

Article

Assessing the effects of wetlands fragmentation and degradation in Silte Zone, Southern Ethiopia

Mohammed Essa¹, Solomon Ummer²

¹Department of Economics, Werabe University, Werabe, Ethiopia

²Department of Natural Resource Management, Werabe University, Ethiopia

E-mail: mohammedessa443@gmail.com

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Abstract

Wetlands are one-of-a-kind environments that provide services throughout the year, both in the dry and rainy seasons. They are, nonetheless, the terrain that is most threatened by human activity. As a result, the purpose of this research was to look into the effects of wetland fragmentation in the Silte zone in Southern Ethiopia. The households were chosen at random from a total of 140. The data was examined with descriptive statistics and econometrics model analysis in SPSS version 20 / Stata version 16. The findings reveal that local populations in the research area are aware of the direct benefits of wetlands but are less aware of the indirect benefits. Improper agricultural operations, settlement growth, overgrazing, deforestation, and sand extraction were identified as important factors of wetland degradation in the study. Logistic regression model demonstrated a significant ($p < 0.01$ or $p < 0.05$) relationship between deforestation, degradation, settlement, institutional effectiveness, overgrazing, distance from the wetland and population pressure. The findings from this study provide significant clues for further research and baseline information for local government and communities in the development of more effective and holistic approaches for reducing wetland degradation in natural ecosystems. In spite of the complexity and multifaceted nature of the problems, however, there is no quick and one-off solution to redress the threats being faced to Mendifa wetland. In order to reverse these emerging problems and conserve these fragile but crucial wetlands, integrated problem solving approach through realizing the collaboration of relevant stakeholders from policy level down to grassroots community is indispensable opportunity to the wetlands.

Keywords determinants; Mendifa; fragmentation; wetland.

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1 Introduction

Armed spending is a significant question for the global economy. It has impact beyond the Wetland resources in Ethiopia are considered as an integral part component of the environment in the country and provide a wide

range of social, economic, and ecological benefits (Tessema et al., 2013). These wetlands are distributed throughout the country from the lowlands of afar depression to the highlands in the bale mountain (FAO, 2008).

Ethiopia owns different types of wetlands which have regional, national as well as global ecological and socio economic significances. Despite all those and other indispensable values, these wetlands are under severe pressure and degradation. Due to human/climate impacts like traditional and modern agricultural expansions, continuous land degradations, urbanizations and industrializations; and ecological problems are the most dominant challenging factors of wetlands in the country. Absence of policy and proper institutional arrangements are the key factors limiting affirmative actions against the degradation of Ethiopian wetlands (Legesse, 2007).

To develop and firm their continuity for the future, cost should be paid to understand the dilemmas that they face and in identifying the good practices which should be strengthened. Therefore, the intent of this review paper is to summarize the threats of Ethiopian wetlands that suspicion their continuity, identifying the possible consequences and strategic policies that can be opportunity in reducing these threats (Bekele et al., 2018).

There are many reasons for which wetlands are degraded either by natural or manmade factors considering the fact that the wetland is the main livelihood asset of many rural and urban dwellers, coupled with the large sizes of recent wetland degradation and drying, this study focuses on the assessing determinants, effects and management practices of wetland fragmentation in Silte zone, southern Ethiopia. Globally, wetlands play important role in ecological, economic, social and cultural functions. Wetlands (mainly rivers and their associated flood plains) have been the heart of human civilization (Mateos, 2004). Thus, wetland resources have played key role throughout the development and survival of humanities. In general, wetland resources contribute billions of birr to people of Ethiopia every year in the form of clean water, pure air, soil formation and protection, crop pest control, and provision of food, fish, fuel, fiber, medicine, recreation, tourism, etc. The reckless attention given by people and policymakers to wetlands is highly damaging these ecosystems. So far, a large number of studies have looked at wetland degradation; however the associated major determinants, and effects and management practices of Mendifa wetland have not been adequately examined. Studies in the country have often focused on the assessed level of community's perception on wetland conservation.

Hence this study focuses on these objectives: (1) To examine the causes of wetland fragmentation in the study area, (2) to investigate the status of marshland fragmentation in the study area, and (3) to estimate the determinants of wetland fragmentation in the study area.

2 Study area and Methodology

2.1 Study site

The study was conducted in the Rift Valley nearly 160 km southwest of Addis Ababa, which is the capital city of Ethiopia. Geographically, it locates at 8 0 02 ' 36.1" N & 38 0 10' 8" E and 7° 42' 0N & 38° 12' 0E and altitude of 1835 m above sea level. The wetland is situated in a remote area 15 km from a small village in the township of Silte.

2.2 Data collection

2.2.1 Sampling techniques and sample size determination

In Silti District there are more than 15 beneficiary districts that lie on adjacent of Tuffa to Mendifa wetland. Within these beneficiaries three rural districts were randomly selected and from the list of total households of the 3 rural districts sampling frame were proportionally organized and the sample size were determined (Table 1). Several rules-of-thumb has been suggested for determining the minimum number of sample households

required to conduct logistic regression analysis. The study used a method developed by Green (1991) to select the total sample size from the total households. He suggested a rule-of-thumb that $N \geq 50 + 8m$, where N is minimum number of sample households required to conduct multiple regression analysis and m is the number of explanatory variables used in the regression analysis. The explanatory variables used in this study were fourteen. So that the minimum sample size is $N \geq 50 + 8 \times 12 = 146$. But for analysis, 140 samples were used in the analysis because six observations were with incomplete information.

Table 1 Sampling technique and sampling determination.

Sampled districts	Total household	How to compute	Total sample
Ashuta B.	3952	3952*140/11553	47
Ashuta B.	3952	3952*140/11553	47
Goflela	4765	4765*140/11553	60
Balo K.	2796	2796*140/11553	35
Total	11553		140

Source: District Agricultural and Rural Development Office (2020/2021).

Both quantitative and qualitative data were used in this study. These data were collected via primary and secondary data sources. To collect these data, different data collection methods were employed.

Primary data were collected by using tools including household survey. Key informant interviews and focus group discussion were employed to produce primary data. Questionnaires were prepared in both open ended and close ended forms and were distributed among 140 households living in and around the wetland. A group of eight people including community leaders, the elderly, youth and women were randomly chosen to participate in each FGD. Three focus group discussions were conducted one from each kebele. In addition to primary data collection secondary data were collected from different sources. The data that were collected from secondary sources include related documents studies, wetland fragmentation and degradation level and other useful written materials needed for the study from internet sources study reports survey reports and other significant published papers. The purposes of using these secondary data were to identify the triggers and impacts of wetland fragmentation due to socio- economic factors and its impacts.

2.2.2 Data analysis

The collected data were analyzed by using SPSS/STATA software. The analyzed data were interpreted and presented by using tables, figures and percentages. While econometrics model like logit were used to analyze the determinants of wetland fragmentation whereas controlling and management mechanism of wetland degradation was analyzed by content analysis or narration.

2.3 Binary Logistic Regression Model

Regression models in which the dependent variable is dichotomous can be estimated by logit or probit models. Logit and Probit models give guarantee for the estimated probabilities increases but never lie outside (0, 1) interval and the relationship between probability of event (P_i) and the explanatory variable (x_i) is nonlinear (Gujarati, 2004). Therefore, for this study binary logit Model is used to

$$Y_i = x_i\theta + e_i$$

where, $e_i/x_i \sim N \{0, \delta^2\}$

$$\text{Willingness to engage in wetland fragmentation} = 1, \text{ if } y_i > 0$$

$$\text{Willingness to engage in wetland fragmentation} = 0, \text{ if } y_i < 0$$

$P(\text{willingness to engage in wetland fragmentation } e = 1/x_i) = P\{y_i > 0/x_i\} = P(x_i\theta + e_i > 0/x_i)$

$P(\text{articipat}) = \ln [P_i/(1-P_i)] = \beta_0 + \beta_1 \text{age} + \beta_2 \text{sex} + \beta_3 \text{hh} + c + B_5 \text{educ} + B_6 \text{Fs} + B_7 \text{defot} + B_8 \text{AWA} + B_9 \text{erosion} + B_{10} \text{settr} + B_{11} \text{inst} + B_{12} \text{pps} + B_{12} \text{graz} + e_i$

3 Results and Discussion

3.1 Analysing factors for wetland fragmentation

As it was concluded by Dereje (2008), inappropriate agricultural activities in the catchment and cultivation of buffering zones have adversely affected wetland ecosystems. It is clear that catchment degradation and cultivation of wetland buffering zones enhance the rate of soil erosion and aggravate the discharge of pesticides, herbicides, agricultural runoff and sediments into the wetland and thereby affects its ecological integrity and reduces the various services of wetlands. This problem also takes place in the wetlands of the study area for further agricultural expansion imposed by rapid population rate. Runoff from surrounding agricultural areas are moved and piled in to wetlands due to clearing of trees and vegetation by the local communities. As trees are cleared, the wetlands are prone to agricultural activities and diverted through digging some ditches to take the water from wetlands to other areas for further cultivation.

The other problems of the wetlands pertaining to cultivation is double cropping and intermixed cropping which further degrade the ecology of these wetlands .

The other factors of fragmentations are overgrazing and deforestation accounts (77% and 73%) respectively. The findings is also supported by those in a study conducted by Ngana et al. (2010) which reported that pastoralism is wide spread in Ruvu sub-basin due to large livestock migration that has been taking place over the years from various regions to Ruvu basin due to the availability of good pasture and water. Wetlands are presently faced serious ecological problems due to deleterious anthropogenic activities in the catchment. Clearing of forest, double cropping and use of fertilizers, herbicides and pesticides all contribute towards the damage of these indispensable ecosystems. As the respondents confirmed cultivation within the wetlands mostly during the dry season are common. This study conforms to Dereje (2008), who reported that inappropriate agricultural activities in the catchment and cultivation of buffering zones have adversely, affected wetland ecosystems.

It is clear that catchment degradation and cultivation of wetland buffering zones enhance the rate of soil erosion and aggravate the discharge of pesticides, herbicides, agricultural runoff and sediments into the wetland and thereby affects its ecological integrity and reduces the various services of wetlands.

Table 2 Areas of wetlands fragmentation in ha during 1975s and the recent.

Year	Area (ha)	Percentage (%)	Remarks
1975	66970	30	
1987	49825.68	25.6	
1992	37120.1	25.5	
2001	27283.3	26.5	
2010	25155.3	7.8	
2019	24274.57	3.5	

Source: Data from study area compiled from document (1975-2019).

3.2 Analysing the progress status of wetland fragmentation in the study area

The area of wetland changed most sharply between 1975 and 2010, reducing by between 30% and 25.6% while there is also slightly increased during 1992 to 2019 that is up to 25.5 to 3.5% (Table 2). The decrease of

wetland area mainly occurred in the periods of 1975 to 1987 and 2001 to 2010, with slow increase of from 1992 to 2001. The areas of wetlands decreased to 24274.57 ha, while the percentage of wetlands respectively increased by 30% and 7.8% between 1975 and 2010. Except for the period from 2010 to 1992, the area of wetland decreased continuously. The wetland area decreased except for the period of 2010 to 2019.

3.3 Indirect determinants of wetland degradation

Most of the respondents (94%) agree that poor watershed management is the major indirect factors of Mendifa wetland degradation. The hydrological balance of the wetlands can be kept for long-term through proper management of watershed; however, due to lack of well-planned watershed management Mendifa wetland degradation. This is in line with Mekonnen and Yared (2018), who reported that due to lack of proper watershed managements, it is quite common to observe when the upstream users divert or excessively use the water and abuse the right of the downstream users, and this ultimately lead to the over exploitation or unwise use of the water resources within the watershed this causes wetland degradation. According to the respondents' views, population increase was also the major triggering factor for wetland loss in the study area it accounts (87%). The population growth and wetland loss of the study area have direct relationship. When population growth increased, wetland loss also increased. In this regard, Girmay (2003) stated that the Ethiopian highlands have experienced a serious LULC dynamics for the last hundred years due to continuously growing population. This study also approved that population pressure adversely degrade wetland resources and it is the means for other related factors. The number of population in the area was increased however, the agricultural area remains the same so that the community is forced to convert and clear wetlands to other land use forms/modifications in an unsustainable way. Similarly, Kameswara et al. (2011) in their study on southern part of Lake Tana basin (GilgelAbay watershed) reported that, the population is growing rapidly and is over-utilizing the resources and brought the scarcity of land, deforestation, over use of lake's water and soil erosion from the catchment. So this could result in immediate effect on the livelihood of the community either through reduced agricultural productivity or through depleting wetland resources which can further result in high climatic variability in the area (IFAD, 2004).

On the other hand poor knowledge and lack of awareness about wetland and institutional factor are also indirect determinant of wetland degradation in the area it accounts (81% and 75 %) respectively. Majority of the societies in the study area are not well informed on the socio-economic benefits and ecosystem services of the wetlands and considered as waste lands. This is similar with Mafabi (2000) that one of the most prominent factors underlying wetland management problems in Kenya as observed elsewhere has been the lack of or insufficient awareness of the functions and benefits of wetlands leading to inappropriate use of their resources. This is also supported by a study of Finlayson et al. (1999), which shows that lack of adequate information and awareness on national inventories on wetland degradation indicates the real extent and loss of wetlands as well as consequences of that degradation as the main reasons for persistent wetland degradation. Local communities, governmental and non-governmental organizations use wetlands in uncoordinated manner and this approach is affecting the vigor of wetlands and speeding up their degradation. The absence of an institution duly empowered to issue and implement wetland laws and coordinate management activities is the underlying determinant for the deterioration of the wetlands.

3.4 Estimating factors that affect wetland fragmentation degradation and in the study area

3.4.1 Distance

As shown in the above distance away from the wetland was statically significant at 1% probability level. The negative coefficient and significant effect of household distance from wetland indicates its negative influence on wetland fragmentation which was as expected. The marginal effect estimates shows, that keeping the influences of other factors constant, one km increase in the distance of the household head reduces the

probability of degrading wetland by 5.3%. This may be due to that the farther the village the household live on about they are getting far there and participation in fragmentation of wetland might not give additional satisfaction. Similar findings of Sakuria et al. (2015) noted a significant and negative relationship between the largest patches of tall arid brush were far away from villages and at low housing density, while patches were more isolated near towns. The patch size of calcareous tall grass steppe was larger close to villages but negatively related to housing density. Patches were more isolated near villages and isolation was positively related to housing density (Table 3).

Table 3 Determinants of wetland fragmentation.

Var	Coeff	St. err	P>Z	Mar Eff
Edu	0.00316	0.004465	-0.48	-0.003
Dis	-0.05384	0.010287	0.000***	-0.053
TLU	0.002569	0.003554	0.471	0.0025
Age	0.001093	0.001767	0.537	0.001
Inf.E	-0.09762	0.051474	0.060*	-0.097
Aware	-0.06423	0.08324	0.442	-0.064
PP	0.148053	0.061827	0.017**	0.148
Graz	0.119453	0.045837	0.010**	0.119
Defo	0.169724	0.069086	0.015**	0.169
Sett	0.142392	0.066164	0.03**	0.14
Arable	0.000047	0.047869	0.99	0.0005
Errors	0.097948	0.098023	0.32	0.1
Constant	0.358779	0.148992	0.017	-

Y = Pr (predict) = 75 %, R2 = 85%, Number of obs = 140

***, ** and *: significant at 1%, 5% and 10% probability levels, respectively

3.4.2 Status of institutional arrangements

Effectiveness of local informal institutional arrangements was statically significant at 10% level. The marginal effect estimates shows, that keeping the influences of other factors constant in cases of where the local institutional arrangements, the effectiveness of institution 9.7% time less than ineffective institutional arrangement. This means that the ineffectiveness of informal institutions accelerate wetland degradation by 9.7%. This is due to that the institutional arrangement effectiveness in the study area never restricts illegal activities and allows things that are forbidden in fragmenting of wetland resource. This study is contradicts with (Badal et al., 2006) who noted a significant and positive relationship between availability and effectiveness of local institutional arrangement of household and the probability of fragmentation on conservation of wetland but it is in line with a study done by study of Hirpo (2018) which states that Decision makers at higher levels are required to strengthen sustainable wetland management efforts through effecting policy and legislation, improving institutional arrangements and supporting capacity building initiative.

3.4.3 Population

Population pressure was statically significant at 5% level. The marginal effect shows that, holding other variables constant; increase in population number (household number) by one person increases wetland fragmentation by 15%. This study is in line with a study done by (Kangalawe and Liwenga, 2005) at Kilombero wetland which is one of the wetlands which have been characterized by increased population pressure, high livestock population and increased demand for land resources As the size of the population

grows, people are compelled to clear land for agricultural activities to ensure their survival in conditions where alternative means of existence.

3.4.4 Deforestation

Deforestation was statically significant at 5% level. The marginal effect shows that, holding other variables constant; people who didn't perceive the existence of increase in deforestation (cutting tree) within the community were 17% times more likely to contribute wetland fragmentation than those who perceive the existence of increase in level of deforestation. This study is in line with study of Msofe et al. (2015), which implies that when most of the household need to produce more food to sustain their families, consequently results into agriculture expansion into marginal areas, agriculture intensification and deforestation.

3.4.5 Settlement

Settlement was statistically significant at 5% level. The marginal effect shows that, holding other variables constant; people who didn't perceive the negative impact of increase in settlement within the community were 15% times more likely to contribute wetland fragmentation than those who perceived the negative impact of increase in settlement. This study is similar with studies done by Derso et al. (2015) and Gebretsadik Mereke (2017). On lake Tana an attempt to convert to farmlands (settlement) are causing severe deterioration to wetlands and their surroundings in Ethiopia, with study conducted by Zhao et al. (2021).

3.4.6 Grazing

Grazing was statically significant at 5% level; the marginal effect shows that, holding other variables constant; people who didn't perceive the negative effect of increase in grazing on wetland were 12% times more likely to contribute for wetland fragmentation than those who perceive the negative impact of increase in grazing. This study is consistent with the study conducted by Yu et al. (2015) whom developed an estimation model of freeze-thaw erosion and applied it to the Silingco Watershed.

4 Conclusion and Recommendation

4.1 Conclusion

Ethiopia is endowed with a significant number of wetlands, which could contribute to the social, economic and ecological development of the country. However, large shares of these wetlands are under threat due to an immense pressure from anthropogenic as well as natural factors, though the anthropogenic factors contribute a lot. The study also shows that local communities in the study area has higher awareness on the direct values of wetland but low awareness on the indirect values of wetland since majority of them ranked most the direct values of wetland. Majority of the respondents reported that farming along the wetland and water for domestic use are the most significant values they obtain over years from using wetland while very few respondents mentioned the indirect values that wetland provides to them. This study found the major determinants of Mendifa wetland degradation which includes improper agricultural activities, settlement expansion, overgrazing, deforestation and sand extraction. Through these improper agricultural activities and settlement expansion are the major drivers of wetland degradation in the study area. In addition, the survey result shows that there are indirect determinants of Mendifa wetland fragmentation /degradation which includes poor watershed management, population pressure, poor knowledge and lack of awareness about wetland and weak local institution. Due to these, most of the communities are not interested to conserve this fragile resource. As a result of these occurrence of flood and erosion, lack of water access, decreasing of crop yield, loss of biodiversity and climate change are the major impacts of wetland degradation in the study area. Deforestation, population pressure, institutional failure, overgrazing, settlement expansion as a result of increase in the need/demand for agricultural land are the factors that accelerate wetland fragmentation . In spite of the

complexity and multifaceted nature of the problems, however, there is no quick and one-off solution to redress the threats being faced to Mendifa wetland.

4.2 Recommendation

Most of the respondents in the study area mentioned that, Mendifa wetlands are being depleted from time to time due to both natural as well as anthropogenic pressures especially the later one is clearly observed in the area. Hence, the issue of appropriate management is an urgent need.

Generally, to alleviate those constrains we need to follow the following guiding principles for sustainable wetland management like:

1. The community and different stakeholders should own the wetlands in their surrounding and should be responsible for their action and work together to sustainably manage the wetlands.
2. Watershed management should be intensified so as to decrease the load of sediment that enters to the wetland like afforestation programs, soil and water conservation activities.
3. The government should work on awareness creation activities on the community through education.
4. The community and different stakeholders should own the wetlands in their surrounding and should be responsible for their action and work together to sustainably manage the wetlands.
5. There should be responsibility with in the community members to use wetland resources wisely.
6. There should be a clear demarcation between wetlands and other land use types so that people can't degrade and convert wetlands as they like.
7. The government should start restoration activities that involve the interest of the stakeholder for promoting wetland management.
8. Wetlands should be conserved based on the interest of the community on the basis of economically viable plus environmentally sustainable way.
9. Existing wetland management are rigid and no intuitions are stand for wetlands hence, Strong institutional arrangement is mandatory to get the long-lasting fruit of wetland values effectively and efficiently.
10. Strong and integrated institutional arrangement frame work is very vital in controlling flooding, overgrazing and the re-settlement on the hearty wetlands.

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