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The Effect of Wetland Degradation on Fish Production in Ethiopia

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Abstract

Ethiopia owns different types of wetlands which have regional, national as well as global ecological and socio economic significances. Despite all those and other indispensable values, these wetlands are under severe pressure and degradation. Due to human/climate impacts like traditional and modern agricultural expansions, continuous land degradations, urbanizations and industrializations; and ecological problems are the most dominant challenging factors of wetlands in the country. Thus, wetlands in degraded area can share biological, chemical and physical problems and alter food webs of wetland ecosystem. As a result this in turn modifies species composition, distribution, abundance and the activities of organisms that rely on these aquatic ecosystems. In order to reverse these emerging problems and conserve these fragile but crucial wetlands, integrated problem solving approach through realizing the collaboration of relevant stakeholders from policy level down to grassroots community is indispensible opportunity to Ethiopian wetlands. Government, Communities, private sector and all others who have stake in wetlands should cooperate and contribute their part. Decision makers at higher levels are required to strengthen sustainable wetland management efforts through effecting policy and legislation, improving institutional arrangements and supporting capacity building initiatives.

Keywords: Anthropogenic and climate impacts, fish, Ethiopia, Wetlands

1. INTRODUCTION

Wetlands are ecosystems or units of the landscape that are found on the interface between land and water. While water is a major factor of wetland definition (Ramsar Convention Bureau 1997), soils, vegetation and animal life also contribute to their unique characteristics (Koetze 1996 and Roggeri 1995).

More than 50 stakeholder interest biased definition and assumptions have been given to wetlands (Smith 1995). But, an international meeting held in Iran, Ramsar in 1971, has developed broadest and most international definition. Accordingly, Wetlands are: "Areas of marsh, fen, and peat land, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters" (RCB 1997). This definition has been found more holistic in types and forms and has got worldwide recognition and acceptance.

As per the Ramsar 1971 definition, Ethiopia owns different types of wetlands which provide enormous socioeconomic and environmental values and that attracts a number of users that benefit the local community directly or indirectly. They are source of water, food, feed, medicinal plants and other income generating activities for the rural community. They are vital in attracting tourists and providing ground for cultural ceremonies (Finlayson and Moser 1991). They also contribute for environmental wellbeing through recharging and discharging underground water,

hosting biological diversity, sequestering carbon, mitigating flood hazards etc. In general, Wetland resources contribute billions of birr to people of Ethiopia every year in the form of clean water, pure air, soil formation and protection, crop pest control, and provision of food, fish, fuel, fiber, medicine, recreation, tourism, etc.(Leykun 2003).

Despite all those and other values, Ethiopian wetlands are under severe pressure and degradation. Due to intensive irrigation agriculture, the expansion of human settlement, industrial pollution, pesticides and fertilizers and water diversion for drainage and the construction of dams and also some environmental factors. Wetland conversion often results in water depletion, the displacement of populations, the destruction of traditional production systems, habitat degradation, salinization, increases of waterborne diseases and other adverse ecological impacts (Zerihun 2003; Yilma 2003). Hence, the impact of wetland degradation is so integrated into different anthropogenic and climate issues that affect aquatic ecosystems especially the fishery and in order to develop and assure their continuity for the future, cost should be paid to understand the dilemmas that they face and in identifying the good practices which should be strengthened. The intention of this paper is therefore to explain the socio-economic aspects of wetlands; to annotate what happens to the aquatic life including fish in different ecosystems as the wetland is degraded; to draw important conclusion and forward sound national initiatives required to rescue the aquatic resource from impacts of wetland degradation.

2. WETLANDS POTENTIAL IN ETHIOPIA

Ethiopia is a country located between the coordinates of 3-15º N Latitude and 33-48º E longitude. Its areal coverage is estimated to be 1,127,000 km^2 of which some 7,444 km^2 is covered by water (Leykun 2003). Climate is the function of the latitude, altitude, angle of the sun, distance from oceans or other water bodies, terrain and the like. Thus, diverse climatic conditions in Ethiopia are the result of the combination of the stated factors. These diverse climatic conditions together with the terrain and physical characteristics in turn also involve in hydrological aspect of Ethiopia. The very high variability exhibited by the climate components of the country over time and space is the main reason behind the spatial and temporal variability in the availability of water and so to wetlands (Yilma 2003).

Detailed inventory of the wetland resource base of Ethiopia is not yet carried out. Hence, the type and inventory of Ethiopian wetlands are not fully documented. However, based on scattered information, wetlands are estimated to cover about 1.14 - 2% of the total land mass of the country (Hillman and Abebe 1993). Hillman (1993) listed a total of 77 wetlands in Ethiopia and Eritrea, together with their locations. Ethiopian wetlands are distributed in different parts of the country almost in all ecological zones. The largest of this are the flood plains of Lake Tana, the flood plains of the Baro Akobo (Gambela), the wetlands of south western Ethiopia, the Dabus wetland and the wetlands surrounding the Fincha Lake in western Ethiopia (Seifu Kebede and Addis Hailu 2011).

3. FUNCTIONS OF WETLANDS

Ethiopia is often referred to as the water tower of Africa mainly because of its wide variety of land forms and climatic conditions, creating an extensive wetland system throughout the country. Wetlands in the country have ample amounts of socioeconomic and environmental importance to the local national and international economy, sustenance of biodiversity and climatic moderations. Functioning wetlands provide a range of under-appreciated benefits and services for people's livelihoods and well-being, including food, fiber, water purification, transportation and cultural values, as well as water supply. Wetland ecosystems also provide fundamental ecological functions including groundwater recharge, storm protection, flood mitigation, shoreline stabilization, erosion control, and retention of carbon, nutrients, sediments and pollutants as well as providing habitats for flora and fauna and serve as migratory routes for animals (Dugan 1990). In addition support for food chains, fisheries production, habitat for wildlife, recreation, natural heritage values, biomass production, water transport, bio-diversity presentation and micro-climate stabilization (IWRB 1992, Dugan 1990).

Many different species of plants and animals make on some parts of the wetland and lakes highly bio-diverse and especially the littoral area is covered with emergent and submergent macrophytes, which serve as shelter, hiding areas and breeding zones for weed bed fauna (annelids, crustaceans and insects), protozoans, rotifers, cladocerans, copepods, ostracods and fish (Tilahun *et al*. 1996). Hence, wetlands are dominated by vegetations which represent habitat of great ecological importance; it protects growing fish

(fry and fingerling) inhabiting the shore area from their enemies and reduce disturbance and destruction caused by beach seine, also it can supply fish feed by generating zoo and phytoplankton from the decomposing organic materials.

4. CAUSES OF WETLAND DEGRADATION

Though wetlands face number of threats from natural factors globally, most of the threats are resulted from the directly or indirectly human interaction with the wetlands. Ethiopian wetlands could not be different from this truth. Like in the other African countries, most of the threats in Ethiopian wetlands are result of the direct and/ or indirect human interactions (Anthropogenic impacts**)**. Environmental factors area also coming importantly influencing factors.

4.1. Anthropogenic impacts

Human effects the aquatic ecosystem through pollution, changes to the landscape or hydrological systems, and larger-scale impacts such as global climate change. Dugan (1990) claims that 65% of wetland disturbances are of human origin, while the remainder have natural origins. Out of these, 73% of disturbances are thought to result from direct human actions, while the remaining 27% are believed to come from indirect sources. Miller *et al* (1989), Williams and Naves (1993), Dehadrai *et al* (1994) and Warren and Burr (1994) have reviewed some of the factors responsible for extinction of fishes in aquatic ecosystems is caused by human. Among the major factors for the decline of fishes in ecosystems that identified by different scientists (Bishaya 1987; Dutta 1987 and Deka *et al* 2005) as physical habitat loss, degradation or alteration, over exploitation, weed infestation, Eutrophication, siltation, pollution, fish disease and destruction of inlet/outlet channels. The multiple causes of wetland degradation due to anthropogenic impacts do not act separately. On the contrary, they usually have many different origins and there are complex relationships between them and the major impacts in the country discussed below.

4.1.1 Degradation of catchment areas

In Ethiopia there is no doubt that the number of people living around in catchments has increased substantially in the last couple of decades. As the size of the population grows, people are compelled to clear land for agricultural activities to ensure their survival in conditions where alternative means of existence and agricultural innovation are limited. Recently, much of the forests covers around the catchments are being removed by the local people for Livestock feed, mosquito control and agricultural activities and grazing. Hence, nutrient and sediment loads increase in the wetland system in recent years (Lemlem 2003 and Spliethoff *et al*. 2009) and also the chemical and physical features of the lake and the wetland are being changed. Consequently, this change can modify species composition, distribution, abundance and the activities of organisms that rely on the aquatic ecosystems including fish. For example, among wetlands which have been converted to dry lands due to siltation and unregulated water abstraction is Lake Haramaya (EWNRA 2008).

4.1.2 Improper agricultural practices and expansions

Agriculture is one of the main sources of pollution that affects wetlands. Agricultural herbicides, insecticides and other types of chemicals used to reduce seed damage or increase the effectiveness of pesticide applications, like fungicides, fumigants, surfactants, and drift retardants, can cause important damages to plants and animals in wetlands. These pesticides can reach wetlands via spray drift, aerial deposition, or most commonly through surface runoff or groundwater flow. In most part of the country many agricultural activities within the basin are subsistence-based, although a few large-scale farms exist close to the lake and the wetland system. The notable one is the flower farm, which uses various agro-chemicals (pesticides, herbicides, fungicides and fertilizers). The amount and types of chemicals used is not easily determined, but certainly leached chemicals from this and other small-scale farming reach the wetland via the drainage system.

In case of the central rift valley wetlands that encompassing Lake Ziway, Abyata and Langano, forms a complex and vulnerable hydrological system with unique ecological characteristics. Recently, the area with irrigated agriculture comprising both open-fields horticulture smallholders and large scale greenhouse growers has expanded rapidly. These subsistent and large scale farming practices in the basin of Hawassa and Ziway wetlands for example are disturbing the respective wetlands (Hengsdijk *et al*. 2008) and easily diffuse the various agro-chemicals (pesticides, herbicides, fungicides and fertilizers) to the nearby wetlands and terrestrial areas which can be easily drained to wetlands. Moreover grazing by

domestic stocks has also been identified as threats of wetlands. When grazing follow continuous cultivation wetlands easily become degraded and loss their natural characteristics. Livestock trample the soil and compact it and their grazing destroys natural vegetation. They erode drainage channels leading to gullies and increase water out flow. These effects often result complete degradations of wetlands by reducing the water table and by changing the original vegetations. In summary, complete conversion and modification of wetlands to cultivated land, improper citation of large scale farming systems, improper farming methods and poor tillage systems, and planting more water requiring perennial crops and plants are some of the agriculture related threats of Ethiopian wetlands that affects directly and indirectly affect the aquatic biota.

4.1.3 Urbanizations and Industrialization

Urbanization is a major cause of impairment of wetlands. Urbanization has resulted in direct loss of wetland acreage as well as degradation of wetlands. Degradation is due to changes in water quality, quantity, and flow rates; increases in pollutant inputs; and changes in species composition as a result of introduction of non-native species and disturbance. The major pollutants associated with urbanization are sediment, nutrients, oxygen-demanding substances, bacteria, and viruses. These pollutants may enter wetlands from point sources or from nonpoint sources. Construction activities are a major source of suspended sediments that enter wetlands through urban runoff.

Accordingly, considerable numbers of Ethiopian wetlands are near rural towns and cities, where business activities are expanding in many sectors. To mention some of these lakes and wetlands Tana, Hawassa and Ziway are a few. These wetlands near urban are suffering negative consequences from the expanding sectors sources (e.g. hotels, health centers, households and factories). For instance, the amount of solid and liquid wastes generated by different sources is increasing in size and composition. This is more severe as most of the wastes from developing societies are organic, although toxic inorganic and pathogenic wastes are not absent (Lardinois and Klundert 1993). Organic waste loading in such systems affect different ecosystem elements, including biological resources (Cunningham and Saigo 1995; Miller 1995).

Practically all of city sewage lines end up into the lake and wetlands. Almost all the municipality in the country has no system to collect and manage solid and liquid wastes. If nutrient concentrations in the receiving waters become high, algal blooms may occur. Such changes to the trophic status of the water body (eutrophication) can affect fish populations in a number of ways. They increase nutrients and turbidity, alter the food chain and ionic composition of the water, increase organic matter accumulation in the sediment, decrease oxygen (and hence cause fish suffocation) and cause changes to water temperatures and macrophyte communities (Jackson 2011 and Taylor 1984).

Industrial centers of Ethiopia such as Mojo, Akaki, Hawassa, Ziway and Bahir Dar are good example in sourcing different solid and liquid effluents to their respective nearby wetlands (EWNRA 2008). The illegal settlements in and around wetlands also affect the health and size of the wetlands significantly. Most of the problems from urban to wet lands in Ethiopia are related to the absence of systems that collect and manage solid and liquid wastes (Abebe and Geheb 2003). In addition, the high amount of impervious surfaces in the wetland created by increasing urbanization and industries prevents rainfall from seep into the soil and then increases erosion and transport of higher amounts of sediments and pollutants into wetlands that creates eutrophication.

4.1.4 Hydrologic alterations

Any change in hydrology can significantly alter soil chemistry and plant and animal communities in wetlands (EPA 2001). Common hydrologic alterations in wetlands include:

Water extraction: Withdrawals of water from a certain watershed for irrigation, industries or domestic use affect the hydrologic and ecological functions of wetlands, diminishing water availability and changing water levels, thus affecting the composition of animal and plant communities. These extractions may take place in upstream rivers or streams, groundwater or, less often, in the wetland itself. This can sometimes exacerbate the effects of other stressors on the ecosystem, resulting in effects that exceed those that would be expected from dewatering alone. For instance, dewatering in a wetland that receives water polluted by organic materials will result in increasing eutrophication due to a higher concentration of these pollutants.

Water diversion structures: Apart from drainage, wetland hydrology has been modified by the construction of channels, ditches and levees to achieve flood control, irrigation, timber harvest, navigation, transportation, and industrial activity. Channelization increases the speed of water moving into and through wetlands. As a result, patterns of sedimentation are altered and wetland functions and values that depend on the normal slow flow of water through a wetland can be affected. In addition, it alters in stream water temperature and diminishes habitat suitable for fish and wildlife. Dams also affect flooding cycles, water chemistry, sediment behavior and fish migrations (Maltby 1986). In general overuse of the wetland together with water resources shift caused heavy erosion and silt accumulation in lakes and irrigation and power dams with the result that the water volume has been decreasing so fast. For instance, basin lakes like Lake Tana, Rift valley and L. Haramaya have the most vulnerable water bodies to this phenomenon and for that matter the last (the only source of water supply to nearby urban centers) has already dried up (2011).

4.2. Environmental impacts

Since, wetlands, as ecosystems that are highly dependent on water, that are significantly affected by environmental impacts (EWNRA 2008; Matthew *et al*. 2006). Hence, Environmental factors area also coming importantly influencing factors next to anthropogenic. There are some expected effects resulting from environmental changes and discussed below.

4.2.1. Changes in precipitation

Changes in precipitation, location and timing that alter wetland and lake water availability are collectively can alter abundance and composition of aquatic organisms and impact on seed availability for recruitment. For instance, changes in water level can alter spawning and recruitment of endemic fish species. Lower water level leads to low water quality due to reduced capacity of productivity of photosynthetic balance. Fish often seek optimal temperature and salinity regimes, while avoiding suboptimal conditions. Thus, freshwater changes as a result of projected climate change including wetland degradation can lead to distributional changes. The absolute and relative abundance and biomass of species of fish inhabiting large rivers are predicted to change in response to both natural intra-annual variations in flooding regimes as well as long-term climatic shifts (Ficke *et al*. 2007). A change in precipitation averages and potentially increases in seasonal and annual variability and extremes are likely to be the most significant drivers of change in inland fisheries as well as other aquatic organisms (World Fish Centre 2007).

4.2.2. Increased temperature

All aspects of an individual fish's physiology, including growth, reproduction, and activities are directly influenced by changes in temperature (Wohlschlag *et al*. 1968; Schmidt-Nielsen 1990; Franklin *et al*. 1995). Therefore, increasing temperatures can affect individual fish by altering physiological functions such as thermal tolerance, growth, metabolism, food consumption, reproductive success, and the ability to maintain internal homeostasis in the face of a variable external environment (Fry 1971). Fish populations that are faced with changing thermal regimes may increase or decrease in abundance, experience range expansions or contractions, or face extinction.

Increases in temperature may enhance eutrophic conditions by stimulating explosive macrophyte growth. A study found that a 2-3^{0}C temperature increase could cause a 300-500% increase in shoot biomass of some aquatic macrophyte (Kankaala *et al*. 2002). A biomass increase of this magnitude would affect the system in various ways. First, because macrophytes take up the phosphorus sequestered in the sediment, the amount of phosphorus immediately available for other primary producers would decline. However, when the macrophytes die and decompose, they release nutrients such as nitrogen and phosphorus into the water column (Cooper 1996; Kankaala *et al*. 2002). This influx of nutrients can stimulate algal blooms and help perpetuate high macrophyte production and the likelihood of anoxia-related fish kills (Klapper 1991). Hence, temperature is one of the primary environmental factors on the production of aquatic organism especially fishes. In addition to these, there are occasions where specific pollution events can have a major impact on a wetland, with effluents being released into the watershed carrying high levels of pollutants of many different types and, sometimes, raising water temperature.

In general, increases in temperature can also augment the productivity of a body of water by increasing algal growth, bacterial metabolism, and nutrient cycling rates (Klapper 1991). Although the complex relationship between wetland degradation and

eutrophication makes prediction difficult, increased temperatures will likely result in a general increase in lake trophic status. Hence, the expected increase in extreme weather events and water temperatures will affect aquatic organisms, which are especially sensitive to these changes and have specific water level requirements. In addition to these, the incidental and intentional introduction of invasive alien species is another emerging issue severely affecting the wetlands of the country. Some of the world's worst invasive species, which are threatening Ethiopia's wetlands, like *Mimosa pigra* and *Eichhornia crassipes* that disrupts hydropower generation (e.g. Koka dam), increases siltation and evapo-transpiration, reduces fish stocks, impairs water transport and fishing activities, and reduce water quality (Dereje 2003).

5. EFFECTS OF WETLAND DEGRADATION

To consider the effect of wetland loss on aquatic resources, there are good examples of wetlands which are already lost (Haramaya) and in loss such as Abijata and Cheffa (EWNRA 2008). Moreover considering the rapid conversion of the Illubabur wetlands is also very important. Bringing these wetlands in to mind, the communities dependent on these wetlands for fisheries, dry season food crops, raw materials for construction, water, feed for animals, medicinal plants, income from sale of the products including handicraft, have lost or is in loss of the stated uses.

The consequence of wetland loss extends to aggravating climatic disturbances by increasing carbon build up in the atmosphere and biodiversity loss (Abebe and Geheb 2003; EWNRA 2008). As the country is prone to desertification and recurrent drought, the effects of wetland loss could be more visible in complicating the situation locally. It can also affect hydrological cycle or rainfall patterns. Rivers and streams may lose their strength. Since, wetlands are prominent shelter of aquatic and terrestrial biodiversity. Fishes, birds and other life forms depend on wetlands. Hence, the loss of these wetlands is devastating to several endemic species and particularly to wetland dependent species. Actually, the complexity of aquatic ecosystems and the linkages within them can make the effect of disturbances on them difficult to predict. These linkages mean that damage to one component of the ecosystem can lead to impacts on other ecosystem components. There are internal factors such as competition and predation between members of a single trophic level and predation activities involving adjacent trophic levels. Many external factors also influence the structure of the food web. The links between wetlands and aquatic organisms including fishes are deeper and more significant than those that exist in mainstream agriculture (FAO 2008). Directly and indirectly there are different factors that affect the productivity of aquatic organisms due to wetland degradation and discussed below.

As wetland degraded by different factors such as pollution and pesticide substances directly inter to the water and may have a lethal effect for animals that are directly exposed to them by eating, drinking, skin contact, etc., and to plants that take contaminated water through their roots or receive direct pesticide deposits on their surface. Aquatic plants and algae are more sensitive than fish or invertebrates to contaminants such as herbicides. Since they form the base of the aquatic food web, impacts on them can cause adverse effects on all higher animal levels in a wetland ecosystem (Hamilton 1993). However, the worst effects may be pesticide-induced changes in the functions of enzymes, cells, or organs of plants and animals that alter how they compete for living space and food, avoid predators, reproduce, etc., thus altering population structure or even community or ecosystem structure (Hamilton, 1993). For example, the higher population structure may be altered by a lack of juveniles because they were more susceptible to pesticide poisoning and pollution due to wetland degradation, or the population of a certain species may grow excessively due to the disappearance or decrease of its predator species.

Again excessive sediment input, usually coming mostly from erosion of agricultural soils, has potential to severely impact wetlands. Sedimentation impacts include increased turbidity that reduces the depth of the photic zone and increases sediment fallout which may cover primary producers and invertebrates and clog wetland vegetation. Excessive sediment input thus potentially alters aquatic food webs as well as basic wetland functions related to water quality improvement, nutrient cycling, water holding capacity and processes that transform and sequester pollutants. Hence, this sediment usually contains high levels of fertilizers and pesticides that contribute to water pollution and eutrophication.

Eutrophication is a process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates that stimulate excessive algae growth. Most cases of eutrophication result from the input of excess nutrients from urban and agricultural runoffs and from sewage discharges (Lammens 1990;

Klapper 1991; Nicholls 1998). In most cases sewage effluent is still rich in nutrients such as ammonium, nitrate and phosphate. This effluent is discharged in lakes and wetlands, raising the concentrations of these substances above the natural levels and contributing to eutrophication (Karabin *et al*. 1997). Moreover, solids that settle on wetland beds can cover flora and fauna resulting in an anaerobic layer that hindering oxygen transfer and reducing light penetration. (Dudgeon *et al*. 2006 and Taylor 1984) and is likely to cause severe reductions in water quality and biodiversity is aesthetically not pleasing, creates problems of taste and odor, and de-oxygenation results the death of other aquatic organisms, such in massive fish kill. Increasing phytoplankton productivity, the imbalance of nitrogen and phosphorus with respect to sulphur has effects on the composition of phytoplankton communities, as it can provoke a shift from diatoms to non-siliceous algae, often harmful for the ecological equilibrium in the aquatic ecosystem is another effect of wetland degradation. These changes in phytoplankton community often precede larger-scale, longer-term changes in ecosystem function, including shifts in nutrient cycles, food webs, and fisheries. In most part of the lake, Eutrophication is due to *Microcystis aeruginosa*, which is the most common toxic cyanobacterium (blue-green algae) in eutrophic fresh waters.

6. CHALLENGES

While wetlands may be the most productive of ecosystems on earth, they are also the most threatened. Wetland destruction and alteration has been and is still seen as an advanced mode of development, even at the government level. Wetlands and their value remain little understood and their loss is increasingly becoming an environmental disaster. While rates of wetland loss are documented for the developed world, the limited study of these ecosystems in the country leaves us with little to say. Wetland loss is evident wherever major developments like dams, irrigation schemes and conversion projects are present in the developing world. While most of the threats that wetlands face result from their misuse, many are also related to unsustainable resource extraction. Another important reason for their vulnerability is the fact that they are dynamic systems undergoing continual change. As a result, many wetlands are temporary features that disappear, reappear and re-create themselves over time (Barbier *et al*. 1996).

Capacity limitations as well as population growth and individual approach of stakeholders (inadequate cooperation among stakeholders) are considered as a challenge due to aggravate to increasing demand for wetland and water; and other challenges are as follows: Improper farming methods and poor tillage systems, which contribute towards the erosion of steep cultivated land, Urbanization and human settlement are amongst the most serious of problems in most parts of the country (Illegal settlement in conservation areas of the lakes); Associated industrial development is also problematic, Farming along the wetland not only disturbs wetland shore ecology but also exacerbates siltation and increases the turbidity of the bank. Resultant sedimentation tends to be more pronounced in the littoral than in the pelagic zones of lakes, affecting aquatic life at the shore as well as fish production in general. Lack of awareness, information and research on wetlands, Poverty, the lack of livelihood alternatives for farmers, poor agricultural technology and productivity, Dependence of local communities on wetland resources (wood fuel) for energy, Livestock pressure on conservation areas (Overgrazing) are the major one.

7. CONCLUSION AND RECOMMENDATIONS

Wetlands provide globally significant social, economic and environmental benefits. Important wetland functions include water storage, groundwater recharge, storm protection, flood mitigation, shoreline stabilization, erosion control, retention of carbon, nutrients, sediments and pollutants. Wetlands also produce goods that have a significant economic value such as clean water, fisheries, timber, peat, wildlife resources and tourism opportunities.

The question raised after discussing wetland degradation and its consequences is how can minimize the extent of degradation. No doubt at all that the wetlands of Ethiopia are facing degradation. At the same time, efforts to assure the health and normal functioning of this ecosystem are negligible. So, this section considers ways in which to reverse existing damaging trends and to improve the situation. As discussed in detail in the above sections, the underlying causes of wetland degradation and loss are multi-dimensional. In spite of the complexity and multifaceted nature of the problems, however, there is no quick and one-off solution to redress the threats being faced to wetlands. Hence, the issue of appropriate management is an urgent need and this can be done either by the government or by the

communities themselves or by both. Generally, to alleviate those constrains and there by strengthen the contribution of the resources to the national economy, we need to follow the following guiding principles for sustainable wetland management: like Building knowledge and awareness about wetlands, Impact assessments and Continuous Monitoring of Wetlands, Building partnerships with stakeholders, Monitoring of upstream-downstream user relations, Development of Policy and Prioritization and management plans for wetlands.

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