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Fruit Based Farming System and Threatened Landscape in the Wetlands of Abaya Chamo Basin, Southern Ethiopia

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ABSTRACT

Ethiopia has diverse climate and altitude conditions, which are suitable for growing both tropical and temperate fruits. To this regard, wetlands in Abaya Chamo Basin have a promising potential for fruits and horticulture farming. But due to human induced constraints, the study wetlands are under immense pressure of degradation. The objective of the research was to examine the economic and environmental effect of fruit –based farming system in the wetlands of Abaya Chamo Basin. In the study mixed research approaches, specifically concurrent triangulation strategy was utilized. Data was collected both from primary and secondary sources. Using purposeful sampling technique three kebeles were selected as sample kebeles. From these kebeles, 180 sample household heads were proportionally selected as sample size using systematic random sampling technique. Finally collected data was analyzed using statistical package for Social Sciences, SPSS and Geographic Information Techniques, GIS. Furthermore, qualitative data was also elaborated using narration.The study findings revealed progressive transformation of land use types from traditional cropping system (sorghum, cotton and sweet potatoes) into more market oriented fruits and horticulture system. The survey data showed that mixed agriculture, (49.4%), cereals (18.9%) and fruit and horticulture (14.4%) are the three top reported household income sources in the area. The analysis of two period (1985 to 2016) satellite data showed that wetlands are dwindled by 663 hectare (20.7 ha per year) at the expense of cropland, which was increased by 506 hectares (15.8 ha per year). In Lake Abaya Chamo Basin, among others farmland encroachment into buffer areas (43.9%), deforestation of wetland (7.8 %), over-grazing (7.8%) and awareness related constraints (6%), development of saline soil (5.6%) and weed infestation (water hyacinth) are the top mentioned environmental challenges. Thus, to revert wetland degradation upland management, Lake buffer protection and increased institutional commitments are areas of intervention, which requires due attention.

Keywords: Geographic Information System, Satellite image, wetland conservation, Wetland policy, Smallholder farmer.

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1. INTRODUCTION

Ethiopia has diverse climate and altitude conditions which are conducive to various agricultural activities. Having such diverse agro ecology, it is suitable for growing both tropical and temperate fruits. Its Substantial areas receive sufficient rainfall and many lakes, rivers and streams could also be used to support fruit production.

Most of the soil types in fruits and vegetables producing regions of the country range from light clay to loam and are well suited for horticultural production. Endowed with favorable soil, water and ecological conditions, the potential to develop horticultural crops, such as fruits, vegetables, root crops and cut flowers is great in present Ethiopia. Despite this potential however, the area under fruits is very small and mainly smallholder based. According to the Ministry of Agriculture and Rural development (MoARD, 2005), the area under fruits is about 43,500 ha with a total annual production of about 261,000 metric tons of which less than 2% is exported. Even though the number of fruit farmers in Ethiopia seems large, they grew unimproved fruit varieties in small scale farms to support household livelihood. Due to low market value and traditional consumption pattern, for most Ethiopian farmers, fruit and vegetable cultivation is not the top priority rather it is a supplementary to crop production.

But currently in the study area, the situation is contrary,where improved tropical fruit trees such as Banana, Papaya, and Mangoare grown as a specialty treeapart from the emerging horticulture crops such as onion, tomatoes and tobacco) which was cultivated for commercial purpose.Before three to four decades, Maize, Cotton and Sweet Potato were the dominant crops grown in traditional smallholder farms, but currently due to the growing market demand of fruits, infrastructural development and introduction of improved banana varieties the traditional cereal based cropping patternwas gradually transformed intomore market oriented specialty fruit trees system.”

In Ethiopia, wetlands are found in almost all ecological and altitudinal ranges covering approximately 2 % of the country’s total surface area (EMNRA, 2008). It is used by the rural community as a source of livelihood for a very long time. While, wetlands are among the most productive and beneficiary ecosystem but they are the most threatened landscape in Ethiopia (Abebe, 2003). Sources have documented wetlands in Ethiopia as the most vulnerable, exploited and mismanaged zones, which have lost their regeneration capacity (Alemayehu, 2006 and Mckee, 2007).

Due to increasing human population, promising price of fruits and vegetable at the national market the wetland areas are progressively transformed into farmland including. Thus downstream siltation due to upland degradation and encroaching fruit farms into the buffer areas has further threatened wetland biodiversity and the Lake too. In addition, institutional commitment and legal framework for developing and ensuring the sustainability of wetlands is lacking in the area. Thus in order to develop and use wetland resources wisely, therefore, past and present status of these resources should be carefully assessed and identified. These problems have initiated the researcher to purposefully choose Abaya-Chamo basin as a research site. The objective of the study is to examine the contribution of fruit –based farming system to the livelihoods of the households and thereby evaluate the environmental effect of the fruit based farming system in the wetlands of Abaya Chamo Basin.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was conducted in the middle Rift Valley System of Ethiopia, mainly in Abaya Chamo Basin. Astronomically it lies between 5° 20’ N to 7° 15’ N latitude and 37° 00’ E to 38^{0} 40’ E longitude (Figure 1). The Rift valley Basin consists volcanic Graben, small domes and

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plain landscape and lakes. Scattered woodlands, thickets, pockets of riverine and wetland vegetation are the dominant vegetation in the area.

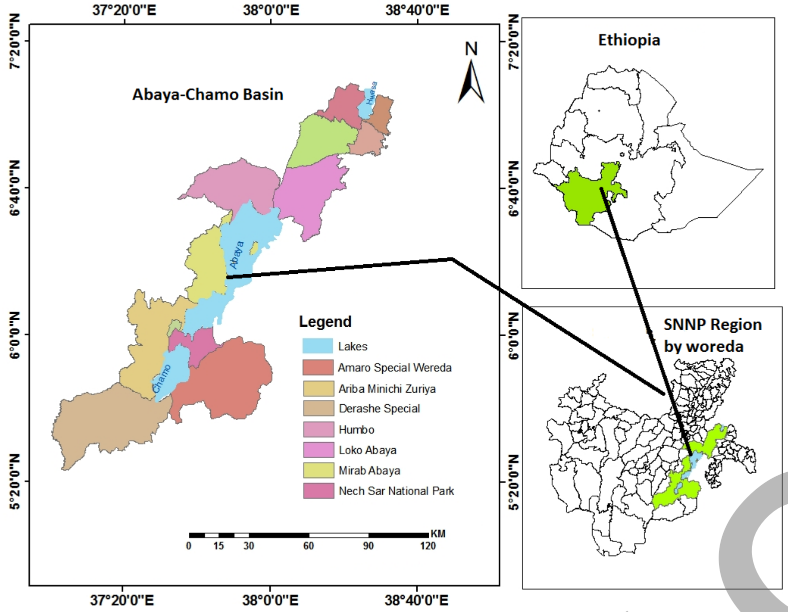

Figure 1: Map of Abaya Chamo Basin

The study wetlands support more than a hundred species of water birds, hippopotamus, crocodiles, monitor lizards and Colobus monkeys etc (Tilahun *et al*., 1996). According to soil groups of FAO, Food and Agriculture Organization , in the study area there are ten soil types (Figure 3). Of these Vertisols (43%), Fluvisols (17.1%), Luvisols (7.4%), Acrisols (6.6%) and Xerosols (5.2%) are the dominant soil groups. But Vertisols and Fluvisols are the top dominant (60 %) soil types in the Lake basin.

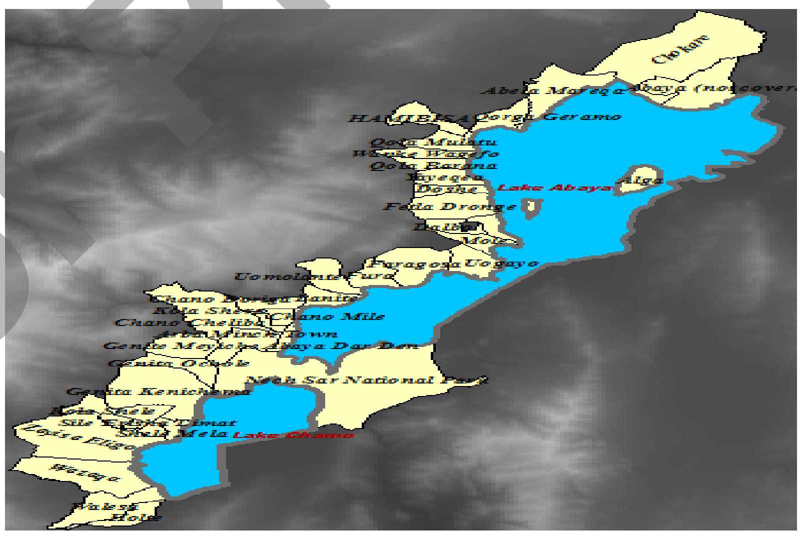

Figure 2: Map of Abaya-Chamo Basin, Southern Ethiopia

Vertisols typically formed from highly basic rocks, such as basalt and characterized by their extensive cracking and seasonal drying. As a result most of the Vertisols in the study area suffered from excess water and poor workability and are also

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underutilized. But Fluvisols are young soils found typically on flooded plains close to the Lakes and rivers, which are periodically affected by flooding, water logging or rising of groundwater. But they are productive and currently under intensive cultivation (Fig. 3).

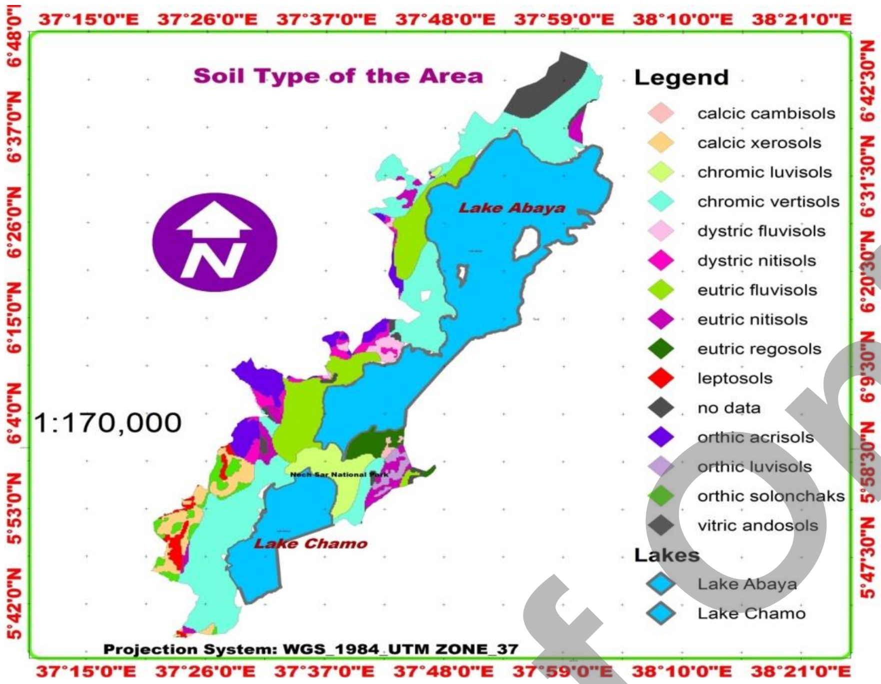

Figure 3 Soil types in Abaya-Chamo Basin, Ethiopia

Abaya-Chamo basin is characterized by hot sub-humid dry climate and received bimodal rainfall pattern (usually between September to November and March to May), where July, December, January and February are the moisture deficit months in the area (Fig. 4).

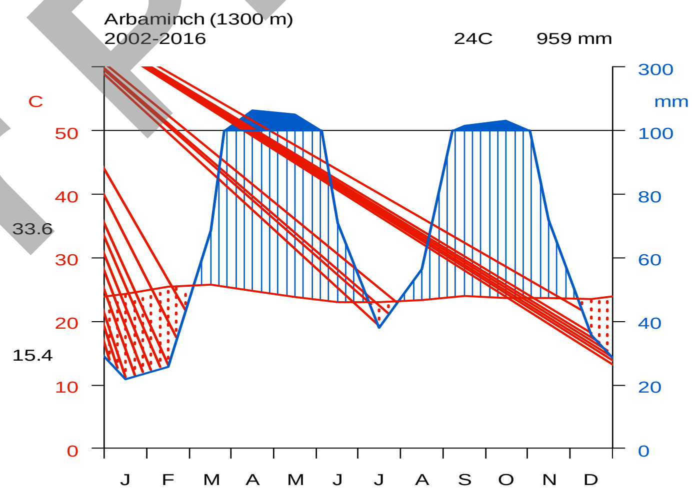

Figure 4Walter's climadiagram for Arba Minch (2002-2017)

In Abaya Chamo basin, rainfall was more variable during spring season (April, May and June) as compared to summer season (July, August and September). Thus, computed coefficient of variation of rainfall was 39.8 % and 12.8 % in*'spring' and summer* season,

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respectively Table 1). But, monthly temperature variation is very low i.e. 22.7 ^{0}c and 25.70c in July and 25.7 ^{0}c and March respectively.

Table 1 Mean and Coefficient of Variation of Rainfall in Abaya-Chamo Basin (1980-2017)

Year	Rainfall (mm) (*Belg* season)		Rainfall (mm) (*Meher* season)	
	Mean	CV	Mean	CV
1980-1998	111.8	34.4	61.4	12.7
1999-2017	121	47.4	56.9	13
1980-2017	116.4	39.8	59.2	12.8

Source: Computed from Meteorological data of Arba Minch Station

According to Central Statistical Agency, CSA (2014) human population in the study area is about half a million. Perennial fruit trees covered a significant portion of cultivated land (23.7%). Currently, due to promising demand at the national market, fruit products such as Mango and Banana along with vegetables such as Tomatoes and Onion, household income of the community showed significant improvement.

2.2 Research Design and Source of Data

Research design helps the researcher to plan in advance of the method to be adopted for collecting the relevant data and techniques to be used during analysis. It is a logical sequence that links the empirical data to the research problems and ultimately to its objectives (Creswell, 2012). To get the general picture of the issue under investigation more deeply mixed research approach, specifically concurrent triangulation strategy (both qualitative and quantitative methods) was used. The purpose of triangulation design is to obtain complementary data on the same topic and to validate quantitative result with qualitative data (Creswell 2003). As stated by the same author that mixed methods enables to better understand the problem more comprehensively.

Bergman (2008) reported that mixed method is often used to overcome a weakness of one method with the strengths of another and it serves for the purposes of triangulation and complimentary illustration of data. Hence, in collecting data the researcher focused on cross-sectional survey design. These approaches gave wider chance for data collectorsto access data from varying sources (Creswell, 2009). Therefore, in the study primary data were generated fromresults of household survey, focus group discussion and field observation, while secondary data were collected from satellite imaginaries (of 1985 and 2016), metrological agency and from reports of Central Statistical Agency.

2.3 Sampling Technique & Instruments of Data Collection

In this study, multi-stage sampling procedures were used in the sampling techniques. The first stage in the sampling procedure was selection of sample kebeles. In this case, three kebeles (*Abaya Goricho, Mole* and *Ganta Kanchame*) from three woredas (Arba Minch Zuria, Humbo and Mirab Abaya) were purposefully selected in view of its emerging severe wetland degradation and the resultant livelihood improvement.

In the second stage, household sample size determination was undertaken using the formula after Yemane (1967).

$n= N/1+N (e)^{2}$,

Where n is sample size; N is total household heads; e is sampling error (0.07). Accordingly,

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to administer household survey 180 sample size was taken from 1506household heads. In this case, selection of sample size from each sample kebele was undertaken proportionally using stratified random sampling technique (Table 2).

Table 2: Total Household heads and sample size

Sample Kebele	Total Household heads			Sample size		
	M	F	T	M	F	T
1. Abaya Goricho	488	54	542	58	6	64
2. Mole	243	24	267	29	3	32
3. Ganta Kanchame	658	39	697	79	5	84
Total	1389	117	1506	166	14	180

Source: Respective Rural Kebele Office, 2016

Supplementary data were collected through key informant interview, focus group discussion and field observation. In addition, land use/ cover data was collected from satellite imageries. To check the validity & reliability of survey questionnaire, pre-test on non-sample respondents was undertaken with close monitoring of the researcher and correction was made on the results obtained.

Satellite image processing

Remote sensing and geographic information system, GIS has been efficient and powerful tool in providing reliable information on natural resource classification and mapping of land-use/ cover change over space and time (Roy et al., 1991). In remote sensing data analysis processes, selection of appropriate satellite imageries is the first task in image data processing. In this study, due to absence of imageries for three periods, the researcher forced to consider only two period data, i.e., 1985 and 2016 (ETM). Thus, to quantify cover data, land-use and land-cover map of the watershed was prepared from a Land sat ETM+ imagery acquired on 7 Feb 1985 and 8 March 2016 (path 169/row 053). Supervised digital image classification technique was employed, complemented with field surveys that provided on-the-ground information about the types of land use and land-cover classes. Seven land-use and land-cover classes were recognized, and the corresponding land use/cover types were mapped for the analysis (Figure 4).

Band Selection: a Landsat 7 ETM+ image has 3 visible, 3 infrared, 1 panchromatic and 1 thermal bands. In order to reduce computer processing time and to treat only the most important data, band correction tests were conducted. Then true color composite (3, 2, 1) has been used for land cover mapping.

Image classification: it is the extraction of distinct classes or themes such as land use and land cover categories from the satellite imagery. There are two methods utilized by image analysts, unsupervised and supervised classifications. Here, supervised classification method was used, where the author defines small training sites on the image, which are representative of each desired land cover category. After the signatures for each land cover category have been defined, the soft ware then uses those signatures to classify the remaining pixels.

Accuracy assessment: accuracy is a measure of how many ground truth pixels were classified correctly. An overall accuracy of 87.5 % was achieved for both 1985 and 2016 Landsat ETM images. According to Lilesand and Kiefer (2000) the minimum level of accuracy in the identification of land cover categories from remote sensor data should be at least 80 %. Thus the classification accuracy of the study

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area is comparable with the aforementioned findings and hence our accuracy assessment estimate was more accurate and reliable.

4.4 Data Analysis Techniques

Socio-economic data was analyzed using statistical package for social sciences (SPSS). In this case, descriptive statistical techniques such as frequency, percentage, and mean, (SD) and (CV) coefficient of variation were used. Furthermore, ANOVA and partial correlation coefficient were also used. Furthermore to quantify and delineate temporal and spatial land use/ cover dynamics Geographic Information System (GIS) and Remote sensing techniques were utilized.

5. RESULT AND DISCUSSION

5.1 Socio-Economic Background

Age and sex structure, being an important demographic variable it has direct implication on size of school age population, labor force, population increase and female population in the reproductive age. As shown in Table 3, there is a marked imbalance between the sex and age groups in the study households. From the survey findings, it appeared that 92.2 %and 7.8 % of the study population were men and female. As to the age group is concerned, over 56 % and 26 % of households in Abaya-Chamo Basin are in their early and late working ages respectively. Therefore, in traditional society like the study area, such large number farming population can negatively affect the environment through wetland cultivation and improper land use practices.

Table 3 Age-Sex structure of the Respondents

Age group	Male	Female	Total	% of Total
18-50	99	2	101	56.1
51-65	43	5	48	26.7
>65	24	7	31	17.2
Total	166	14	180	100

Source: survey data, 2016

As can be seen on Table 4 that age disparity among the study population was paramount. The CV was estimated to be 126 %, where the minimum and maximum age limit was 18 and 76 respectively. Furthermore, about 82.7 % of the study population in the working age group (18 and 65), which significantly contribute to agricultural production in the area.

Table 4 Demographic and land related variables

Variable	mean	mínimum	Máximum	CV, coefficient variation	Remark
Age	47.3	18	76	126.2	
Family size	7.07	2	14	30.99	56% have more than 7 family size
Educational level	-	Unable to read & write	Secondary school	77.12	46.7% are un educated 52.9% are literate
Land holding	1.05	0	5	131.5	
Total					180

Source: Survey Data, 2016

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But a significant portion of the households (46.7 %) have adult education or less. The coefficient of variation of educational level showed great disparity (77.1 %). Average household land holding was estimated to be one hectare,. Similar to the age variables, land holding also revealed great variation (i.e. over 131 %).

5.2 Fruit Based Farming System and Rural Livelihood Transformation

The people in Abaya-Chamo Basin exercise different types of livelihood strategies. According to the views of village elders, before three to four decades small scale traditional agriculture (mainly cotton, sweet potatoes and sorghum) and fishery are the dominant livelihood sources. But currently, progressive demands of fruit product at national market the cereal-based subsistence farming system was transformed into market-oriented system of irrigated banana, vegetable and maize farms. This finding was in line with Fanos (2014) report. The same source witnessed the development of small scale irrigation schemes and introduction of cash crops, which gradually improved livelihood of the households in the area.

Survey result showed that income from mixed farming, crop production and banana farm occupied the 1st, 2nd and 3rd income sources according to its importance (Table 5). The other income sources from livestock products, fishery and fuel wood collection shared 7.8 %, 5 % and 2.8 % of the respondents respectively.

Table 5source of household income of the respondent

Livelihood	Frequency	Percent
Sale of banana, mango & avocado	26	14.43
Fuel wood collection	5	2.8
Fishery	9	5.0
Livestock products	14	7.8
Crop, mainly maize and teff	34	18.9
Mixed farming	89	49.4
Others	3	1.7
Total	180	100

Source, own survey (2017)

To assess the contribution of fruit based farming system to household income; survey in two banana producing rural kebeles (namely *Ganta Kanchame and Mole*) was conducted. Accordingly, households posses farm size less than 0.5 ha and have small banana farm are considered to be “poor.” Such households didn’t cultivate banana instead they grow maize for household consumption. This is because banana is a perennial tree, which did not meet their immediate household food need. Survey result confirmed that such households earn 10,000 to 12,960 birr per year. In contrary, households with banana farm more than one hectare are considered to be “rich” household. Such households earn at an average 250,000 to 300,000 birr per a year. The survey data further depicted that the average income of banana growers (i.e., 15% of survey households) was estimated to be 49,670 birr per a year. Informants reported that attractive market price of banana has significantly facilitated the encroachment of banana farms further into the wetlands.

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It was evidenced from the survey findings that over 50 % and 26 % of the respondents reported that income from fruit farm raised household food security status and enabled them to live in well equipped modern residence, respectively (Table 6). This finding is congruent with previous studies by Wogayehu (2016), which was carried out in the wetlands of Lake Chamo basin. Contrarily, 6.7 % of them reported that its contribution to the improvement of household livelihood was low.

Table 6 Livelihood change due to income from fruit farm

No	Livelihood style	frequency	percent
1	Improvement in the status of household food security	101	50.1
2	Live in well equipped residence	47	26.1
3	Raise thier childeren inprestigiou schools	11	6.1
4	use better health facilites for medication	5	2.8
5	No improvement in the livelihood	12	6.7
6	Others	4	2.2
	Total	180	100

Source: own's survey, 2017

5.3 SPatio-temporal Land Use/ Cover Dynamics in Abaya-Chamo Wetlands

The land use/ cover change analysis conducted in two periods (1985 and 2016) showed eight categories of land use/ cover types. The major land use types were perennials land (covered by Banana, Mangoes) and vegetable farms (covered by tomatoes, Cabbages and onion) annual crop land (Maize). In the area, traditional cereal subsistence farms were transformed into marketable small scale fruit farms. A similar study conducted in Central Himalayan, India revealed a significant replacement of traditional crops by cash crops at the expense of forest land (Semival et. al, 2004). The major constraints of land use/ cover changes in the area were deforestation, sedimentation and land use transformation. Areas covered by maize and perennials are progressively increasing at the expense of wetlands and shrub lands. In this case, in the last thirty two years cropland and Banana farms are annually increased by 0.21 % and 0.02 % respectively. Contrarily, wetlands showed amazing decline by 0.28 % annually or 662.5 hectares in the studied period, which was due to encroachment of fruit and vegetable farms. Data collected from household survey confirmed shrub lands also experience a similar pressure from the expansion of settlement and farmlands.

As reported on Table 7 that over 60 % of the respondents replied that wetlands in their locality were decreasing through time. Only 15 % of them replied as it was increasing, suggesting that wetland dynamics is a major environmental constraint in the area. A number of studies conducted in varying localities of Ethiopia revealed similar findings. For instance, Zeng Yongnian et. al, (2003) observed a remarkable expansion of forestland and grasslands at the expense of cropland. Therefore, from the afore said studies it was possible to suggest that in the study area unfriendly human-environment relationship resulted into dramatic cover dynamics.

5.4. Challenges of Wetlands in Abaya-Chamo Basin

a) Demographic pressure:

Human population being an important demographic variable can negatively affect the

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natural resource use and can also led to increasing demand for cultivated land in the basin. With 2.9% annual growth rate, in 2017 the population of Abaya-chamo basin reached to 57.2% as compared to the base year figure 113,430 in 1990's (SNNPR annual statistical abstract 2013/14). Similarly, household head size has also showed proportional increase to population size in the basin (Table 8). As the result of demographic pressure, per capita cultivated land at household head level decreased from 1.72 ha to 0.99 ha in 1998 and

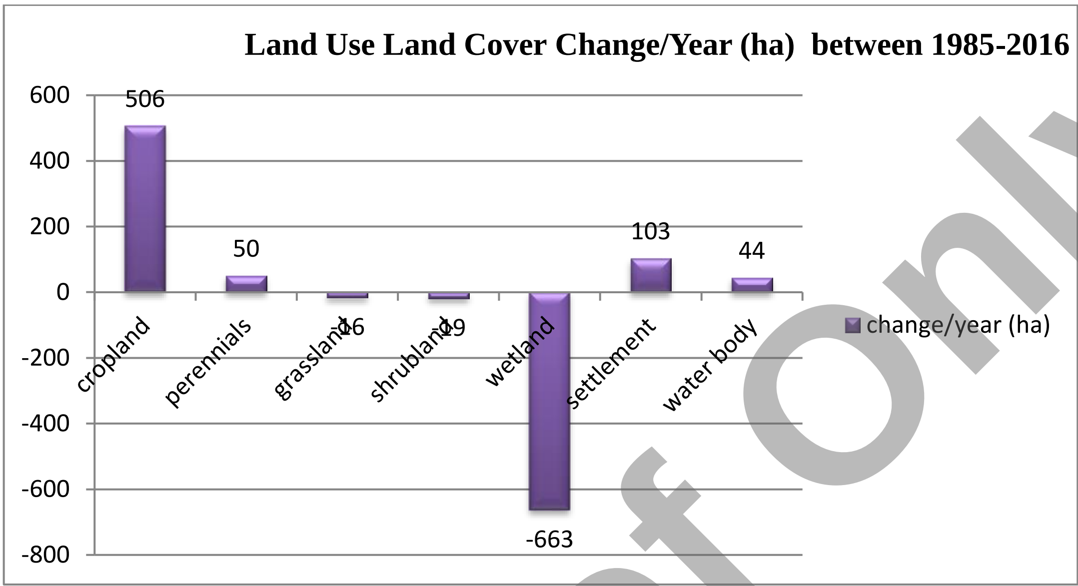

Figure 5 Land use/ cover dynamics in Abaya-Chamo Basin (Landsat image(1985 and 2016)

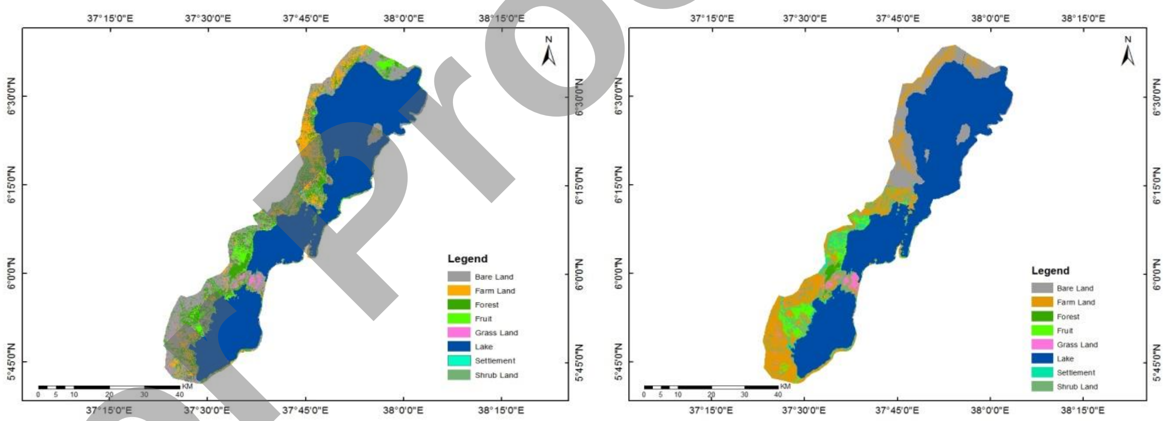

Figure 6 land Use/ Cover Change between 1985 and 2016

Table 7 Response on the status of wetland

No	Variable	Frequency	Percent
1	Increasing	27	15
2	Decreasing	110	61.1
3	No Change	14	7.8
4	Unable to Detrmine	29	16.1
	Total	180	100

Source: survey data, 2017

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2017 respectively. In the same way, per capita cultivated land for person dropped from 0.35 ha in 1998 to 0.20 ha in 2017

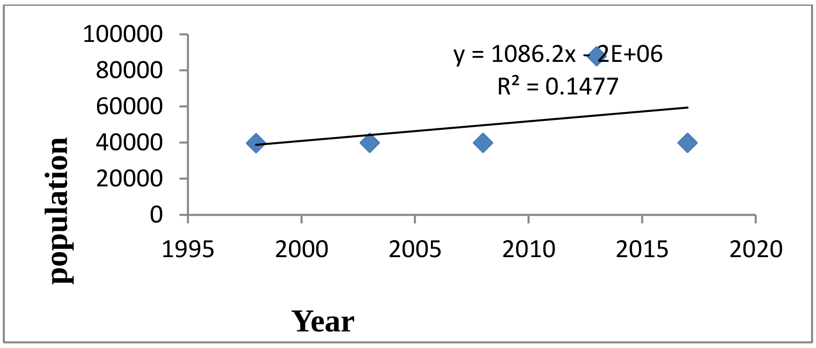

Figure 7Growth of population in the study area (1998-2017)

It is clear from Table 5 that both household head has been increasing in a statistically significant rate (R= 0.993) and size of cultivated land showed significant decrease (R= 0.147). These findings were concomitant to the studies of Jayne et. el (2003), Mebratu (2014)and Tafesse (2011). Their studies showed that land to person ratio for Ethiopia has declined from 0.508 in the period 1960-69 to 0.252 in 1990-99.

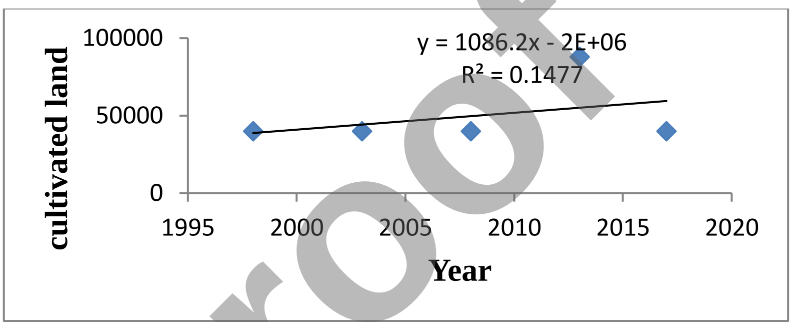

Figure 8 Cultivated land (ha) in the study area (1998-2017)

In 2017 each household head in the basin holds 0.99 hectare of cultivated land, according to Table 8 if additional 1174 newly emerging household heads are joined to the existed households, the remaining 3200 hectares of wetlands and grasslands will completely encroached by agriculture within two years and seven months period. Thus, beyond this period there is no more extra land that is available for further use.

Table 8 Rural population and cultivated land in Abaya-Chamo Basin

Year	Size of Household head	Cultivated land (ha)	Farm size/ HHH (ha)	Per capita Farm size (ha)
1998	23,149	39,794	1.72	0.35
2003	26,819	39,822	1.49	0.3
2008	31,070	39,850	1.28	0.26
2013	35,996	39,877	1.11	0.23
2017	40,492	39,900	0.99	0.20
mean			1.32	0.28

Source: owns computation, 2017

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Thus, finding from satellite data was supported by results of household survey, which showed that 43.9 % of the respondents replied as farmland encroachment is their top constraints of wetland in their locality (Figure 9).This result is congruent with previous studies by Ethiopian Economic Association (2002) and Gebre sellassie (2006). If farmland encroachment into wetlands and grasslands are increased at the present status, the available per capita cultivated land (i.e,0.99 ha) cannot adequately support the livelihood of community in the basin without additionallivelihood means, such as agricultural intensification and livelihood diversification.

b) Loss ofbiodiversity:

Deforestation on the shores of Abaya-Chamo basin was the second top challenge of wetland as reported by 35.6 % of the respondents. Though Rural Land Administration and Land Use Proclamation of 2005 gives special attention to the conservation of bio-diversity in wetlands, its forest and pasture ecosystem are diminishing due to farmland encroachment, overgrazing and the growing demand of sedge for construction purposes. According to the elders view, before three to four decades shore areas were covered by thick indigenous trees. They further reported that currently we cannot find most of them, except some patches of acacia, Bedena trees and sedge grasses. Indigenous tree species such *as Bisana (Anika), Wanza (Moqotsa) , Shola, Iron wood, Soke, Zigiba, Dokima etc* disappeared from the shore.

As can be seen from figure 10, wetland vegetation was dramatically damaged by human intervention. As a result lakes were threatened by sedimentation siltation and turbidity. Group discussion result reported that before thirty to forty years Hayina, Tigers, Lions are found in significant number. But currently wetland biodiversity was at its extinction stage. This finding was inconsistent with Mckee (2007) study that was conducted on the wetlands of Tana, Hawasa and Shala.

c) Encroachment of small scale agriculture

It is evident that wetland is the most productive ecosystem on the earth, because they are provides great volume of food for a significant portion of flora and fauna inhabited there.

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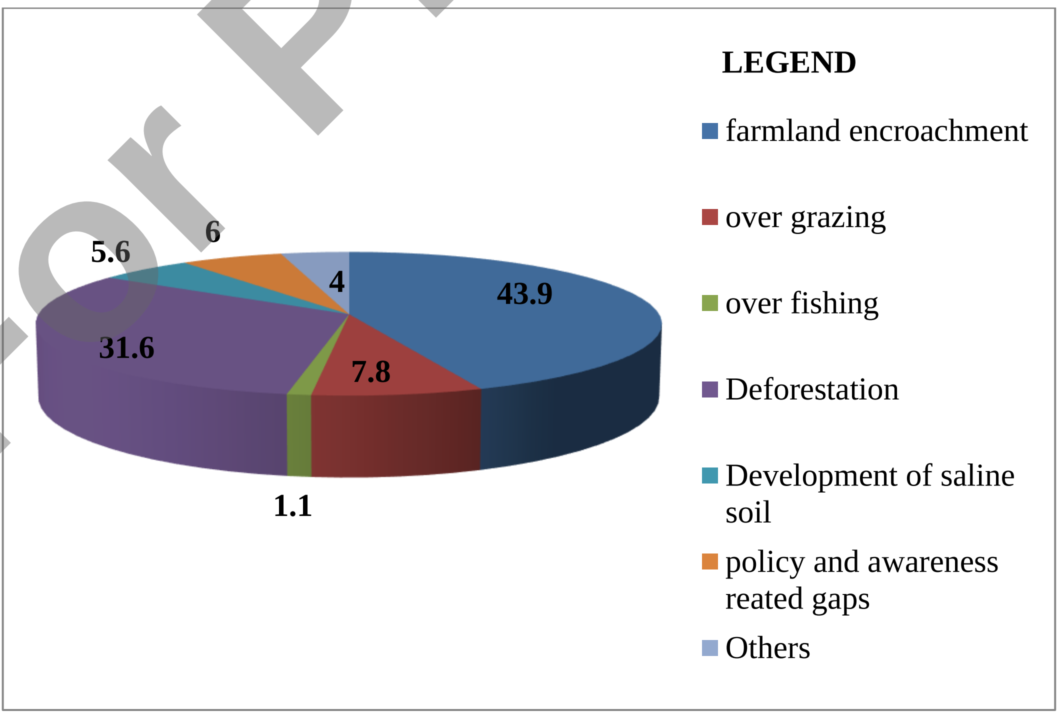

Figure 9 Wetland challenge in Abaya Chamo Basin

As a result it is considered by some as biological super market (Abebe, 2003). Having such a great benefit, wetlands in Abaya-chamo basin are unfriendly encroached by fruit and vegetable farms and the resultant challenges of soil salinity. Continuous uses of lake water for irrigation increased the salt content of the soil. During field survey, whitish precipitates of salt crystals were observed on the surface of irrigated vegetable farms (figure 8). Though the concentration of salt in the soil can be judged after laboratory analysis, it was plain to suggest that soil salinity was the third constraint of wetland agriculture as reported by 5.6 % of the respondents (figure 7). A study conducted by Tuma et al. (2014) in the same locality also reported similar findings. Accordingly, Tuma et al. identified soluble salt content of 16.86 dsm^{-1} on irrigated cotton field. This shows that there is problem of soil salinity in the studied farms. A similar finding was reported by Shegena et. al (2017). Shegena et al. reported salinity problem in their studies conducted in Sego Irrigated farm in Chamo basin. Hence it is possible to suggest that salt affected fields need intervention measure before complete exhaustion.

Figure 10 Deforestation of shore of Lake Abaya, Southern Ethiopia

Figure 11 Horticulture farm in the buffers of Lake Abaya & Chamo

Similar sources reported the adverse effect of saline soil on crop yields of the area (shahid and Al-shankiti (2013) and Yadava et al., (2011). In the downstream area, weed infestation, sedimentation and gully formation are the other top mentioned challenges of wetland ecosystem (Figure 12).

Increased agricultural practices on the wetlands easily diffuse agrochemicals into the nearby wetlands and lakes, contaminate the lake biodiversity. Furthermore, the nutrients over load in the lake facilitate growth and expansion of exotic *water hyacinth* (*Eichhornia crassipes)*. Thus siltation of sediments from surrounding farms and expansion of floating water weeds

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can threaten sustainability of the lake and its biodiversity as evidenced in Lake Haramaya and Lake Bahir Dar. Similarly, in Lake Abaya-Chamo wetlands the incidence of invasive weeds is considered to be the major environmental problem affecting the lake system. As stated by sources that the consequence of water hyacinth (*Eichhornia crassipes*) is devastating in the wetlands of Baro-Akobo, koka and Bahir Dar in Ethiopia (Dereje, 2003). Dereje reported the challenges of invasive weeds such as *Mimosa pigra and Eichhornia crassipes* threaten the fish resource, quality and sustainability of lake water in the studied wetlands.

Figure 12 Development of water hyacinth, sedimentation and development of gully in Banana farm

As can be seen from figure 9 that over grazing (7.8 %) and over fishing (1.1%) are the other reported challenges in the study area. As reported by 6 % of the respondents, policy and awareness related gaps are among the most pressing challenges that are responsible for the current ecosystem degradation of wetlands in the study area. In the eyes of discussants and personal observation of the researcher, policy and awareness related constraints are the primary cause for all evils of buffer zone degradation of the Lake system.

Communities in the study area have misconception about wetlands; they consider it as a source of malaria and no man's land that lacks defined tenure rights. As a result wetlands are mismanaged and lacks due attention both by the community and Development agents. Furthermore, wetlands didn't have stand alone and specific policy document, rather wetland issues in Ethiopia are addressed by other policies such as water, forest, land and agriculture. In this case, detail wetland issues are over looked by other general objectives and only marginal part is covered by these policies. In addition, because of absence of policy document there is no institutions and professionals that look after wetland issues. Therefore, because of the cumulative effects of all these constraints, wetland ecosystem in Abaya-Chamo Basin is on the verge of degradation as can be presented in Figure 10, 11 and 12. This result is congruent with the studies of IBD (2005) and Melaku et al., (2012). It is possible to suggest that policy gap and absence of empowered institution on the issues and misconceptions on the significance of wetlands are the major cause for wetland degradation in the study area and elsewhere in Ethiopia.

d) Over utilization of Lake Water

Rift valley Basin is characterized by semi-arid climatic condition, thus the rainfall situation is irregular and not sufficient for agriculture. In response to this problem, both annual crops and perennial trees supplement its water nerds either from rivers and Lakes. Most tributaries empty its water to the Lakes are originated from the degraded surrounding mountains, which has low discharging capacity. As a result of

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excess evaporation of the Lake water due to aridity, over exploitation related to back ward irrigation practice and low discharge capacity of rivers of water into the lake are some of the cause for the scarcity of irrigation water in the area. As a result, to supplement the water gap and exploit fertile lands most the small holders are changed the wetlands into farmland and it became the major source of wetland degradation and biodiversity loss in Abaya Chamo Basin.

According the survey result about 81.1% of farmers were use Lake chamo wetland tributaries as a source of irrigation, at about 12.6% were use irrigation directly from the Lake chamo wetland, 2.8 % were also used from both the lake chamo wetland and the remaining 3.8 were use ground water as a source of irrigation for their farm land.

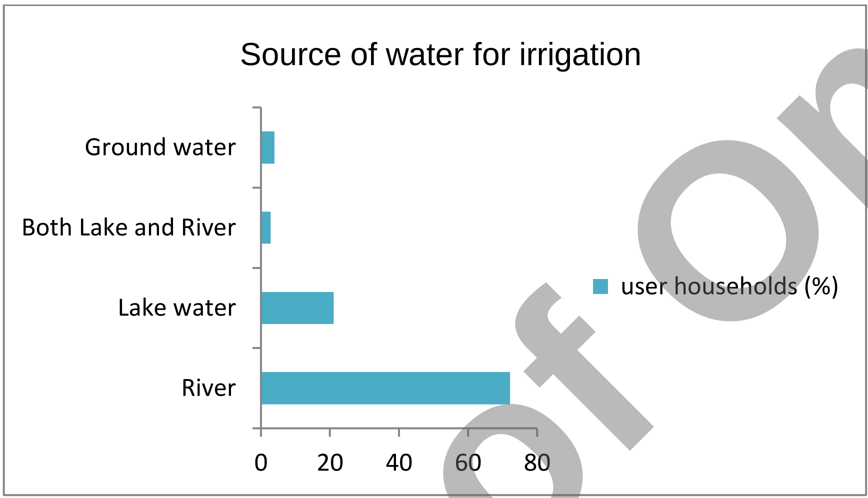

Figure 13 source of water for irrigation

As mentioned above that due to the scarcity and variability of rainwater in the area, 72.2 % of respondent smallholders used river water to irrigate their farm, from the perennial rivers such as *Baso, Shafe, Ugaye, Sega, Sile and Bilate* (figure 13). As reported by 21.1 % of Respondents Lake Abaya and Chamo are the second source of irrigation water for the households in the wetlands and surrounding plains. This implies that a sizeable amount of lake and river water was diverted into wetland farm and remained the major challenge for loss of biodiversity and sustainability of the lake water.

Figure 14 Lake water is diverted for irrigation purpose

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e) Siltation

South western and Northern highlands in the Abaya-Chamo Basin were the major source of water for the rift valley drainage system. But due to mountainous landscape, unsustainable farming system and deforestation in the surrounding highlands, it remains the major source of fine-grain sediments deposition in the lakes and surroundings, which is due to severe erosion. The result is in line with the findings of Alemayehu and Rahu (2010). The authors blamed the steep terrain of Lake Abaya-Chamo watershed as a contributory to Aggravated soil erosion and the resultant sediment deposition in the wetland system. The findings are also supported with the focus group discussion result, stated that discussants witnessed the gradual increase of sediment deposited landscape on the shores of Lake Abaya.

Fig 15 sediment deposition in the mouth of River Sile, Chamo Basin

During field observation as it was observed in, large amount of sediment deposition were seen along the lake shore. Informants reported the increase of sediment deposition during the summer season when the volume of river water increases. This evidence clearly showed how much wetland in the Abaya-Chamo basin is threatened by host of environmental and human induced problems.

f) Over Fishing

According to survey result fishing was the dominant economic activities before two decades but recently due to the increased engagement of new households in the fishing activity and traditional fish catch practices, the potentials of fish in the lake declined at alarming rate. The fishers were also asked the reason for the decline of fish in the wetland. They replied that seasonal variability of lake water and use of small sized mesh net to catch the fish catching. This finding was in line to Kirsten’s (2005) report. Kirsten noted that the use of mesh size smaller than the recommended size at least by four cm would results such effect. Therefore, wetlands of Abaya Chamo Basin are under the threat of severe degradation and needs due attention both from the government and the community at large.

g) Institutional, policy and property right related constraints

Due to the institutional negligence, resulted from lacking proper institutional support and commitment are considered to be the major challenge. As a result in most offices wet land issues are not under their priority list or top agenda rather it is a supplementary concern. That is why, in Abaya chamo basin, in the presence of professionals from District Agriculture and Environmental Resources offices, due to improper agricultural practices in the buffer areas of the lake, wetland

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biodiversities are negatively threatened and they are on the verge of extinction. Furthermore, individuals that illegally exploit wetland resources are not punished by court of law or did not get proper punishment as a result immense wetland resources are threatened by violators. Ethiopia is not a signatory country of Ramsar convention and even the country don't have its own stand alone rules and regulation on wetland. Thus, this all are among the many constraints that impede sustainability of wetland resource. In addition, respective government offices and the community consider wetland as a no man's land and did not consider them as a significant resource. That is why wetlands in Abaya Chamo Basin were progressively threatened lacking government focus.

5.5 Measures to rehabilitate wetlands

As well discussed in the preceding sections that Wetland degradation and the effort of local government in assuring the health of wetland ecosystem was negligence. Though, buffer area cultivation and the resultant siltation and growth of *water hyacinth* in the lake is critical environmental concern in the area, the problems receive less attention from the stakeholders. Even though, negligent lake shores cultivation and identification of endangered lake ecosystem needs comprehensive research, the survey finding of this study recommends the following intervention.

Accordingly, upland and buffer area management and awareness creation measures are the top listed intervention measures as rated by 45 % and 28.9 % of the respondents. As stated earlier, that hill side cultivation of Abaya Chamo watershed and awareness related constraint on the benefits of wetland (it is considered as waste land) are the major challenges in the area. The result is consistent with the findings of Seleshi and Awulachew (2006). In their studies Sileshi and Awulachew strongly recommended the importance of upland protection for sustainable utilization of downstream land resources. Strong institutional commitment both from local and regional level (as rated by 10.6 %) and above all effective wetland policy at the grass root level (rated by 5.6 % of the respondents) is the other measures to be considered. This result is in agreement with previous studies conducted by Hagos et al., (2014). Currently, wetlands in Abaya basin are cleared indiscriminately resulted from the priority given for investment in agricultural sector. Thus, wetlands are untapped resource of the country, it should get institutional and policy support, which is currently, received insignificant attention.

Table9 Top Listed protection measure to Wetland Degradation

No	Measure	frequency	percent	remark
1	Awareness creation	52	28.9	
2	Increased institutional commitment	19	10.6	
3	Effective wetland policy	10	5.6	
4	Upland & buffer area management	81	45	
5	Controlled grazing &over fishing	3	1.7	
6	Others	15	8.2	

Source: Survey Data, 2017

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7 CONCLUSION

Banana and Mango are the two important fruit crops cultivated in the wetlands of Abaya-Chamo basin, which is produced mainly for small scale commercial purpose. It was reported that the production of fruit and horticulture crops particularly income from sale of banana and onion has changed the livelihood of cultivators in the Lake basin. Even though, there is promising demand for banana in the national market, insufficient water supply for irrigation, traditional production practices and unorganized market arrangements are among others the significant challenges that lowers the volume of production and benefits of cultivators at the grass root level. In spite of the aforesaid economic benefits, due to neglect, lack of institutional support, absence of land property right and unsustainable development priorities wetland environment in Abaya Chamo basin has severely threatened by farmland encroachment and the resultant effects. Hence, in order to reverse the negative effects, efforts such as upstream rehabilitation, community level awareness creation, enacting stand alone wetland policies both at the regional and local levels and commitments from the stakeholders are needed. Furthermore net sediment loss/ discharge from surrounding uplands into the lake system need an in-depth study.

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