 | 1 | 0.12 | 0.11 |
| Homestead (ha) | 0 | 0.75 | 0.24 | 0.11 |
| Woodlots (ha) | 0 | 0.8 | 0.22 | 0.12 |

**Ecosystem Services of Geray Wetland**

All the respondents reported that the Geray wetland plays several roles and provides ecosystem services that are important for their livelihood. Ecosystem services were also grouped into provisioning, regulating, cultural, and supporting services, which were assessed using collective methods of field observation, household interview data, key informants, and FGD. These ecosystem services are consistence with the ecosystem services reported by various researchers (Wondie, 2018; Tesfaye, 2019; Yilma, 2019; Camacho-Valdez et al., 2020; Zekarias *et al*., 2021).

***Provisioning Services***

As part of ecosystem services, most respondents reported that several provisioning services they get from the wetland, namely crop cultivation (21.9%), fish for consumption and sale (29.8%), water for irrigation (64.9%), water for domestic uses (20.2%), water for livestock drinking (73.7%), fodder and grazing services (65%), woods for construction, agriculture, and fuel (8.7%), thatching grasses (10.5%) and medicinal plant collection (2.6%) (Table 4).

Among the listed provisioning services, fresh water supply is the most valuable product of the wetland ecosystem. The wetland fresh water is an immediate resource for many people who have no piped water sources at home. All the interviewed inhabitants have used wetland water for washing clothes and different household materials, bathing, swimming, and livestock watering. Similarly, Dixon and Wood (2007) and Wondie (2010) reported that water from wetlands guarantees the local community's year-round access to drinking water for themselves and their livestock in Ethiopia.

The wetland also contributed to food security by providing space for growing crops. The major cultivated crops by irrigation in the shore area are vegetables (pepper, onion, cabbage, etc.), fruits (banana, papaya, mango, etc.), sugarcane, etc. Discussions with stakeholders revealed that the Geray wetland plays a key role in providing irrigation water, and the farmer cultivates vegetables and fruits in the shore area of the wetland. In line with the present study, Zekarias et al. (2021) reported that Abaya-Chamo lake-wetland provides irrigation water (77.1%) and fertile soil for primary (crop) production (27.9%) to the local communities, respectively. The study is also in line with the study by Turyahabwe et al. (2013) reported that wetlands contributed to food security by producing wetland products to raise cash income that is then used to purchase food in Uganda.

The result showed that all the interviewed local people are practicing livestock agriculture. They use the shore for grazing and water for their livestock. They rear different livestock such as cattle, sheep, goats, donkeys, etc. Livestock grazing is the most visible use of wetlands. The contribution of the wetland to the provision of water for livestock watering is also very influential. Almost all livestock holders used the wetland water for their livestock. In a similar study also reported by Getaw (2019), about 59% and 20% of the interviewed farmers are collecting grass fodder and leaves and fruits, respectively,

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from vegetation found on the lake shore of Lake Hawassa to feed their livestock.

Fish is another important resource that is collected from the wetland (Table 4). It has great potential to produce different commercial fish species, such as *Cyprinus carpio*, *Carasius Auratus*, and *Clarias gariepinus* and *Oreochromis niloticus.* Most of the fishermen are landless or have small farmland sizes, and they use most of the fish products for sale. In Ethiopia, irrigation and fishery is the most common source of income along with living near or the borders of the lakes and wetlands (Tenalem & Degnachew, 2007; Spliethoff et al., 2009).

The wetlands are also the main sources of ceremonial reeds and thatching grass used for the construction of house walls and roofs, animal fodder, crop guarding huts, wood for shelter, agricultural tools, and fuel (Table 4). The local community commonly also uses the reeds and *Jancus* sp. for their special coffee ceremony. Information from KIs and FGD also revealed that the livelihood of several young people, especially females, depends on harvesting and selling "Cheffe." Similarly, 4% of households from the wetland were reported to depend on wetland water for seedling rising. Moges et al. (2016) reported similar findings that wetlands provide water for crop production and the rising of seedlings in natural wetlands in the Jimma Highlands of Ethiopia.

***Regulating Services***

Geray wetland provides different regulating services, such as climate regulation through sequestration of carbon (81.6%), water purification (45.6%), erosion control (54.4%) and sediment retention (60.5%) (Table 4). Moreover, ecological functions were mainly reported by the technical staff at kebele, district sub-county local government levels. The wetland, like any inland water, provides water during dry seasons, and it serves as a water storage site during the wet seasons. As wetlands harbor vegetation, it has huge roles in the storage, dilution, filtering, removal and recycling of organic compounds and other nutrients that enter the water from point and non-point sources (Wondie, 2018). According to Abebe and Geheb (2003), wetlands are also instrumental in water storage, filtration, and supply, flood control; perform sediment, nutrient, and retention functions.

Similarly, (Tenalem, 2004; Shewit et al., 2017) reported that wetland is important for stabilization and water purification. Another study reported by Zekarias et al. (2021) reported that the Abaya-Chamo wetland is valuable in the regulation of local climate as the wetland has a cooling effect during daytime in months of hot weather conditions due to wetland breeze resulting from the air pressure differences between land and the wetland. The same author also reported that wetland also regulates air quality by storing the huge amount of dissolved $CO_2$ within its surrounding swamps by reducing the amount of greenhouse gas emission to the atmosphere. The Geray wetland also plays its role as a key source of rainfall to the local people (farmers) as the wetlands and lakes are conducive surfaces for evaporation to take place, meaning it facilitates the hydrological cycle, which is a supportive service for crop farming (MEA, 2005).

***Cultural Services***

Another major benefit derived from Geray wetland is cultural service. Interviewed households recognize the cultural services of the wetland, and it is an ideal place for recreation (78%), spiritual (21.9%), and educational and research services (25.4). Wondie (2018) and Tesfaye (2019) reported similar findings from Lake Tan and Hawassa wetlands, respectively. Likewise, Zekarias et al. (2021) have reported that wetlands provide cultural services such as tourism and aesthetic values (74.5%), recreational (e.g., swimming), and ceremonial (e.g., weddings, parties) services in Lake Abaya-Chamo wetland. This finding also agrees with the findings of Moges et al. (2016) in Jimma wetlands, where the local people derived spiritual services from the wetland. Respondents of the current study derived recreational benefits from the wetland because it contains wild plants, wild animals, and water.

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Wild animals, particularly water birds, attract bird-watching. The local people (especially the youth) frequently swim in the wetland as the wetland water provides space for swimming.

***Supporting Services***

A high number of respondents have recognized the role of wetlands hosting various bird species and other wildlife. The wetland provides supporting services, including the provision of breeding nurseries (69.3%) and habitat (54.4%) for wetland plants and animals, soil formation (accumulation of organic matter) (26.3%) and nutrient cycling (7.8%) (Table 4). The wetland is rich in bird diversity and harbors some fish species. FGD and KIs also acknowledged the importance of the wetland in providing habitats for several species of birds and fishes. Based on the present survey, about 44 bird species, such as the common crane, Great white pelican, Yellow-billed duck, Egyptian goose, African jacana, wattled crane, crowned crane, and others, exist in the wetland. Ethiopia has 73 important hot spot bird areas, of which 43 are wetlands that provide shelter to endemic, globally endangered, vulnerable, and near-threatened bird species (Aynalem, 2007). Other research also reported that wetlands provide for wildlife breeding and nursery habitats (Moges et al., 2016) Likewise, Sahle (2019) reported that wetlands in Lake Hawassa provide a suitable habitat for reproduction and shelter for different birds, fishes, wild animals, plants, and microbial species. These habitats are becoming increasingly recognized as among the most productive natural resources because of their ability to fulfill a range of functions and produce several products that are socially and economically beneficial to the local community (Dugan, 1990).

**Table 4: Main ecosystem services (ESs) of Geray wetland based on household perception**

| | Ecosystem services provided | N | % | Relative degree of ESs |
|---|---|---|---|---|
| Provisioning Services | Crops (Teff, chickpea etc.) | 25 | 21.9 | ● |
| | Fish | 34 | 29.8 | ● |
| | Uncultivated fruits | 7 | 6.8 | ● |
| | Wetland products (e.g., reeds) | 4 | 3.9 | ● |
| | Water for domestic uses | 23 | 20.2 | ● |
| | Water for irrigation | 74 | 64.9 | ● |
| | Water for livestock drinking | 84 | 73.7 | ● |
| | Fodder and grazing services | 74 | 65 | ● |
| | Woods (for construction, agriculture, fuel) | 10 | 8.7 | ● |
| | Medicinal plant | 3 | 2.6 | ● |
| | Craft materials (e.g., basket, mat etc.) | 2 | 1.75 | ● |
| | Thatching grasses | 12 | 10.5 | ● |
| Regulating Services | Temperature regulation (Carbon sequestration) | 93 | 81.6 | ● |
| | Water purification (pollution control) | 52 | 45.6 | ● |
| | Sediment retention | 69 | 60.5 | ● |
| | Erosion control | 62 | 54.4 | ● |
| Cultural Services | Recreational services | 89 | 78 | ● |
| | Spiritual services | 25 | 21.9 | ● |
| | Educational and research services | 29 | 25.4 | ● |
| Supporting Services | Nursery | 79 | 69.3 | ● |
| | Habitat | 62 | 54.4 | ● |
| | Formation (accumulation of organic matter) | 30 | 26.3 | ● |
| | Nutrient cycling | 9 | 7.8 | ● |

 

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**Driving Forces of the Degradation of Geray Wetland**

The degradation of Geray wetland has been driven by crop-farming expansion (67%), sedimentation (48%), deforestation of wetland vegetation (39.5), overgrazing (22%), uncontrolled irrigation practice (10%), which are governed by high population pressure (56%), weak institutional performance (38%) and lack of ownership (27%) (Fig. 2). Although the wetland ecosystem is a source of livelihoods to most communities around, degradation of ecosystem probably has increased problems. Findings from this study show that many unsustainable human activities are likely to endanger the well-being of the wetland ecosystem. Obvious environmental destruction was observed due to unsustainable agriculture, overgrazing and deforestation, which had resulted in soil erosion, reduced water availability, and endangering the existence of the wetland. Soil erosion in the basin was generally connected with cultivation and deforestation, specifically to farming methods and management. Deposition of soil in the wetland leads to sedimentation. These uncontrolled human activities were rampant due to poverty, poor policies governing agriculture and land use, and low levels of awareness of sustainable land use, agriculture and livestock keeping, as stated by Zekarias et al. (2021). The destruction of forests poses direct consequences for the biodiversity they support and also has significant and cumulative impacts on the catchment hydrology. In the current study, most respondents listed the main causes of the problem to be environmental destruction due to poor land farming, overgrazing and siltation. Almost all respondents (75%) reported a noticeable decline in wetland size and depth that is associated with excessive agricultural expansion activities and, thereby, siltation. The same result is also reported by Zekarias et al. (2021). Increasing water abstraction using several motor pumps is also another potential threat to the wetland (Fig 2).

Informants and discussants of the FGD also confirmed that the expansion of farming (to the extent the wetland lost its buffer zone) and intensive grazing resulted in the degradation of the Geray wetland. According to these key informants and discussants of the FGD, decision-making bodies continue to devote little attention to the importance of wetland ecosystem services. In line with this finding, the Kenyan (Gichuki et al., 2001) and Rwandan (Gowa, 2009) governments have also supported the conversion of wetlands for crop production to mitigate food insecurity and improve the livelihoods of rural communities. The expansion of farming has resulted in the removal of natural vegetation (e.g., woodland, grassland, forest, and bush) on the shore of the wetland (which was used as a buffer zone of the wetland) and loss of its biodiversity and the destruction of the natural vegetation adjacent to the wetland aggravated the magnitude of sedimentation and the entrance of chemical pollutants into the wetland. A key informant stated that the degradation of the Geray wetland is annoying due to the lack of clear regulations and legal frameworks on the exploitation and protection of resources of the wetland.

 

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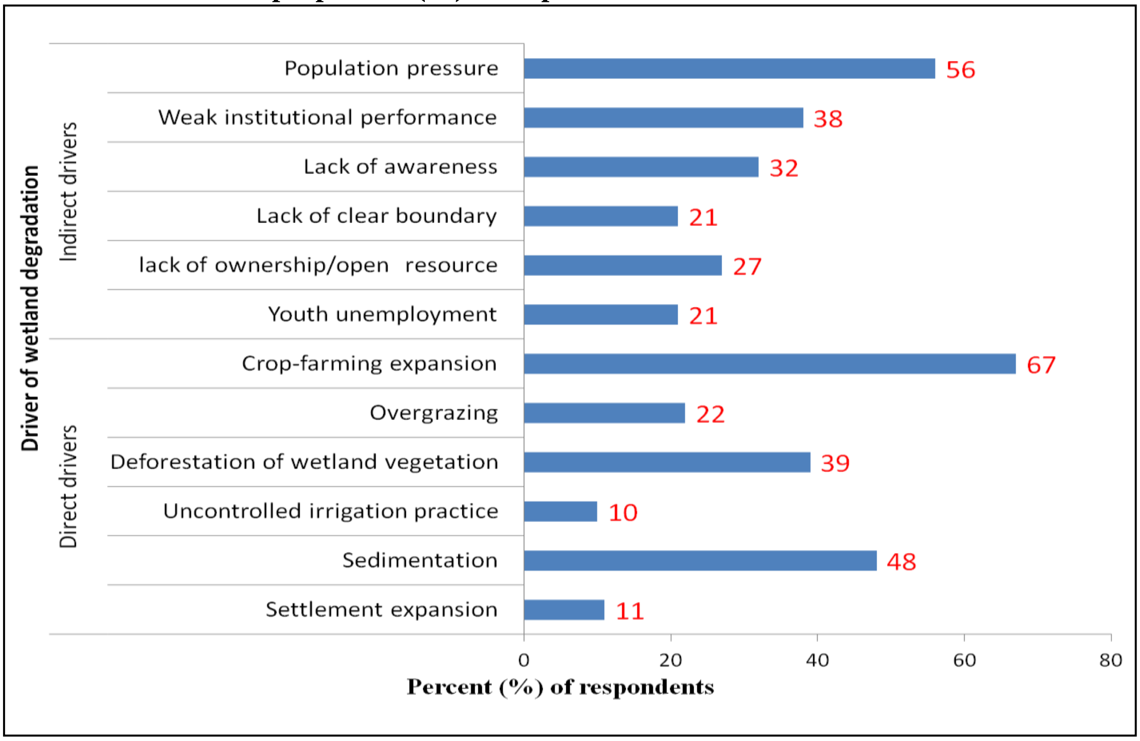
**Figure 2: Major driving forces (direct and indirect causes) for the degradation/loss of Geray wetland based on the proportion (%) of respondents.**




Predictors variables like household size, land holding size, livestock population, and age have significant impacts on the Geray' wetland ecosystem' at a 99% confidence level (Table 5). Among these, household size, with a beta coefficient of -0.73 and a sig value of 0.005, was found to have a significant negative impact. The predictor variables such as the age of the household head with a beta coefficient of 1.52 and sig value of 0.009, landholding size with a beta coefficient of 2.1 and sig value of 0.009, livestock population with a beta coefficient of 0.2 and sig value of 0.009 revealed significant positive impacts on the Geray wetland ecosystem at 99% confidence level (Table 5). This means the likelihood of generating products from and encroachment on the wetland resources and the contribution to the degradation of the wetland is higher for a high number of households than a low number of households (Table 5). Having large heads per family demand high food for consumption, and forced them to convert the wetland to farmland to find extra farmland. That is why high number of households might have negative impact on the sustainable utilization of the wetland.

In contrast, the age of the household has a positive impact on the wetland. Because elder households own plots of land for their farming system and have also relatively higher awareness of the importance of wetlands, they agreed on the conservation of wetlands for sustainable utilization. However, young age people are landless, and these landless people create pressure to convert the wetland to croplands by deforesting wetland shore vegetation. Based on various empirical evidence, younger farmers are more likely to exploit wetland resources and convert them into cultivated lands than older people due to their small plots of land or landlessness (NABU, 2014). The large size of young household heads implies the pressure on the wetland resources. Likewise, landholding size and livestock population have a positive impact on wetland sustenance. Respondents who have high farmland have agreed on the conservation of wetlands and have not practiced wetland conservation to wetland. Similarly, respondents who have high number of livestock have agreed on the conservation of wetlands even though these livestock are the cause of wetland degradation.

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**Table 5: Binomial logistic regression for determining factors affecting wetland sustenance**

| Variables | Beta coefficient | | | | Statistics | | 95% C.I.for EXP(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | SE. | Wald | df | Sig. | Exp(B) | Lower | Upper |
| Location | -0.306 | 0.780 | 0.154 | 1 | 0.695 | 0.737 | 0.160 | 3.398 |
| Sex | 1.258 | 0.966 | 1.696 | 1 | 0.193 | 3.518 | 0.530 | 23.357 |
| Age | 1.522 | 0.586 | 6.751 | 1 | 0.009 | 4.584 | 1.454 | 14.454 |
| Family size | -0.737 | 0.264 | 7.791 | 1 | 0.005 | 0.479 | 0.285 | 0.803 |
| Educational level | 1.189 | 1.294 | 0.845 | 1 | 0.358 | 3.285 | 0.260 | 41.463 |
| Occupation | -2.047 | 1.721 | 1.414 | 1 | 0.234 | 0.129 | 0.004 | 3.770 |
| Land holding in hectares | 2.102 | 0.808 | 6.762 | 1 | 0.009 | 8.183 | 1.678 | 39.903 |
| Number of livestock | 0.203 | 0.078 | 6.773 | 1 | 0.009 | 1.225 | 1.051 | 1.428 |
| Constant | 0.175 | 2.619 | 0.004 | 1 | 0.947 | 1.192 | | |

*a. Dependent variable: wetland sustenance/degradation)*

**Wetland Conservation Measure**

A high number of respondents (85%) were aware of the measures to overcome the problems that Geray Wetland face. Planting trees (63.2%), trace building as a controlling method of erosion (42.1%) and conservation education to the community (38.59 %) are the main conservation measures that are suggested by respondents (Table 6). Moreover, the majority of the KIs and members of FGD replied that little effort had been made to date toward restoring and protecting areas in and/or around the wetlands through the participation of the local community. Indeed, there are no management activities/ physical and biological conservation measures that have been taken around wetlands. A similar study was also conducted by Moges et al. (2016) in Jimma Wetland, which reported that people's participation in conservation efforts was inadequate. However, they maintained a positive attitude toward wetland conservation.

Furthermore, the absence of a wetland policy and the delayed ratification of the Ramsar Convention by the Ethiopian government has also contributed to the unrelieved conversion of wetland ecosystems. Insufficient policy or poor implementation of environmental policies by the governments are contributing to the degradation of wetlands (UNEP, 2006). However, respondents in the present study mentioned good control measures against problems of wetland degradation. Apart from these good suggested solutions, there was no implementation in place.

**Table 6: wetland conservation measure suggested by respondents**

| Wetland Conservation Measure | Frequency | Percent |
|---|---|---|
| Planting trees | 72 | 63.2 |
| Control of water seepage | 30 | 26.3 |
| Shoreline fencing | 19 | 16.6 |
| Trace building as a controlling method of erosion | 48 | 42.1 |
| Avoid grazing near the wetland | 12 | 10.5 |
| Clean up dirty and sediments from the wetland | 17 | 14.9 |
| Not to burn trees and grasses | 2 | 1.75 |
| Controlled use of wetland water for irrigation | 14 | 12.28 |
| Conservation education for the community | 44 | 38.59 |

## CONCLUSIONS

Geray wetland supports the livelihood of surrounding people by providing multiple benefits such as provisioning services (fish, water for livestock drinking, water for irrigation, fodder and grazing services, firewood, crop and fruit), regulating services (temperature regulation, water purification, sediment retention and erosion control), cultural services (recreation, tourism, aesthetic and educational and research services) and supporting services (nursery, habitat and accumulation of organic matter as soil formation and nutrient cycling. Despite this listed importance, Geray wetland is degraded due to farm expansion, sedimentation, overgrazing, uncontrolled irrigation practice, and deforestation of wetland vegetation, which are rooted by rapid-by-rapid population growth, open access to wetland resources, lack of awareness, lack of clear boundary and weak institutional framework was the main cause of the wetland degradation. Predictor variables like household size have a negative, and landholding size and age have positive significant impacts on the Geray wetland ecosystem. A high number of respondents were also aware of the measures (planting trees, trace building as a controlling method of erosion and conservation education to the community) to be taken to overcome the problems that Geray wetland faces. Thus, a strong conservation-based educational program should be set and implemented to create awareness among the local people on how they can participate in managing the wetland in order to obtain more benefits from it and minimize its destruction.

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