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Research article

Wetlands ecosystem service in terms of economic values: A case of Lake Hawassa, southern Ethiopia

Getaw Yilma

Ethiopian Environment and Forest Research Institute, P.O.Box: 24536 (Code 1000), Addis Ababa, Ethiopia

*Corresponding Author: yilmagetaw@yahoo.com

Abstract: Wetlands are one of the most productive ecosystems that play a significant role in providing multiple ecosystem services. However, this resource has got less attention in national and regional planning. Hence, the objective of this study was to figure out the socioeconomic contribution of Lake Hawassa for the local and national economy, and call for the concerned body (like; policymaker and planner) take possible action will be measured the lake from further degradation. A total of 164 households' questionnaires collected from five kebeles, and thus households were selected randomly from each kebele. Then, the data were analyzed using descriptive statistics, ANOVA and linear regressions model. The result showed that the majority of households' livelihood income strategies were from irrigation (54.8%), rain-fed (33.8%), livestock (6.5%), fishing (3.5), off-farm seasonal work (1.2) & others (0.2). The average annual total household income was 53,716.39 ETB. Out of this, lake income constituted 59.7% of the total income. The local households' income contribution of Lake Hawassa within selected kebeles was statistically significantly different by livestock watering, pasture for grazing animals and water for washing body or close. Other are did not reveal significant differences among the five kebeles for all the parameters analyzed. Overall result confirmed that the Lake contributed significantly to the household economy of the local people and hence, it is important to protect and improve the management of the lake and its wetlands for livelihood enhancement, while also securing their long-term ecological functions.

Keywords: Degradation, Driving factor, Ecosystem service, Household income, Livelihood strategies, Restoration.

INTRODUCTION

Wetlands are whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Ramsar, 1997). Ethiopia is endowed with rich wetland resources that include lakes, marshes/swamps, rivers, flood plains, reservoirs, manmade ponds and dams (Leykun, 2003). These wetlands are located in almost all ecological and altitudinal ranges covering approximately 2% (22,600 km^2) of the country's total surface area (EPA, 2004; EWNRA, 2008). If water bodies are included, in ANRS 3.7 % is covered by wetlands, with 288,744 ha covered by swamps and marshes, and 316,609 ha by water bodies (EWNRA, 2008). Some of the major wetlands and aquatic bodies of the Rift Valley basin are Ziway, Abjatata, Shalla, Langano, Hawassa, Abaya, Chamo and Chew Bahir and drain an area of about 52,000 Km^2 (Alemayehu, 2006). A total of 77 wetlands have been identified in Ethiopia and Eritrea (Abebe & Geheb 2003).

Currently, the importance of the wetland ecosystem to the local communities in terms of social, economic and environmental values receives great public attention. Most of Ethiopia's aquatic and wetlands are providing broad socio-economic benefits and ecological functions for so long time (EPA, 2002). Among the wide range of socio-economic and ecological benefits, including the supply of food, water, furniture, pasture (grazing area for cattle), construction and fuel wood, raw materials for making household furniture, fodder, and medicine to rural communities, waste treatment and other several ecological services such as microclimate stabilization and serve as a carbon sink (MEA, 2005). Economically, there are many development projects, which aimed on using the water and land resources sustainably and thereby improve the livelihood of the people through various activities such as fishing, irrigation, handcraft making, livestock raring, collecting wood fuel wood for domestic purpose, agriculture, forestry, tourism, and as a mechanism for adapting droughts (Hillman *et al.*, 1993; Guillemette *et al.*, 2005; Handisyde *et al.*, 2006; Hefting *et al.*, 2013). Further to their economic values, Ethiopian wetlands are historical, cultural and ritual importance (Houghton *et al.*, 2001; Jorge *et al.*, 2014), and a large number of societies are depending on these wetlands for their livelihood (Junk *et al.*, 2013).

According to MEA (2005), wetlands ecosystem services are divided into four main parts; the provisioning (food, freshwater, fiber and fuel, biochemical, animal feed, medicinal plants, genetic material, income and house construction material, and transportation), regulating (climate regulation, water regulation, water purification, retention of sediments

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and pollutants, flood and erosion regulation, natural hazard regulation and habitat for pollinators), cultural (spiritual and inspirational, recreational, aesthetic and educational) and supporting (soil formation, nutrient cycling, and carbon sequestration server as migratory routes for animals and habitat for flora and fauna). Wetlands of Ethiopia have also a great biological significance in terms of harboring a huge amount of biodiversity, particularly endemic, globally endangered and vulnerable bird species (Menbere & Menbere, 2018).

Lake Hawassa is one of many Ethiopian wetland resources. It lies near the town of Hawassa in the middle of a series of rift valley lakes and multiple social, cultural and ecological values for the local community. Furthermore, the town of Hawassa is famous and attractive primarily due to the lake. The town and the lake are celebrated resorts for local and foreign visitors. The magnificent views of the lake from resort hotels together with the many precious water birds make the wetland one of the country's most renowned tourism Center.

However, despite their values, Hawassa Lake is polluted (Abate *et al*., 2015) and the associated wetlands are caught in a spiral of degradation and fragmentation (Abebe & Geheb, 2003). Until know, aquatic and wetlands in Ethiopia and elsewhere in the Horn have had less attention in the national as well as regional planning, their potential to enhance the local and national economy has been overlooked, and they provide multiple economic, social, cultural, and ecological functions and services which are crucial for the local, national and global society has been not well addressed (Giweta & Worku, 2018). Therefore, this study to figure out the ecosystem service in terms of socio-economic contribution of Lake Hawassa and the associated wetlands for the local community and the national economy and call for policymakers, planners and natural resource managers take an action the landscape level, before further degradation of the resource. In this regard, this article is timely to understand the problems of Lake Hawassa and associated wetland are facing, and its possible action will be taken.

MATERIAL AND METHODS

Description of the study area

The study site is situated in the middle of a series of rift valley lakes at an altitude of 1680 M.A.S.L and 275 km south of Addis Ababa. Lake Hawassa lies to the west of Hawassa town, the capital of the Southern Nation Nationalities and Peoples' Regional State. The study sites (kebeles) are directly connected from western parts of the lake. The locations of each kebeles demonstrate in figure 1. The area receives a mean annual rainfall of 950 mm and has a mean annual air temperature of 19.8°C. The lake has a patch of wetlands and its surface area of 90 km^2 and a drainage area of 1,259 km^2 (2018 Google earth map). It is a closed lake with no waterway outflow. Compared to other rift lakes, the water is relatively dilute probably due to some sort of subterranean inflow, dilution from the feeder Tikur Wuha River and past basin overflow.

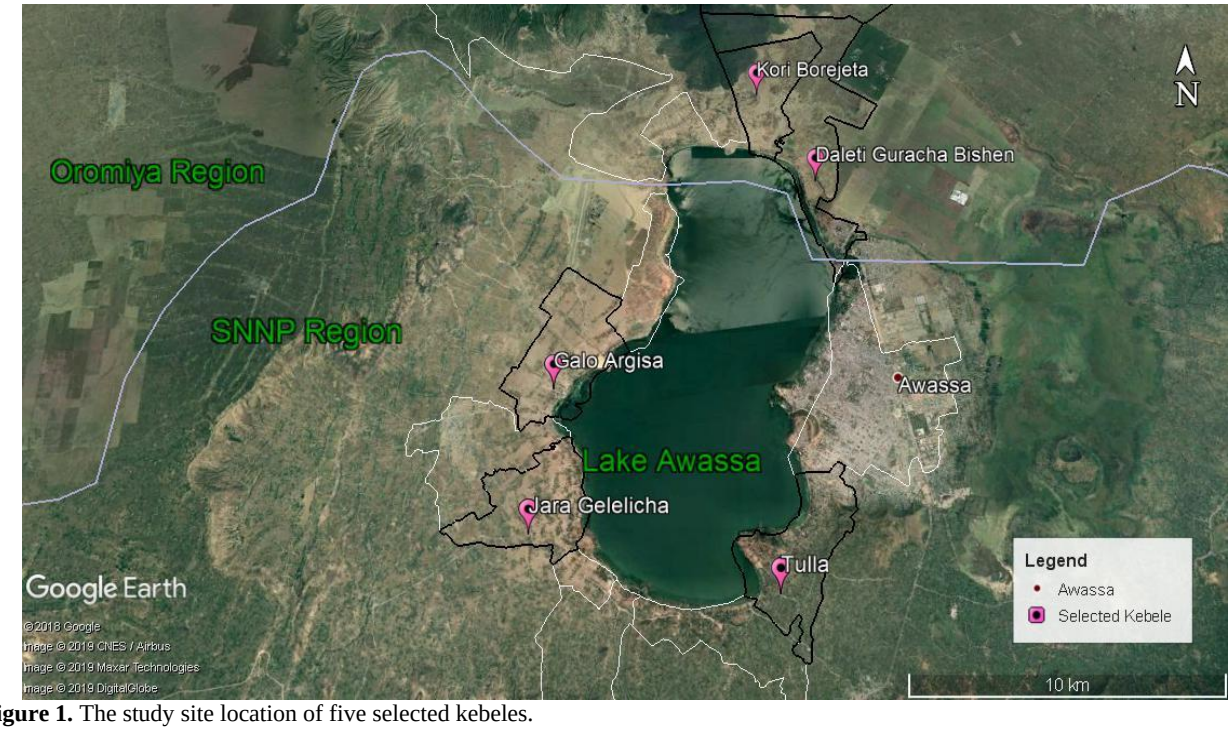

Figure 1. The study site location of five selected kebeles.

The communities of surrounding lakes have utilized the resources as a source of livelihood income. Northern, central and southern parts of the land scopes are manly agricultural lands populated by smallholder and mechanized

commercial farms. The water of the lake is used for irrigation, bathing, recreation and drinking water for domestic use and wildlife. The fishery of the lake supplies vital fish protein and income for the people of the area and beyond. The wetland yields grasses and other vegetation on which cattle may be grazed, boats constructed ('*tankua*'), mattresses, mats and agricultural implements created and houses built. The major types of soil in the catchment include cambisols, vertic Cambisols, andosols, vertic luvisols, Regosols, greysols, alisols, and leptosols. Furthermore, the town of Hawassa is famous and attractive primarily due to the lake.

Sampling and economic evaluation methods

Random sampling was employed to select study kebeles and respondents. Five administrative kebeles *i.e.*, Daleti, Cheleleka, Galo Argisa, Tulla, and Gelelcha, out of eleven rural kebeles were selected directly connected to the lake. A total of 164 households were randomly selected for a household survey. In addition, 40 individuals (*i.e.* 8 households from each kebele) participated in a focus group discussion and 15 key informants (*i.e.* 5 households from each kebele) were purposely selected for an in-depth case study and interviews. In the field, data collection and sampling techniques are following by the procedures Campbell *et al.* (2002) and Zenteno *et al.* (2012).

The economic methods used to value wetlands are no different from the methods used to value any other type of environmental asset. These include market value approaches (which rely on quantification of production), surrogate market or revealed preference approaches (which rely on observation of related behavior) and simulated market or stated preference approaches (which rely on direct questioning). The simpler methods produce a total value, whereas those that involve the construction of models are better for estimating marginal values (the additional value generated by each unit of production) (Turpie *et al.*, 2010).

Research design

The reconnaissance field survey was made to obtain an overview of the study site, followed by a detailed preliminary survey, which was made between the 4th weeks of January to the end of February 2017. Guided by principles of social-ecological co-evolution theory (Colding *et al.*, 2003) and mixed quantitative and qualitative research design (Creswell, 2009) was employed to collect data.

Data collection

For this study, an integrated qualitative and quantitative approach method was used. The primary data were collected through a household survey, focus group discussions, key informant interviews and a guided transect walk for observation (Campbell *et al.*, 2002; Cavendish, 2003). A structured questionnaire that includes both closed and open-ended were designed and employed to generate quantitative and qualitative data from respondents. The main secondary data sources that were used in this research were both hard copies and online materials such as published and unpublished; articles, proceedings, project reports and other data available at district, zonal, regional, national and international levels. Pre-testing of the questionnaire was conducted to see about inclusiveness, its validity, relevance, and comprehensiveness. Based on the pre-testing feedback, the final questionnaire was prepared and administered accordingly. Data were collected on a number of variables including household characteristics, livelihood strategies, household assets, lake contribution to the local and national economy, income composition, expenditure and preference of lake water management system.

Data 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 ANOVA. Descriptive statistics like mean, percentage and frequency distribution were used to analyze quantitative data. ANOVA used to test the significant difference of lake contribution between selected kebeles. Moreover, data were analyzed using the linear regressions model. A linear regression model (MLM) is one of econometric model mainly helps to analyze the dependent variables which are numerical data with the other independent variables which are either categorical or continuous. This model was used to analyze factors influence for income contribution of sample households from Lake Hawassa. The secondary sources used for narrative description and interpreted on spot.

RESULT AND DISCUSSION

Demographic characteristics of sampled households

The structured questionnaire was administrated to a total of 164 household heads. Of this, the socio-demographic information showed that majorities of the sampled households (79.9%) were male-headed, while the rest were female-headed (Table 1). This shows that male-headed households highly dominated female-headed households in the surveyed area. On the other hand, the mean respondents' age was 37 with a minimum and maximum of 18 and 85, respectively (Table 1). Regarding the level of literacy, the results showed that still low penetration of the formal

education system. Only 11.6% of studied in the secondary level of education and near to one fourth (24.4%) of interviewed households didn't follow formal education to write and read. Others, constituting 62.8% have got access to the attended primary level of education (Table 1). On the other side, the mean family size of the surveyed households was 6.77 with a minimum and maximum of 1 and 21, respectively. The result show that, the mean landholding size of each household had 1.1 with a range of 0.05-11.00 hectare, and land use type composition (%) were; rain-fed (49.3), Irrigation (20.4), both (11.9), Wood lot (1.5), Grazing land (15.2) and Closure area (1.9). The majority of surveyed households' livelihood income strategies were from irrigation (54.8%), rain-fed (33.8%) and livestock (6.5%). The composition of livestock species (%); cattle (56.7), Goat (19.2), Sheep (10.3), Donkey (9.8) & others (10.1) were reported by households in the study areas (Table 1). It is important information to know the demographic characteristics of the local community for policymaker, planer and natural resource manager to manage, sustainable utilization, and restoration of the lake at local, regional and national levels.

Table 1. Socio-economic characteristics of the sampled households.

Socio-economic characteristics	Descriptions
Gender	Male: 79.9% and Female: 20.1%
Age	Mean: 37 and Range: 18-85
Literacy level	Illiterate: 24.4%; Primary: 62.8%; Secondary: 11.6% & Diploma (1.2%)
Family size	Mean: 6.77 and Range: 1-21
Land holding size(Ha)	Mean:1.1 and Range: 0.05-11
Land-use type composition (%)	Rain-fed (49.3), Irrigation (20.4), Both (11.9), the Wood lot (1.5), Grazing land (15.2), Closure area (1.9)
Households' income livelihood strategies (%)	rain-fed (33.8), Irrigation (54.8), Livestock (6.5), Fishing (3.5), Off-farm seasonal work (1.2) & Others (0.2)
Livestock composition (%)	Horse (0.9), Cattle (56.7), Goat (19.2), Sheep (10.3), Donkey (9.8) & Others(10.1)
Religions (%)	Muslim (40.2), Orthodox (4.9), Protestant (50.6), Catholic (1.2) & Others (3)

Income contribution of Lake Hawassa for the local and national economy

The households' income sources from the lake could be categorized under irrigation production (52.3%), livestock watering (10.0%), Fish for Sale (7.2%), water for domestic purposes (7.1%) and others (Table 2). The average annual household income from irrigation was 35120.45±114066.67ETB and this was the major total household income (54.8%) of the study area. Other high household income next to irrigation was Wage or daily laborer salary (11957.14±13647.018ETB) and fish for sale (9710.32±11527.25ETB) respectively, and least household was getting from tourism (1250±1060.66 ETB) (Table 2).

The income contribution of Lake Hawassa for the local households' was statistically significantly different between selected kebeles by livestock watering, pasture for grazing animals and water for washing body or close. Other are did not reveal significant differences among the five kebeles for all the parameters analyzed (Table 3).

The other important question is which variables (*i.e.* Age, Family size, Sex, Educational status, and Kebele) affect the income contribution of Lake Hawassa, and the results indicated that the total annual income and lake income contribution of the sample households there was no statistically influenced by kebeles, Age, sex and education status. Only sex was affected other (*i.e.* the sum of wage/salary, Wood and wood product, Grasses, Wild fruit trees, Water for domestic purpose, Livestock watering, Medicinal plants, Fertile land for crop growing, Honey for beekeeping, Sand for construction, Sand for sale, Pasture for grazing animals, Firewood for cooking, Washing body or close, Tourism) income contribution of the lake. The factors which affect for statistically significant at alpha 0.05 is significance level as shown in table 4.

Table 2. The type of income they have got due to the presence of Lake Hawassa.

Income source	Type of ESs	N	Economic valuation approaches	Min. income (Year/ ETB)	Max. income (Year/ ETB)	Avg. income (Year/ ETB)	Std. Deviation
Farming/irrigation	Provision service	62	Market value	100	900000	35,120.45	114066.674
Wage/salary	>>	14	Stated preference	800	48000	11,957.14	13647.018
Husbandry/fishing	>>	6	>>	1500	35000	10,903.33	12543.049
Fish for sale	>>	31	>>	400	50000	9,710.32	11527.25
Sand for sale	>>	9	>>	2500	20000	7277.78	5662.989
Fertile land for crop growing	>>	2	Change production	4800	5000	4900.00	141.421
Livestock watering	>>	102	>>	60	200000	4082.36	20441.897
Fish for house hold feeding	>>	101	Stated preference	120	72000	2811.42	7414.602
Water for domestic purpose	>>	109	Market value	96	100000	2728.73	9810.983

Fire wood for cooking	>>	19	Market value	250	5000	2459.47	1560.016
Wild fruit trees	>>	5	Market value	120	5000	2369.00	2422.768
Honey for bee keeping	>>	11	Market value	150	6000	2179.09	1758.354
Wood and wood product	>>	1	Market value	2000	2000	2000.00	.
Medicinal plants	>>	1	Stated preference	2000	2000	2000.00	.
Grasses	>>	42	Market value	100	12000	1909.17	2374.391
Pasture for grazing animals	>>	34	Market value	300	9600	1891.82	1849.177
Washing body or close	>>	98	Change production	96	10080	1354.88	2050.527
Tourism	Cultural service	2	Market value	500	2000	1250.00	1060.660
Sand for construction	Provision service	13	Market value	100	4000	1246.15	1130.351
Firewood for sale	>>	0	Market value				
Trading/providing hand Crafts for tourists	>>	0	Market value				
Poles for construction	>>	0	Market value				

Note: ESs- Ecosystem service; ETB- Ethiopian Birr; Min.- Minimum; Max.- Maximum; Avg.- Average; Std.- Standard.

Table 3. Households' income contribution of Lake Hawassa in selected kebeles.

Income source of lake	Cheleleka (year/birr)	Daleti (year/birr)	Galo Argisa (year/birr)	Gelelcha (year/birr)	Tulla (year/birr)	Significance
Wage/salary	4800.00	7000.00	3600.00	4200.00	18914.29	0.505
Irrigation			56136.65	24027.08	13726.50	0.814
Legal fisherman		5000.00		7973.33	18250.00	0.696
Grasses for livestock fodder	110.00		1330.29	2121.88	3342.86	0.184
Wild fruit trees			2780.00	725.00		0.529
Water for domestic purpose	6540.69	3028.57	1229.88	882.31	2106.89	0.177
Livestock watering	5517.92	25692.50	903.24	1340.50	1135.00	**0.029** *
Fish for house hold feeding	4931.20	2900.00	1424.62	1572.03	4700.00	0.343
Fish for sale	13600.00	9000.00		7510.00	6620.00	0.580
Honey beekeeping	883.33	800.00		2704.00	3500.00	0.310
Sand for construction	700.00			1900.00	1250.00	0.228
Sand for sale		8666.67		6583.33		0.636
Pasture for grazing animals	2666.67	1000.00	1473.47	1687.14	9600.00	**0.000** *
Fire wood for cooking	2320.00	3500.00	2675.00	1816.67	1800.00	0.789
Water for washing body or close	2487.59	1296.36	385.55	838.46	1609.6	**0.002** *

Note: * indicates the significance at p=0.01. ETB stands for Ethiopian Birr.

Table 4. Factors of total annual income and lake annual income contribution of Lake Hawassa.

Explanatory variables	Total annual income	lake annual income contribution			
		Irrigation	Fishery	Others	Total
Kebeles	0.453	0.421	0.263	0.585	0.813
Age	0.929	0.566	0.124	0.139	0.509
Family Size	0.772	0.897	0.106	0.336	0.843
Sex	0.792	0.704	0.688	**0.019***	0.811
Educational status	0.484	0.859	0.468	0.325	0.769

Note: Figures in the table indicate p-value (p=0.01) from the linear regression model.

DISCUSSION

The main livelihood strategy of the local community is agriculture, mainly from the irrigation. This finding similar to the Shewit *et al.* (2017) study, which stated that the backbone of development in Ethiopia is agriculture and this activity, is mainly practiced at the expense of the aquatic resources, particularly wetlands. A similar study in rift valley Lake Ziway was the average annual household income from irrigation (Gezahegne, 2015). In Ethiopia, irrigation and fishery is the most common source of income along with living near or the borders of the lake (Tenalem, 2004; Tenalem & Degnachew, 2007; Spliethoff *et al.*, 2009; Chance, 2016). However, in the cause of Lake Hawassa, wages or daily laborer are high individual incomes than fishery because of high-quality sand accumulation in the lake and the local community to dig out those sands for the investor with good pay, and these views also support by Wondie (2010).

The importance of this study, to show the ecosystem service (only some of the provisioning and cultural service) were converted into monetary value for the local and national economy because of the total economic value of unconverted wetlands is often greater than that of converted wetlands (François *et al.*, 2005). While it can be difficult to calculate the economic value provided by a single wetland, there are some ways of the ecosystem service of wetlands that are converted into monetary values. For instance, areas of intact mangroves wetlands in Thailand have a total net present economic value calculated based on the economic contribution of both marketed products such as fish and non-marketed services such as protection from storm damage and carbon sequestration at the range of $1,000 - $36,000 per hectare compared with about $200 per hectare when converted to shrimp farms (François *et al.*, 2005). Thus result showed that the total economic values of protected wetlands are at least five times greater than that of converted wetlands. They serve to slow down storm flood, trap sediments, protect property damage in downstream, and the siltation of dams (Amsalu & Addisu, 2014). A global value for ecosystem goods, services, biodiversity, and cultural considerations of US$ 6,579x109 $year^{-1}$ has been estimated for all inland waters and wetlands in comparison to US$ 5,740x109 $year^{-1}$ for all other non- marine ecosystems combined (Junk *et al.*, 2013). Globally, the monetary value of ecosystem services provided by all wetlands amounts can be impressive. According to one assessment of natural ecosystems, the dollar value of wetlands worldwide was estimated to be $14.9 trillion (Costanza, 1989). This fact, thus studies the value of wetlands contributes to the economy.

Furthermore, the importance of this study point towards to developed our country a Natural Resource Accounts (NRA) for endowed wetland resources. You know a country's economic performance is measured in terms of its national income and asset base, and the average income per capita is a common indicator of societal wellbeing. National income is calculated in the National Accounting process, which generates various measures of income such as Gross Domestic Product (GDP), Net Domestic Product (NDP) or Net National Product (NNP). The National Accounts quantify the value of capital assets and the annual value of production at a national scale. As a supplement to the national accounts, many countries have now also developed a number of Natural Resource Accounts (NRA) for various natural assets such as water and minerals (Lange *et al.*, 2003). The NRA production accounts measure the use-value, in terms of contribution to Gross National Product, of the natural resources each year, and as such are normally included in the national accounts. The NRA asset accounts measure the value of natural resource stocks as capital assets (Turpie *et al*., 2010).

Generally, Lake has greatly contributed ecosystem service in terms of monetary value (directly/ indirectly) for local and national economy, this include provisioning service (irrigation, fishery, Wage/salary, Wood and wood product, Grasses, Wild fruit trees, Water for domestic purpose, Livestock watering, Fish for household feeding, Fish for Sale, Medicinal plants, Fertile land for crop growing, Honey for beekeeping, Sand for construction, Sand for sale, Pasture for grazing animals, Firewood for cooking, Washing body or close), cultural service (Tourism), and other non-monetary value (regulating and supporting service). Similar findings are stated in terms of ecosystem service (Abebe & Geheb, 2003) and wetlands in the Lake Tana (Wondie, 2010). Generally, wetlands are provide a host of ecosystem services that benefit their surrounding populations, such as flood control, water purification, sediment and nutrient retention, dry season grazing, agriculture, microclimate stabilization, recreation and cultural values, water supply (domestic and livestock), construction (thatching reeds), medicine, and habitat for birds (Lamsal *et al.*, 2015; Shewit *et al.*, 2017). Ethiopia has 73 important bird area 'hot spots', of which 43 are wetlands that provide shelter to endemic, globally endangered, vulnerable and near-threatened bird species (Ayinalem, 2007; Moges 2008). These habitats are becoming increasingly recognized as among the most productive natural resource s, because of their ability to fulfill a range of functions and produce a number of products that are socially and economically beneficial to the local community (Dugan, 1990). Ecologically, wetlands are instrumental in water storage, filtration, and supply, flood control; perform sediment, nutrient and retention functions and habitats for the biodiversity of both flora and found (Abebe & Geheb, 2003).

CONCLUSION

Wetlands provide multiple economic, social, cultural, and ecological functions and services that are crucial for the local, national and global society. Even if the researchers give more attention to wetland loss and status, the actual extent of wetland loss on a global scale, particularly the cause of human activities are remains uncertain (Hu *et al.*, 2017).

This study inspires the policymaker, local community, governmental and NGO bodies by figure out the ecosystem service in terms of monetary value; how much contribute to the local and national economy, the threatening factors and its possible action will be taken. This leads the governmental bodies to design appropriate policy intervention for its conservation, mitigation, and restoration through economic value valuation methods. Because the lake is under high risk

of deleterious anthropogenic activities and it needs more attention, effort, and commitment at all levels, from grassroots to decision and policymakers, in order to minimize and reverse the threats and to bring a sustainable solution to the problem.

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