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C O N T E N T

The Declining trend of Wetland in Chefa (Amhara Region, Ethiopia) and its Impact on Local Ecosystem Services

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ABSTRACT: The objectives of this study were to study the perception of local community towards wetland ecosystem, assessing existing ecosystem services, investigating drivers, pressures, state (detecting land use/land cover changes observed in the wetland), impacts, responses, discovering the challenges and forwarding potential conservation strategies of Chefa wetland ecosystem. The study employed household survey, key informant and observation data collection techniques and adapted the driver, pressure, state, impact, response framework to assess ecosystem service. Statistical Package for Social Sciences and Micro Soft Excel were used to analyze respondents view. Geographic Information System, Remote Sensing and Earth Resources Data analysis System techniques were used to generate and analyze historical data regarding changes in wetland area coverage. The study explored the perception of local community towards wetland and large numbers of respondents has low perception towards wetland services especially regulating and supporting services. The wetland provides an estimated 721,000 and 845,000 quintals of crop, fruit and vegetable food provisioning services respectively. An average number of 6,230 fish,60,931.4 tons of feed for livestock and 60,931.4tons of sand is gained from the wetland ecosystem. Water, medicinal plants and thatching grass are also the vital provisioning services rendered by Chefa wetland. Valuable cultural benefits; religious gathering, wedding ceremony celebration, health benefits and educational services, regulation services; flood prevention and local climate conditioning; supporting services such as habitat for varied fauna and flora were found to be important services of the wetland. Various drivers such as population and policy exerted pressures like overexploitation of resources and inappropriate farming practices which in turn altered the state of the wetland manifested in terms of decrease in wetland area coverage, species composition and disruption of ecosystem services. The wetland area of 7,490.04ha in 1988 was declined to 1,815.91ha in 2018 which means 75.76% is changed to different land use/land cover classes. Different challenges contributed to the inexistence of management practices in the study area such as low understanding of ecosystem services by local communities, planners and practitioner, absence of appropriate wetland management policy, complete dependence on the wetland resources, climate variability etc. So, actions such as awareness raising, family planning, diversifying livelihood etc. need to be implemented to minimize the root causes/drivers of change on the wetland and to ensure its sustainability.

KEY WORDS: Ecosystem Services, Wetland, Conservation Strategies, Spatial change

Introduction

Wetlands are one of the most robust divisions of natural infrastructure i.e. the topography of earth surface. Wetlands typically and significantly offer a variety of services and benefits to human society, earth's natural ecology or ecosystems and they have played a central role in human development throughout history. Wetlands are the most productive and diverse ecosystems hydrologically and ecologically both. And as a result they are able to deliver a wide range of ecosystem services (ESs) of value to people and society living nearby in and around. Ecosystems generate services that contribute to human welfare and wetlands can be considered a form of wealth.

Wetlands are among the most valuable ecosystems on the planet. As described in Mitsch and Gosselink (2015, pp. 3–4) and earlier editions:

Although the value of wetlands for fish and wildlife protection has been known for a century, some of the other benefits have been identified more recently. Wetlands are sometimes described as kidneys of the landscape because they function as the downstream receivers of water and waste from both natural and human sources. They stabilize water supplies, thus mitigating both floods and drought. They have been found to cleanse polluted waters, protect shorelines, and recharge groundwater aquifers. Wetlands also have been called nature’s supermarkets because of the extensive food chain and rich biodiversity that they support. They play major roles in the landscape by providing unique habitats for a wide variety of flora and fauna. Now that we have become concerned about the health of our entire planet, wetlands are being described by some as important carbon sinks and climate stabilizers on a global scale.

From thousands of years, river landscapes have been used as settlement areas, infrastructure and production areas. Ecosystem services are natural assets (Barbier 2011) produced by the environment and utilized by humans, such as clean air, water, food and materials and contribute to social and cultural well-being (Fischer et al. 2009) and have high economic value (Barbier et al. 1997, Emerton and Bos 2004, Turner et al. 2008). Wetlands are among the world’s most productive and valuable ecosystems. They provide a wide range of economic, social, environmental and cultural benefits. Wetlands provide a wide range of ecosystem services that contribute to human well-being and in recent times they have been broadly classified as provisioning, regulating, cultural and supporting (MEA 2005).These services include maintaining water quality and supply, regulating atmospheric gases, sequestering carbon, protecting shorelines, sustaining unique indigenous biota, and providing cultural, recreational and educational resources (Dise 2009). Despite covering only 1.5% of the Earth’s surface, wetlands provide a disproportionately high 40% of global ecosystem services (Zedler and Kercher 2005).

Population growth, economic development, the increasing intensification of freshwater (-resources) and land use (infrastructure development, land conversion, water withdrawal, eutrophication and pollution, overharvesting and overexploitation, and the introduction of invasive alien species.) are the primary direct and indirect drivers of the degradation of wetland ecosystems. The associated changes lead to a shift in the available functions and the associated services of river landscapes and are the reasons why the degradation and loss of wetlands is more rapid than that of other ecosystems wetlands.

However, much of the researches into wetland Ecosystem Services have focused on large wetlands receiving protection under various designations and in contrast the “small patches” of wetlands that are often overlooked and unprotected, due to their omission from wetland inventories, can play a pivotal role in the delivery of a number of important ecological services. These include: water quality regulation; hazard control (e.g. flood risk); numerous resources for human uses; habitats for plants, animals and micro-organisms; recreational opportunities; and the aesthetic value of the countryside. Much of this ability to deliver ESs arises out of their position within the landscape, as they are often located at significant positions along hydrological pathways where they are able to interact with waters draining agricultural land (Baker et al. 2009), or provide wildlife refuges within agricultural systems (Trochlell and Bernthal 1998).

It is universally understood that wetland ecosystems play an 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). Wetland ecosystems played a key role throughout the development and survival of the humanities. Since the 1971’s Ramsar convention, the issue of wetlands has dominated the discussions. Seldom people missed to realize the importance of wetlands for their sustenance. Majority of people assume that wetlands are common resources to exploit and are in abundance and anyone is entitled to use them (Schuyt, 2005). Many people have not observed wetlands are either drained or lost and need proper management. Studies show that 50% of the world’s wetlands have been disappeared in the past century (Gourbesville, 2008).

Ethiopia possesses a great diversity of wetland ecosystems (shallow lakes, rivers and streams, swamps/marshes, flood plains, reservoirs and ponds, and high mountain lakes) as a result of the formation of diverse landscape; however, wetlands and their resources are not fully documented (Siraj, 2004). These wetland ecosystems have been providing various services including water, grass, agricultural land, wild life, recreational, flood mitigation as well as spiritual and cultural values. Their uses also include a source of pasture during dry seasons (Shewaye, 2008).

Chefa wetland is one of the largest wetlands of Ethiopia found in Oromia Special Administrative Zone in Amhara Regionthat provides a wide variety of ecosystem services to its local inhabitants. The wetland provides multiple provisioning services to the local communities and peoples in its vicinity. It is a shelter to 50,000 Afar and Oromo pastoralists and provides feed source for their 200,000 livestock (Gutema, 2003 as cited in Tessema et al., 2013). It has an immense importance as environmental, socio-economic services as well as for the sustenance of the local community.

The purpose of the present study is to measure the declining trend of areal extent of Chefa wetland and also to evaluate and make assessment of the ecosystem services provided by it, the major drivers of changes, challenges for its conservation and the potential conservation strategies to protect and preserve the Chefa wetland.

Literature Review and Background of the study

The concept of Ecosystem Services (ES) originated in the 1970s and gained importance in environmental discussions in the 1990s. According to the “Millennium Ecosystem Assessment”, ES are the interface between ecosystems and human well-being and can be defined as the benefits that humans can derive from ecosystems (MEA 2005b). Vemuri and Costanza (2006) found a significant relationship between natural capital (in terms of ES) and life satisfaction. The concept of ES thus also represents an important approach to making services and functions provided by ecosystems "tangible" and to communicating their significance to various stakeholder groups. Therefore the ES concept can also play an important role in knowledge transfer and in demonstrating the importance of ecologically functional river landscapes (e.g. Böck 2016); Poppe et al. 2016).

The concept of ecosystems as natural assets is already having an influence on how policymakers view wetlands. For example, the Changwon Declaration of the 10th Conference of the Parties of the Ramsar Convention states that “wetlands are vital parts of the natural infrastructure we need for addressing climate change” (Ramsar Convention 2008). Given that wetlands, which comprise coastal wetlands, freshwater swamps and marshes (including floodplains), and peatlands, amount to 6–8 million km2 globally (Mitsch et al. 2009), these ecosystems are an abundant source of natural capital.

In identifying the ecosystem services provided by natural environments, such as wetlands, a common practice is to adopt the broad definition of the Millennium Ecosystem Assessment (MEA 2005) that “ecosystem services are the benefits people obtain from ecosystems”. Thus the term “ecosystem services” is usually interpreted to imply the contribution of nature to a variety of “goods and services”, which in economics would normally be classified under three different categories (Barbier 2007): (i), “goods” (e.g. products obtained from ecosystems, such as resource harvests, water and genetic material); (ii), “services” (e.g. recreational and tourism benefits or certain ecological regulatory and habitat functions, such as water purification, climate regulation, erosion control and habitat provision); and (iii) cultural benefits (e.g. spiritual and religious beliefs, heritage values).

To assess the contribution of nature in providing such “goods and services”, one needs to measure its impact on human welfare, or, as Freeman (2003, p. 7) succinctly puts it: “The economic value of resource-environmental systems resides in the contributions that the ecosystem functions and services make to human well-being”, and consequently, “the basis for deriving measures of the economic value of changes in resource-environmental systems is the effects of the changes on human welfare.” Similarly, Boyd and Banzhof (2007, p. 619) state that “final ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being.”

Regardless of how one defines and classifies ecosystem services, as a report from the US National Academy of Science has emphasized, “the fundamental challenge of valuing ecosystem services lies in providing an explicit description and adequate assessment of the links between the structure and functions of natural systems, the benefits (i.e. goods and services) derived by humanity, and their subsequent values” (Heal et al. 2005, p. 2).

The structure and functions of many wetlands can be uniquely defined by hydrological processes; it is possible to identify the spatial unit, or natural landscape, that is distinct to each type of wetland. In particular, different aspects of the hydrological system underlying wetlands and their services operate at different scales, e.g. surface inundation (flooding), water quality and biodiversity. Thus, as a wetland landscape varies in scale, due perhaps to conversion, draining or other human-induced disturbances, the impact on the provision of and synergies between wetland services can be substantial. Such a landscape approach is being used increasingly for assessing the cumulative effects of wetland loss and degradation, characterizing wetland boundaries and identifying restoration or mitigation opportunities (NRC 1995, Bedford 1996, 1999, Gwin et al. 1999, Mitsch and Gosselink 2000, Simenstad et al. 2006). It follows that the various goods and services provided by a wetland will also be tied to, and thus defined by, its landscape extent; i.e. “wetland values depend on the hydro geomorphic location in which they are found” (Mitsch and Gosselink 2000, p. 27).

If the hydrology-related services of wetlands are related to their landscape extent, then characterizing wetland ecosystems as natural assets is straightforward. In other words, as there are “reciprocal interactions between spatial pattern and ecological processes” (Turner 2005, p. 319), it is the spatially heterogeneous area of a wetland landscape that is the fundamental to its ability to provide the various wetland ecosystem services.

There are several studies that are focused on large wetlands and ignorant or overlooked small wetlands and they have often been viewed as problematic in terms of agricultural production and, consequently, have been subject to land drainage (Acreman and McCartney 2009). There is also some evidence that suggests these wetlands may be significant contributors to greenhouse gas emissions (Hefting et al. 2006, Matthews et al. 2009, 2010) and, in some cases, increase the potential for flooding (Bullock and Acreman 2003).

Wetlands play an important role in hydrological regulation (Bullock and Acreman 2003), but because of their ability to improve water quality through processes such as denitrification and sediment retention, they have been described as “kidneys of the landscape” (Mitsch and Gosselink 2007). However, in performing these processes, greenhouse gases can be produced that affect air quality and climate (Hefting et al. 2006). Furthermore, they can enhance biodiversity conservation (Pilgrim et al. 2010) by providing habitats for plants and animals (HillbrichtIlkowska 2008). In some contexts they may be part of productive systems, hence providing biological products.

Wetlands continue to decline globally, both in the area and in quality. As a result, the ecosystem services that wetlands provide to society are diminished. The state of the world’s wetlands involves a myriad of aspects of quantity and quality. Providing a historical perspective, the MEA (2005) reported that more than 50 % of the area of certain wetland types had been lost during the 20th century in parts of Australia and New Zealand, Europe and North America. It noted that extrapolating this rate of loss to other regions or wetland types was “speculative only.” For example, according to Junk et al. (2013), the amount of loss of wetlands around the world varies between 30 and 90 %, depending on the region under consideration.

Davidson (2014) provides the most recent and comprehensive picture of historical wetland losses. In his study of 189 wetland assessments, Davidson estimated that wetland losses in the 20th century were 64-71 %, “and for some regions, notably Asia, even higher.” He found that “losses of natural inland wetlands have been consistently greater, and (have occurred) at faster rates, than (those) of natural coastal wetlands.” His review found that the extent of inland wetlands declined 69-75 % during the 20th century, while coastal wetlands declined 62-63 %.

Recent studies on a regional scale have generally produced similar negative findings, although the rate of loss varies significantly from region to region. For example, the Yellow Sea has been identified as an area of greatest concern in the East Asian-Australasian Flyway (MacKinnon et al., 2012). Using a remote sensing methodology, Murray et al. (2014) studied approximately 4,000 kilometers of the Yellow Sea coastline. They reported a loss of approximately 65 % of intertidal wetlands over the past 50 years. From the 1980s to the late 2000s, approximately 28 % of intertidal wetlands were lost, which constitutes a 1.2 % annual decline.

Wetland ecosystems, including rivers, lakes, marshes, rice fields, and coastal areas, provide many services that contribute to human well-being and poverty alleviation. Some groups of people, particularly those living near wetlands, are highly dependent on these services and are directly harmed by their degradation.

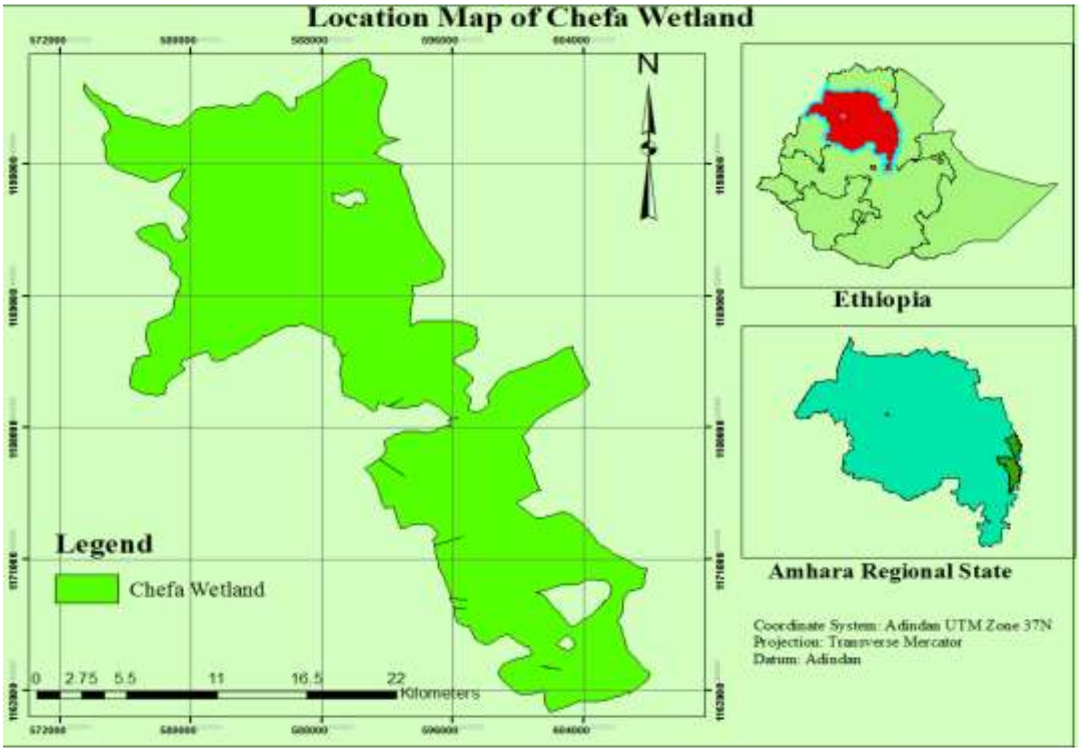
The local people are getting benefit from irrigation in the dry season, fishery, source of feed and water for their cattle. A study conducted by Tessema et al. (2013) on the role of Chefa wetland to the local communities around Kemissie provides some information with respect to provisioning services (crop, livestock, fishery, and mattress making). Moreover, the wetland provides significant habitat and support services. Gutema (as cited in Tessema et al. 2013) stated that the Chefa wetland host large number of bird species next to Lake Awassa. According to Getachew et al. (2011) there is great biodiversity in Chefa wetland area like; 2789 macro invertebrates belonging to 34 families, 3128 birds belonging to 57 species. But, these functions and services of wetlands are under threats from a wide range of causes. Wetland cultivation, overgrazing, wasteful use of water from feeder streams, conflict over limited grazing resource are reasons for the degradation of wetland ecosystem. The attention given to them by government institutions, local administrators, communities and other beneficiaries is very low or even non-existent in some circumstances.

Wetland Ecosystem in Ethiopia is under pressure emanating from conversion into agricultural lands; especially for rice production, over exploitation of wetland resources, deforestation, soil erosion and land degradation, siltation, settlement, climate change and pollution. Fogera and Chefa wetlands in Amhara national regional state, for example, are highly affected by excessive use of swamps and flood plains for cultivation of rice and other horticultural crops. Moreover, Boye-Kito wetland located around the town of Jima and Lake Chelelaka in Bishoftu town has shrunk due to expansion of agriculture and urbanization (EBI, 2014).

Research Methodology

Study Area

Chefa wetland is located 300 km northeast of Addis Ababa, the capital of Ethiopia. The wetland plain is located within $10^{0}32'$ to $10^{0}58'$N latitudes and $39^{0}46'$ to $39^{0}56'$E longitudes. Its total area is 50,317.3ha. The wetland type comprises seasonal intermittent freshwater marshes on inorganic soils, including sloughs, seasonally flooded meadows, and sedge marshes. There is hot springs on the eastern side of the flood plains and a few isolated hills. The altitude of the wetlands ranges from 1445 m to 1520 m above sea level, but altitudes exceed 2000 m and even 3000 m in the surrounding Ethiopian Highlands. The main feeder of the wetland system is the Borkena River, which is heavily silted during periods of rain.



From 19 kebeles (administrative Blocks) five kebeles were selected based on cluster hence one kebele from upper catchment and four kebeles (two from each) were selected from middle and lower catchment of the study area.

Research Design

The descriptive research design is used for this particular study since it helps to describe systematically existing situation, ecosystem services, perceptions and challenges towards these services, and to find out conservation strategies for the sustainable conservation of the wetland ecosystem.

The prime concern of this research is to study the perception of local communities towards wetland ecosystem, prevailing services of the wetland that are important to human wellbeing, socio-economy, wild fauna and flora. It also focused on identifying the major drivers, pressures, state, impacts, and responses, challenges of conservation and strategies to fix the challenges. So, the research method applied was inventories through field survey, direct observation, spatial mapping besides to assessing through semi-structured interview and survey questionnaires. Thus, the study collected data through participatory approaches, including key informants and experts' opinion, native knowledge of households and stakeholders, and trend analysis using GIS and RS. Moreover, it reviewed secondary data sources (Published articles, books and reports).

Sample Size Determination

The sample size of the present study is calculated based on Cochran (1963) formula.If the population is small then the sample size can be reduced slightly. This is because a given sample size provides proportionately more information for a small than for a large population. The sample size ($n_{0)}$ can be adjusted using the following equation,

$$n = \frac{n_0}{1+(n_0-1)/N}$$

Where, n=required sample size

n_0 = sample size without finite population correction

1=constant

N= the target population size

Thus, the final sample size at 93% of confidence level was:

$$n = \frac{n_0}{1+(n_0-1)/N} = \frac{162}{1+(162-1)/5334} = 157.$$

So, the final sample size (n) for the household survey was 157.

The sample size is distributed among five kebeles as follows;

S.No	Kebele Name	No.of Households	% share	No.of Samples
1	ChiretiDebeso	1892	35	56
2	Sitir	1170	22	34
3	BisheEdeda	943	18	28
4	Gerbi	750	14	22
5	Kelo	579	11	17
Total		5334	100	157

The respondents/households of respective kebeles were listed by order with their ID No given to them. Then after, systematic sampling with the formula n^{th} value was employed to select respondents from each kebeles. The study computed "n^{th}" value by dividing the size of the target population by the desired sample size where "n" is stands for the sampling interval.

So, n^{th} value $= \frac{\text{Target population}}{\text{required sample size}} = \frac{5334}{157}$ = 34 was sampling interval

Some key informants are selected based on purposive sampling because they are more familiar and own more understanding in their respective profession/issues, not large enough for power of probability sampling and they provide crucial information based on field surveys, semi structured interviews and questionnaires for analysis and interpretation.

In order to analyze the spatio-temporal change of the wetland, Land sat imagery of 1988, 2003 and 2018 was freely downloaded from United States Geological Survey (USGS) website. These data were used to produce the historical land use/ land cover maps of the study area and wetland changes monitoring and mapping in particular. The source and acquisition date of these data are given in table below.

No.	Satellite image	Date of Acquisition	Path	Row	Resolution	Source	Application
1	Landsat5	05/03/1988	168	53	30m	USGS	LULC map
2	Landsat7	24/03/2003	168	52	30m		
3	Landsat8	27/03/2018	168	53	30m		

To collect, organize and analyze the relevant data the materials and software used are Earth Resources Data Analysis System (ERDAS Imagine 2014) for image pre-processing, stacking single bands, and supervise maximum likelihood classification of land classes, ArcGIS 10.3.1 for data analysis, management, spatial referencing, geo referencing and make layout for final mapping and the study area clipping process was operated by ArcGIS software.

Analysis and Discussion

Perception of Local Community towards Chefa Wetland Ecosystem Services

Household respondents were asked on a total of 12 services (Table 1) such as provide a place of beauty, conserve native plants and animals, help native animal movements, provide native fish habitat, increase bird life which in turn decreases pests, recharge ground water, help to trap and recycle nutrients, help control floods, help prevent soil erosion, provide recreational opportunities, an important source of income, and is valued by the community to put their level of agreement.

As clearly presented in table 6, from the total of 157 respondents that expressed their perception on the service provide a place of beauty, 54 (34.4%) replied disagree or not important, followed by 45 (28.7%), 34 (21.7%), 15 (9.6%) and 9 (5.7%) strongly agree, agree, undecided and strongly disagree respectively. The service conserves native plants and animals was selected by 73 respondents as not important (53 disagree and 20 strongly disagree) whereas 53 respondents perceive important followed by 31 undecided.

Concerning help native animal movements 145 respondents replied disagree (73), undecided (48) and strongly disagree (24).Seven of the total respondents replied agree and only five replied strongly agree. The wetland service habitat for native fish was recognized by large number of the household respondents, with 52.2% and 47.13% response rate of strongly agree and agree. Only, 0.6% the respondents disagreed with the service. This implies that the Chefa wetland ecosystem hosts native fish to a considerable level

The wetland service habitat for native fish was recognized by large number of the household respondents, with 52.2% and 47.13% response rate of strongly agree and agree. Only, 0.6% the respondents disagreed with the service. This implies that the Chefa wetland ecosystem hosts native fish to a considerable level. Regarding increasing bird life which in turn decreases pests 66, 37, 34, 14, and 6 respondents perceived or replied disagree, undecided, agree, strongly disagree and strongly agree respectively. This service was perceived less important or not understood at all by the majority of the respondents. On the service recharges ground water more than a quarter of respondents (40.76%) replied disagree and strongly disagree followed by 38.12 % replied agree and strongly agree. Few proportion (21.12%) responded undecided.

The other service selected to capture the perception of respondents was the role of wetland to trap and recycle nutrients. The frequency result shows that 60 (38.2%) replied disagree, 52 (33.2%) undecided, 23 (14.6%) strongly disagree, and 22 (14%) replied strongly agree and agree. Services such as flood control prevent of erosion, recreational opportunities and as a source of income were strongly agreed by six, five, 17 and 18 respondents respectively. There was no respondent who replied strongly agree for the variable named the wetland was highly valued by the local community. As well, 26,20,32,35 and one respondent replied agree for the stated services. Likewise, respondents with a size of 31, 33, 22, 26, and 1 replied undecided. This low understanding of respondents towards ecosystem services was explained by one key informant as 'Local communities perceive wetlands as the place only used to graze cattle and expand agricultural lands. This perception entirely stemmed from the low level and awareness towards nature and environment.'

Table 1: Summary of Perception of Household Respondents towards Chefa Wetland Ecosystem

Ecosystem Services	Level of Agreement									
	Strongly Agree		Agree		Undecided		Disagree		Strongly Disagree	
	Number of respondents	%	Number of respondents	%	Number of respondents	%	Number of respondents	%	Number of respondents	%
Provide a place of beauty	45	28.7	34	21.7	15	9.6	54	34.4	9	5.7
Conserve native plants and animals	11	7.0	42	26.8	31	19.7	53	33.8	20	12.7
Help native animal movements	5	3.2	7	4.5	48	30.6	73	46.5	24	15.3
Provide native fish habitat	82	52.2	74	47.1	0	0.0	1	0.6	0	0.0
Increase bird life which in turn decreases pests	6	3.8	34	21.7	37	23.6	66	42.0	14	8.9
Recharge groundwater	17	10.8	43	27.4	33	21.0	45	28.7	19	12.1
Help to trap and recycle nutrients	11	7.0	11	7.0	52	33.1	60	38.2	23	14.6
Help control floods	6	3.8	26	16.6	31	19.7	70	44.6	24	15.3
Help prevent soil erosion	5	3.2	20	12.7	33	21.0	78	49.7	21	13.4
Provide /recreational opportunities	17	10.8	32	20.4	22	14.0	64	40.8	22	14.0
An important source of income	18	11.5	35	22.3	26	16.6	55	35.0	23	14.6
Is valued by the local community	0	0.0	1	0.6	1	0.6	66	42.0	89	56.7

Asked whether they practice wetland conservation practices such as maintaining a tree/vegetation around wetland area, managing grazing access to wetland, action to restore drying of wetland, control of weeds in wetland or not, 155 (98.7%) of the participants replied 'no.' The remaining 2 (1.3%) respondents replied yes. The respondents present their own reasons for not undertaking conservation measures. From the total of 155 respondents who replied 'no', 78 (50.32%) replied wetland management is not my concern followed by 63 (40.64%) lack of knowledge. Cost and time as a constraint for not applying conservation measures were selected by 40 (25.8%) of respondents, 20 (12.9%) for each.

Provisioning Services of Chefa Wetland Ecosystem

A total of 19 provisioning services, namely food (fish, birds of different variety, leaves and fruits, crop), water (irrigation, drinking/both animal and human, household use/ washing, cooking), firewood, animal products from wildlife, wood for charcoal making, grass for fodder, thatching grass, sand and stone for construction, agricultural tools, and medicinal plants were listed and presented to respondents to select among them. Accordingly, medicinal plants were selected by 99.4% (Table 7) of the respondents which indicates its prominence as a provisioning service. Medicinal plants locally named 'Tena Adam', 'KundoBerbere', 'Kentefa', 'Warka', 'Shiferaw', 'Ye LomiZaf,' were used for both animal and human diseases healing. Water provisioning services such as drinking water and household use (washing, cooking) were selected by 98.7% and 97.5%

of the respondents respectively which shows the vitality of the wetland as a source of water for the local community. These provisioning services were gained from both ground and surface water sources like springs, deep wells and hand dug wells support household drinking whereas rivers and streams (Abaya, Beteho, and Borkena) utilized to meet the demand for household water uses such as washing, cooking, and livestock drinking.

Table 2: Provisioning Services of Chefa Wetland Selected by Household Respondents

Provisioning services	Number of respondents	%
Medicinal plants	156	99.4
Drinking water	155	98.7
Household use/washing, cooking	153	97.5
Thatching Grasses (for hamlets)	148	94.3
Crop	136	86.6
Fodder (Grasses)	134	85.4
Leaves and fruits of plants as fodder	114	72.6
Fish	102	65.0
Fuel wood	78	49.7
Irrigation	72	45.9
Animal products from wild life	61	38.9
Tool making/agricultural	57	36.3
Bird	57	36.3
Sand for construction	41	26.1
Bee Keeping	16	10.2
Wood for Charcoal making	2	1.3
Timber	0	0.0
Termite Hill (clay soil)	0	0.0

The other water provisioning service rendered by Chefa wetland was irrigation which was selected by 45.9% of the respondents. Irrigation for dry season cultivation was obtained from rivers (Abaya, Beteho and Borkena), community ponds and deep wells.

One of the key informants emphasized the key role of Chefa wetland as a water source for the local community as 'Being known for its enormous water potential in the region, Chefa wetland provides the community with a lot of water source alternatives from surface (rivers) and ground water sources (rope pumps, hand dug wells and deep wells) for both household consumption and livestock drinking. Food provisioning service primarily crop was the life sustaining service of Chefa wetland selected by 136 (86.6%) of the respondents. The wetland ecosystem grows a broad variety of crops used for both household consumption and market. Cereal crops like Teff, Sorghum, Maize, Chick Pea, and Bean were some of the crops grown in Chefa wetland ecosystem.

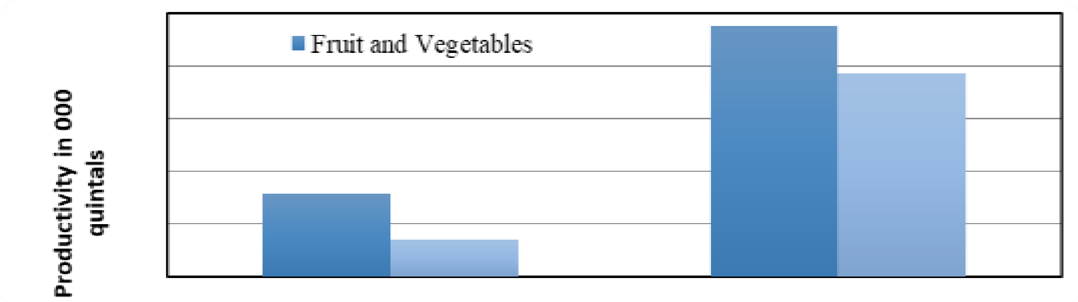


Figure **2**: Crop, Vegetable and Fruit Production in the Study Area Using Irrigation in 2017

Cultural Services of Chefa Wetland Ecosystem

As shown in table 3, cultural services such as religious gathering and healing from diseases were selected by 155 (98.7%) and 152 (96.8) respondents.

Table 3: Summary of Cultural Services of Chefa Wetland

S.No.	Cultural Services	No.of respondents	%
1	Religious gathering	155	98.7%
2	Using hot springs for health benefit	152	96.8%
3	Swimming	98	62.4%
4	Recreation from viewing birds	92	58.6%
5	Wedding ceremony	40	25.5%
6	playing games	39	24.8%
7	Educational trip to the wetland	10	6.4%
8	Experimental/practical work	3	1.9%
9	Academic research	0	0.0%
10	Birthday ceremony	0	0.0%

Respondents also gave their witness for other services such as swimming (98) viewing birds (92), wedding ceremonies (40), playing games (39), educational trip to the wetland (10) and experimental/practical work (3). Academic research and birth day celebration were not selected by household respondents

Religious gathering was mainly practiced in the wetland during the sacred holydays of Muslims namely 'Eid Al Fatir (at the end of fasting month) and Eid Al Adha (after 70 days of Eid Al Fatir) to perform prayer. This activity was undertaken twice per year on the green fields/pastures of the wetland.

Hot springs, assumed as the miracles from the Creator among the locality, were valuable services of Chefa wetland recognized by the majority. They were not only used by those who got illness but also by those who were healthy since the hot springs are considered as a preventive mechanism against different diseases.

Among the participants one respondent has raised that 'Chefa wetland is a naturally gifted healing place for being endowed of its impressive hot springs. There is no need to visit health centers for diseases like skin and fever as long as the hot springs are there. Anybody, whether from the local resident or any other place else, can take bath in the hot springs without any payment for the service.'

Regulation Services of Chefa Wetland Ecosystem

The study has used six common regulation services of wetland ecosystem (Table 4) and household respondents were asked on each variable to forward their level of agreement based on their understanding and experience. Accordingly, from the total respondents 59 replied undecided followed by 58, 29, eight and three respondents replied disagree, agree, strongly disagree and strongly agree respectively for the service flood control. On the service ground water recharge 40.13% of the respondents replied agree followed by 26.11% disagree, 22.3 % undecided, 5.1% strongly disagree and 1.91% strongly agree.

Maintenance of fresh air and local weather conditioning was selected as inexistent service with 63 responses followed by 36 undecided responses. Respondents of 24, 20 and 14 size were replied agree, strongly agree and strongly disagree respectively. For the services maintenance of soil fertility, purification of water sources, and waste assimilation 60, 65, and 90 respondents were replied disagree, followed by 47,45,and 22 undecided , 32,29,and 32 agree, 11,13, and 10 strongly disagree, five, seven and three strongly disagree respectively. The survey result depicts that, majority of the respondents have low understanding on regulatory services of Chefa wetland ecosystem with the exception of ground water recharge which was responded strongly agree and agree by almost half (49.68%) of the respondents.

Table 4: Summary of Households Perception on Regulatory Services of Chefa Wetland

Regulation services/ Variables	Stro-ngly Agree	Agree	Unde-cided	Disagree	Strongly Disagree	Total
Flood control and water overflow prevention	3	29	59	58	8	157
Ground water recharge	15	63	35	41	3	157
Maintenance of fresh air and local weather conditioning	20	24	36	63	14	157
Maintenance of soil fertility	7	32	47	60	11	157
Purification of water sources	5	29	45	65	13	157
Waste assimilation	3	32	22	90	10	157

Supporting the response of few households' agreement and strong agreement some of the key informants clarified flood control and water overflow prevention service as stated under:

The flat geographic nature, which reduces the flood speed and the presence of marsh areas (areas with high absorption capacity) in Chefa wetland ecosystem, prevents the overflow and inundation of Borkena River to agricultural lands and settlements. The right witness for this service is observing the inundation of the flood plain during summer (rainy season in Ethiopia). If the wetland was not there the agricultural lands and settlements you see around the wetland were totally impossible to think.

In the same way, a remarkable idea was presented by one of the key informants on the service ground water recharge as follows: 'Percolation has a direct relationship with the slope, soil type and vegetation cover of a specific area. Chefa wetland ecosystem can be described as a sponge placed in a bucket of water. The gentle slope along its vegetation cover and fertile soil resources allows good percolation and storage capacity and less evapotranspiration as compared to highlands and surrounding areas. In addition to this, even though few in numbers, the swamps absorb both the high runoff and the incoming rain which in turn plays a pivotal role to recharge ground water significantly.'

Decrease in Spatial Extent of Chefa Wetland

Land use/Land cover in 1988:

The land use/land cover of the study area was classified in to five classes(Table 5) for the mentioned year. Agricultural and grazing land covered the largest portion of LULC with an area of 21,419.3ha (42.6%) and 11,030.02 ha (21.9%) respectively. Area covered by forest was

9,274.27ha (18.4%) whereas wetlands (swamps and water body) 7490.04ha (14.9%). The smallest proportion 1103.65 ha (2.2%) of the study area was covered by settlement.

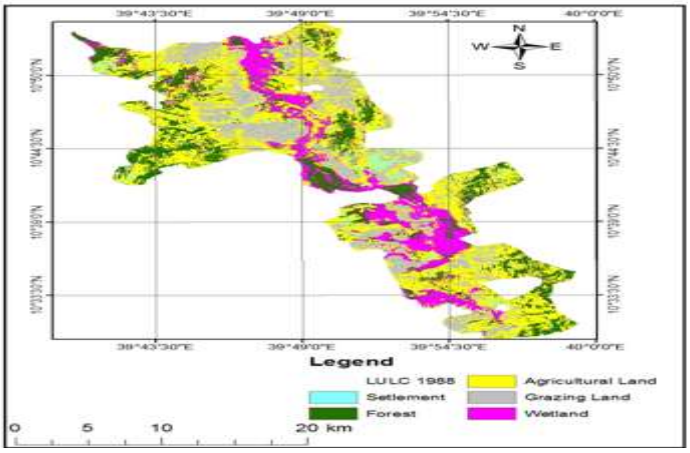


Figure 3: Land use/land cover Map of the Study Area in 1988.

Table 1: Area Coverage of LULC in the Study Area 1988-2018

S.No	Class Name	LULC in 1988		LULC in 2003		LULC in 2018	
		Area (in 000'ha)	%	Area (in 000'ha)	%	Area (in 000'ha)	%
1	Agricultural Land	21.42	42.60	24.46	48.60	22.95	46.6
2	Forest	9.27	18.40	10.02	19.90	6.87	13.6
3	Grazing Land	11.03	21.90	9.13	18.20	15.27	30.3
4	Settlement	1.1	2.20	3.18	6.30	3	6.6
5	Wetland	7.49	14.90	3.49	6.90	1.90	3.8
Total		50.32	100.00	50.28	100.0	50.33	100.0

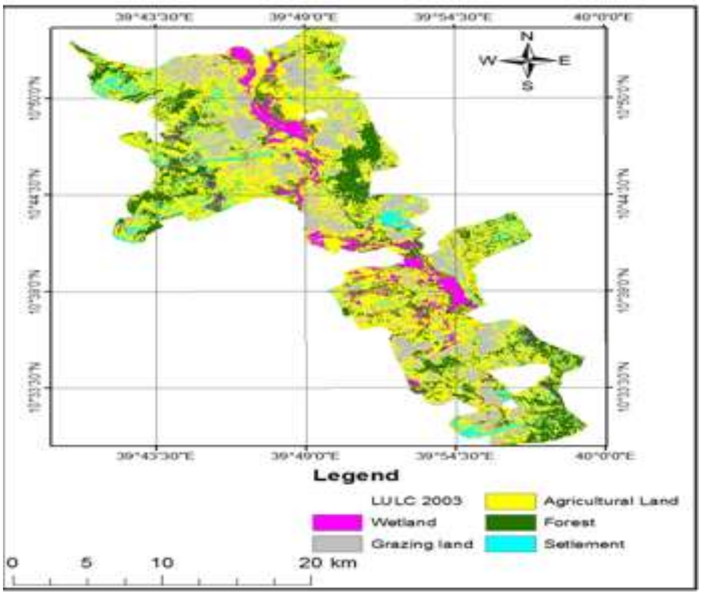


Figure 4: Land use/land cover Map of the Study Area

The pink color in the Figure 3, represents wetland (water bodies and marshes) which indicates the presence/distribution of these valuable resources in the upper, middle and lower catchment of study area for the 1988. This distribution of wetlands indicates the anthropogenic intervention in the study area were low for the mentioned year.

In the year of 2003 the Land use/Land coverafter 15 years, moderate LULC changes were observed on agricultural land, settlement and forest land which showed 6.01%, 4.1% and 1.5% increase respectively (Table 5). On the other hand wetland area in 200 undergone dramatic decline figuratively expressed as 8% followed by grazing land that was reduced to 18.2% (0.2% decline).

As depicted from figure 4, the wetland distribution in this year was highly limited to the upper and middle catchment of the study area indicating the high prevalence of wetland conversion to different LULC classes in the lower catchment.

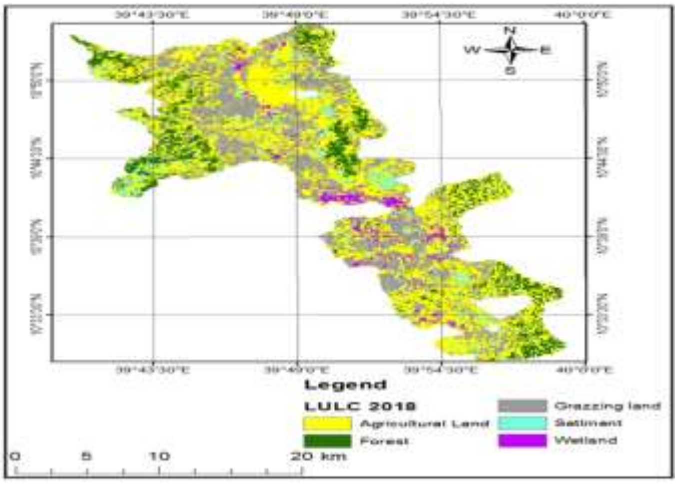


Figure 5: Land use/Land cover Map of Chefa Wetland in 2018

After three decades, Land use/Land cover in 2018 a significant LULC change was observed on grazing land that showed a 12.1% rise (6,138.4ha). Settlement was also increased by 0.6%. Inversely, agricultural land was declined from 48.7% to 45.6%, followed by forest land which was reduced to 13.7%. Wetlands continue to decline as the previous 6.9% coverage was reduced to 3.8%.The abundance of wetlands throughout the study area declined after 30 years (Figure 5) which shows the high anthropogenic impacts on the wetland ecosystem.

Land use/Land cover Change Matrix between 1988 and 2003

As described in table 6, LULC change matric between the years 1988 and 2003 shows that a total wetland area of 5,747.29ha was converted to different LULC classes. The largest proportion of the wetland area was converted to agriculture (3,712.91ha) followed by grazing land (1910.39ha), forest (123.08ha), and settlement (0.91ha). This shows that agricultural expansion on the wetlands was a leading driver resulted in change of Chefa wetland state particularly important habitat types.

Likewise, the conversion of wetlands to grazing land depicts the swamps and water bodies were dried of different pressures exerted on them at different times. The matrix result also shows forestry (eucalyptus plantation) and settlement was undertaken on the wetland.

Table 6: Land use/Land cover Change Matrix between 1988 and 2003

	LULC 2003						Column Total
	LULC Class	Agriculture	Forest	Grazing land	Settlement	Wetland	
LULC 1988	Agriculture	12,676.08	2,693.53	3,130.11	2,127.96	767.42	21,395.09
	Forest	2740.36	5291.61	331.79	124.78	774.92	9,263.47
	Grazing Land	4893.36	425.09	5150.37	390.97	161.49	11,021.27
	Settlement	438.22	30.01	184.44	409.34	40.52	1,102.52
	Wetland	3,712.91	123.08	1910.39	0.91	1742.55	7,490.04
	Row Total	24453.70	10020.63	9127.32	3176.96	3,486.9	50,265.16

Note: the ☐cells in the table indicate the unchanged LULC classes

Land use/Land cover Change Matrix between 2003 and 2018

In similar fashion the LULC change matrix between 2003 and 2018 indicates that continued wetland conversion to agriculture, forest, grazing land and settlement was observed in the study area. Agriculture land area of 1,815.91ha (Table 7) was expanded on the wetland in those years. Considerable area of wetland (1061.09ha) also converted to grazing land followed by tree plantation (66.98ha) and settlement (0.97ha).

Table 7: Land use/Land cover Change Matrix between 2003 and 2018

	LULC 2018						
	LULC class	Agriculture	Forest	Grazing land	Settlement	Wetland	Column total
LULC 2003	Agriculture	11814.83	1635.51	8112.59	2004.99	888.04	24455.95
	Forest	3775.70	4966.51	521.59	357.03	399.24	10020.08
	Grazing land	3941.49	38.22	4791.94	316.20	40.73	9128.58
	Settlement	1672.86	59.24	943.72	477.97	24.64	3178.43
	Wetland	1815.91	66.98	1061.09	0.97	542.07	3487.02
	Row total	22920.79	6866.46	15253.94	3334.15	1894.73	50270.06

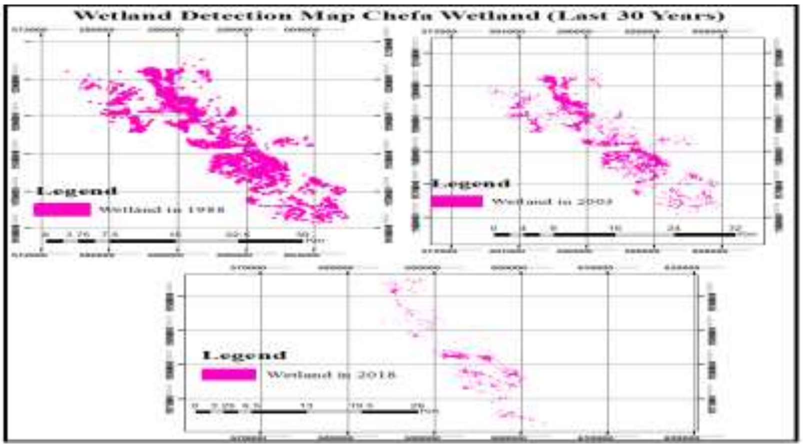


Figure 1: Wetland Change Detection Map of Chefa Wetland between 1988, 2003 and 2018

As demonstrated in figure 6, comparison of the last thirty years wetland area distribution in the study area shows great variations as wetlands were extensively observed throughout the study area for the base year 1988. The distribution started to decline after 15 years from the base year since the wetland distribution was decreased in all catchments though the degree differs. Massive decrease in wetland distribution was observed after 30 years as the distribution was narrowed to middle catchment and negligible coverage was noticeable in upper and lower parts of the Chefa wetland.

In addition to households and key informants view, results from satellite image analysis and interpretation were used to know the regulating services of Chefa wetland. According to the data from Landsat8 (2018), the LULC of the study area was constituted by 45.6% agricultural land, 30.3% grazing land 13.7% forest, 6.6% wetland (water body and swamp)and 3.8% settlement (Table 5). Those different LULC of the wetland provide undeniable regulation services. Forests and plantations provide local weather conditioning, ground water recharge, purification of ground water sources, prevent soil erosion and maintain soil fertility. Likewise, swamps largely provide waste assimilation other than the above mentioned services. Moreover, the gentle slopes allow negligible runoff and soil erosion is unexpected. The high carbon stock in marsh lands and under the root of vegetation covering the grazing land maintains the carbon cycle and increases soil fertility in the area.

Conclusion and Recommendation

Conclusion

The objective of this research was to study the perception of local community to wards wetland ecosystem, assessing the existing ecosystem services. Finally, the study has reached on the conclusion that Perception and awareness towards ecosystem services of Chefa wetland was limited particularly on the supporting and regulation services. This low understanding was prevalent encircling the vast rural community and even the educated part of the community especially managers and political leaders. This has its own implication for policy intervention either in educating the local community and or building capacities institutions found at different levels. The assessment and inventory made by the study displays Chefa wetland ecosystem provides enormous ecosystem services ranging from direct/tangible to intangible/abstract services. A total of 16 provisioning services and nine cultural services were identified. The services play a pivotal role to sustain the whole life system in the locality. They provide the basic necessities like food, water, medicine apart from spiritual and health benefits, maintaining biodiversity, regulating climate and prevention of hazards. Understanding these multidimensional services there must be a mechanism either to boost or use them in a sustainable manner.

In Chefa wetland ecosystem lots of drivers were interacting to pose pressure bringing changes to state of the wetland and consequently impacting the services gained from the wetland ecosystem. In the absence of response or remedial actions the possibility of the wetland ecosystem to supply its services in sufficient or sustainable way raises big question.The findings are in conformity with the LUC detection made for the last three decades that shows substantial change in habitat and land use/land cover. A valuable part of the wetland has undergone through complete conversion to other land uses indicating a quick response for rehabilitation. Besides these, there were also challenges that complicated wetland management in the study area with some have relation with understanding and lack of knowledge, others have strong relationship with institutional and policy failures and few challenges had innate relationship with the natural system or climate variability. So, interventions to tackle problems/challenges should be all rounding and systematic in nature. Potential conservation strategies are proposed based on the findings and challenges identified by the study. The interventions proposed have again an awareness, policy and institutional context.

Recommendations

The services provided by wetland ecosystem are unique and valuable for the community and the environment. What matters most is the sustainability of these life supporting ecosystem services. So, the study has proposed the following recommendation to be undertaken at different levels and times.

- Awareness creation and raising understanding of the local community, planners, decision makers, project implementers and local governments towards ecosystem services should be undertaken consistently so as to bring behavioral change.
- Incorporating issues related to wetland ecosystem services in to capacity building activities given for experts working at different levels of administration and institutions.
- Making consecutive support, inventory, monitoring and evaluation of wetland ecosystems services to undertake timely and appropriate measures for the changes that would be observed.
- Facilitating academicians and higher education institutions to undertake research and use efforts to implement the findings of those academicians to the extent possible.

Recommendations for Rural Land Administration and Use Office (RLAUO) and Agriculture Development Office (ADO) at Wareda (block) Level

- Internalizing family planning in coordination with health sectors, introducing best varieties of animals and crop, building adaption and resilience to climate variability and diversifying the income sources of the local community.
- Applying environmental friendly agricultural technologies/inputs and reducing the high dependence on inorganic and environmentally polluting inputs minimize the impacts on water resources and existing biodiversity has to be undertaken by local governments and farmers.
- Undertaking environmental impact assessment prior to the implementation of farm projects and establishment of industries on the wetland ecosystem.
- Stooping illegal settlement, drainage and plantation of eucalyptus and rehabilitating the damaged parts of the wetland ecosystem in combination with local community and political leaders exercising power at different levels.
- Controlling the expansion of invasive alien species and preventing the encroachment of local communities into the wetland ecosystem
- Decreasing the high livestock population by introducing high yield providing livestock breeds and implement proper grazing land management through controlled and rotational grazing systems

Recommendations for Further Research

- Quantification of carbon sequestration capacity of the wetland
- Economic Valuation of wetland ecosystem services
- Quantifying the environmental consequences of wetland reclamation and conversion in to other land uses

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