CHAPTER 1

Wetlands of Lake Victoria Basin, Kenya: distribution, current status and conservation challenges

Okeyo-Owuor J.B, Raburu P.O., Masese F.O and Omari S.N

Summary

Tropical wetlands are known to be very productive, providing water and primary productivity upon which large numbers of plants and animal species depend for survival. In the Lake Victoria Basin (LVB), wetlands are part and parcel of many water bodies where they are hydrologically and ecologically linked through the supply of water, nutrients and organic matter. In the upper reaches of the LVB, many wetlands have been formed by spring water draining into valley bottoms where the gradient is low and hence water accumulates, hence supporting characteristic biota. Other wetlands are formed as a result of shallow water table in depressions, though most of these are seasonal and their area fluctuates depending on the prevailing weather conditions. Other wetlands in the upper reaches have been formed out of damming of streams and rivers for domestic and industrial water supply. In the middle reaches, springs fed wetlands still dominate, with a few riverine wetlands occurring along the edges of the large rivers. In the lower reaches and floodplains, we have seasonal wetlands that form during the rainy season when rivers over-top their banks. Many of the large wetlands in the LVB are found at the river mouths of the major rivers and in the inshore areas of the lake. Examples include the Nyando Wetland, Yala Swamp, Bunyala Wetland, River Mara Swamp, Mosirori Wetland, Osodo Swamp, Ngegu Wetland and Kuja Delta Wetland. Because of their high productivity, these wetlands are threatened by human activities, exacerbated by high human population growth. Changing land use and intensity in the catchments has compromised their integrity, resulting into sedimentation, poor water quality and eutrophication. There is thus a need for awareness creation, adoption of best management practices at the catchment scale and research, especially in socioeconomics, to help avert the negative influences on the wetlands in the LVB.

1.0 Introduction

Tropical wetlands are known to be very productive (Denny, 1993), providing the water and primary productivity upon which large numbers of plants and animal species depend for survival. They are also important locations of plant genetic diversity and support large numbers of bird, mammal, reptile, amphibian, fish and invertebrate species. However, the human population explosion, particularly in sub-Saharan Africa, coupled with unsustainable exploitation, have led to a decline in wetland goods, particularly fisheries (Balirwa, 1998). This is evidenced by poverty among the riparian communities as well as the unsustainable encroachment upon wetland ecosystems, leading to continued drainage, pollution, overexploitation or other unsustainable uses of their resources.

Many communities in developing countries depend heavily on the exploitation of natural resources for their livelihoods. Most of the resources are found among very poor rural communities whose livelihoods mostly revolve around fishing, farming, and harvesting various wetland products. Thus, the over exploitation and high dependence on wetland habitats and their natural resources by resident human populations and their domestic animals have increased on these ecosystems, causing a myriad of both direct and indirect threats and negative impacts both to biodiversity and environmental sustainability, and ultimately the livelihoods of peoples.

1.1 The Lake Victoria Basin

A substantial natural resource base is thought to be one of the many reasons that led European powers to scramble for the African interior during the 18-20th century, where economic ventures was the main agenda (Bohannan and Curtin, 1995; Bennet, 1984). In East Africa, early European explorers geared their expeditions in search of and finally the discovery of the biblical source of River Nile by Speke in 1862, which to the then European powers, was a vital aspect to control trade routes for the Egyptians (Wisnicki 2008, 2009). The explorers found that the entire catchment of Lake Victoria was already a vibrant civilization centre with well structured indigenous governance systems in place to regulate the utilization of resources around the lake. Today, Lake Victoria, the world's second largest fresh-water lake, stands as the most critical economic resource that links its three riparian countries of Kenya, Tanzania and Uganda, as well as Rwanda and Burundi, which form its drainage basin. The lake and its basin are currently valued at around US$ 12.4 billion and is the single most valuable shared natural resource in the region and the major lifeline to the downstream countries of Sudan and Egypt. Indeed, the lake and its vast resources currently form the basis of the arrangements around the East African Community (EAC) regional cooperation (EAC 2000, UNEP 2005).

The LVB (Figure 1) occupies an area of about 251 000 km², of which 69 000 km² is the lake surface. The elevation of the lake surface is about 1135 m asl, whereas the basin is made of a series of stepped plateaus rising from 1135 m a.s.l. at the lake shores to the highest point of over 4000 m a.s.l. on Mt Elgon. The lake is generally considered as being shallow compared to other African lakes such as Tanganyika and Malawi. The average depth of Lake Victoria is 40m with a maximum depth depth of 80-90 m. In Kenya, the catchment area of the lake covers the entire Nyanza and Western Provinces and drains extensive sections of the eastern slopes of the Rift Valley, an area that extends from Cherangani Hills to the Mau Forest, including the Masai Mara Game Reserve in the Rift Valley Province.

Fig 1: *Map of Lake Victoria and its catchment. (Adopted from Koyombo and Jorgensen, 2006*)

To the East African community, the LVB is a unique area especially due to its environmental, cultural, scientific, socioeconomic, immense natural resources and huge investment potential. This is derived from its rich resources such as fishery, biodiversity, water, land, forests, wildlife, minerals, multimodal transport and communication and tourism (EAC, 2004; LVBC, 2007 and LVFO 2006 & 2007, Kisumu, 2007). The lake's fresh water and energy also provide great potentials for enhanced agriculture, trade and industry. Thus, the Lake Victoria Basin has been designated as an "economic growth zone" by the Summit of the EAC (EAC, 1997). For example, the lake is the largest inland water fishing sanctuary in the region with a total harvestable fish biomass of between 700,000 MT and 1,000,000 MT and annual income peaks estimated at US$ 500 million or nearly US$ 1.4 million per day, mainly coming from Nile Perch fishery (Mkumbo *et al.* 2005). This sector employs over 3 million people with over 10 million dependants. The lake's full potential can still be enhanced to treble the current value through using efficient and sustainable methods of fishing (LVFO, 2007).

The lake is also valuable for its wetlands resources which are major sources of livelihoods for riparian communities. On its own, the lake catchment or basin is rich in natural resources. For instance, the wildlife which characterize the Masaai Mara and Serengeti National Parks present a characteristic phenomena of high populations and diverse animal species. The wildlife driven tourism revenues from these two parks alone is worth nearly US$ 12 million annually (UNEP 2006). Significant natural forests are also found in the basin as well as high valuable minerals such as gold and diamonds. In addition, the good fertile soils combined with high rainfall in the entire basin, makes the basin a high

potential area for agriculture. It is the also natural water reservoir for hydroelectric power generation. Further, the lake and the extensive river networks in its basin remain the most reliable source of drinking and industrial water for the populations living in rural areas, most major cities and towns in the basin. The vast rooted and floating fringing wetlands of the lake provides a critical function of moderating and buffering the nutrient and pollutant laden inflows from the several rivers and drainages entering into it, a function continuing to make the lake waters valuable for various uses, and supports the rich biodiversity. The typically equatorial weather and climate of the East African region is influenced and moderated by the Lake Victoria Basin. According to Okungu *et al.* (2005), the equatorial location of the lake drives the process that defines the weather or meteorological characteristics of the entire basin and its neighbourhoods. On the average, rainfall amounts increase from east to west of the lake, ranging from 600 mm to 2800 mm annually. Historical meteorology trends in the lake show that over the years, driest years were 1953, 1965 and 1996 while the wettest years were recorded in 1961, 1968 and 1997 (LVEMP, 2005; Swenson and Wahr, 2009). Further, the wind movement patterns over Lake Victoria closely follow the pattern of the movement of the sun across the Equator through the Inter-Tropical Convergence Zone (ITCZ). Temperature in the basin mirrors the trends in rainfall, with February being recorded as the hottest month, just before the onset of the long rains, often starting in mid-March.

1.2 Wetlands of Lake Victoria Basin

In Kenya, wetlands include deltas, estuaries, mangroves and mudflats, swamps, marshes, flood plains, shallow lakes, rivers and the edges of deep lakes and rivers. Of Kenya's 583,000 km², some 3-4% (or 14,000 km²) are wetlands. In dry areas, the pressure on these wetlands is great, since they continuously supply areas with water, making them suitable for farming and livestock keeping.

In the Lake Victoria Basin, three major categories of wetlands are recognized. The *riverine* system includes all wetlands and deepwater habitats contained within a channel or an open conduit, either naturally or artificially created, which periodically or continuously contains moving water, and connects any two bodies of standing water. Such *lacustrine* systems include wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; and (3) total area exceeds 8 ha (20 acres). This category may include freshwater marshes, aquatic beds as well as lakeshores. The palustrine system includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%. Wetlands can also be characterized according to the dominant vegetation or by the way they function. There are two functional types of wetlands: rooted and floating, all of which are found in Lake Victoria. In a rooted wetland, the dominant vegetation is attached to a substratum, mainly sediment or mud, which acts as a source of nutrients to aquatic plants. Floating wetlands occur as suspended vegetation mass on water column as the water body becomes deeper than 2-3 m as one moves towards the open lake. A floating wetland can be formed when a rooted mat made up of interlacing and interlocked rhizomes and roots gets detached from the main substratum.

Most wetlands bordering Lake Victoria are dominated by *Cyperus papyrus* L. or *Miscanthidium violaceum*. Other wetland vegetation types that occur include *Phragmities mauritianus, Typha domingensis, Laudetia phragmitoides* and *Vossia cuspidate,* but these are less dominant (Kansiime, *et al*., 2007). Papyrus wetlands are the most dominant in the Lake Victoria Basin and the inshore areas of the lake. Papyrus

wetlands occupy the transitional zone between permanently wet and generally dry environments. Because of the wide distribution of papyrus in the Eastern, Central and Southern Africa, papyrus wetlands have been subject of intense study (van Dam *et al.*, 2011; Morrison *et al.*, 2012). These wetlands are highly productive and provide important ecological services (Osumba *et al.*, 2010).

Lake Victoria wetlands constitute a vital life support system for about 12 million people who extract fresh water, fish, medicinal plants and building materials. Because of their ecological significance and importance to the livelihood of the local populations, wetlands of Lake Victoria need to be conserved and managed in a sustainable manner. The enormous socioeconomic potential of wetlands in Lake Victoria has not been fully exploited, primarily because of limited knowledge of wetland ecosystems and little appreciation of their role in alleviating poverty and supporting sustainable development. The main objective of this chapter is to give an overview of wetlands in Lake Victoria Basin (LVB), Kenya, and highlight their current status and the challenges they face.

1.3 Wetlands distribution in the Lake Victoria Basin

In Kenya, the Lake Victoria wetlands constitute about 37% of the total wetland surface area in the country (Koyombo and Jorgensen, 2006). According to Katua and M'mayi (2001), 523 distinct parcels of wetlands which are linked to the lakeshore (beaches, estuaries, bays and inlets), floodplains and deltas of rivers and streams are found in the LVB. Another study also identified a number of wetlands in the Lake Victoria Basin (KLA, 2008). The latest wetland inventory by Kenya's Ministry of Environment and Mineral Resources is yet to be released but it is expected that this would give a more comprehensive account of wetlands in the LVB.

The many rivers draining the Kenyan side of the LVB and their tributaries support a number of wetlands in their upper reaches, along their flood plains and at the river mouths (Table 1). These wetlands offer a number of values to nearby communities including economical, cultural and spiritual; educational, recreational and scientific values. These wetlands also perform several functions such as groundwater recharge and discharge, flood control, water storage and purification, protection against erosion, storm protection, food chain support, freshwater fisheries, biodiversity, carbon storage and climate regulation. The channels of many rivers are fringed by a narrow belt of grasses mixed with reeds as well as small patches of riverine forests. Wetlands in the river catchments include springs, water storage dams, fish farms or ponds and valley bottom marshes. As a result of these wetland functions along river valleys, the quality of water reaching the lake is higher than would be the case for their absence.

In the upper reaches of the Lake Victoria Basin, many springs drain into shallow depressions, forming long stretches of waterlogged areas that were once occupied by macrophytes form a series of riverine wetlands. These are the most common types of wetlands in the upper reaches of many river basins in this region. There are also many small dams in the basin that have been constructed for water supply such as in the Nzoia River basin or road construction quarries as in the case of Lower Nyando River Basin which also support characteristic wetland biota (Table 1). Some wetlands in the upper reaches are of special significance because they support threatened and rare species of animals. Examples include Kingwal Swamp and Saiwa Swamp that are the only ones harbouring the Sitatunga. Because of this, Saiwa Swamp has been protected and is a national park. However, Kingwal is owned by community members who own tracts of land that stretch into the swamp even as efforts are being made to protect the swamp from encroachment for farming, grazing and brick making.

In the LVB, the middle river reaches are dominated by spring fed wetlands but the main-stem of large rivers support water dependent plants and animals along their edges. During heaving rains, the rivers over-top causing floods in the flood plains of the riparian areas convert many tracts of land into temporary wetlands although some such as Kingwal in the upper Yala River remain permanent wetlands. In the lower reaches, a number of wetlands occur including the deltaic wetlands at the river mouths of the rivers, floodplain wetlands along the rivers, the lakeshore and fringing wetlands that are influenced by both the influent rivers and the lake. The shoreline and river mouth wetlands of Lake Victoria are the most expansive and rich in both plant and animal diversity, including fishes. For instance the Yala Swamp has been described as a biological museum because of its rich diversity of haplochromine cichlids, most of them threatened or thought to be extinct in Lake Victoria (Aloo, 2003).

A special type of wetland in the LVB is the shoreline wetlands fringing the lake. The shoreline on the Kenyan side of the lake is estimated to be between 550 and 620 km long. Within the shoreline there are approximately 300 beaches some of which are well known wetlands which includes wetlands within the Winam Gulf i.e. Nyando River Wetland, Dunga Wetland, Osieko Wetland, Luanda Konyango (Migori River) and the Yala Swamp; Osodo Swamp and the Mara Wetland. According to Mati *et al* (2008), the Mara Wetland has been increasing in size over the years because of the sediments brought in by the Mara River. Along the Winam Gulf shore, a number of smaller wetlands occur such as Kibos, Dunga, Nduru and Kusa Swamps. Many of the inshore wetlands are also influenced by lake sedges and the backwater effect that bring in both surface and subsurface water during backflows (Khisa *et al*., 2012). The shoreline and river-mouth wetlands in the Lake Victoria Basin have remarkably high levels of biodiversity and support livelihoods of the riparian communities, apart from their obvious ecological functions, despite the eminent threats by adverse human activities and Climate Change.

Table 1: *Wetlands found in the different river basins of Lake Victoria basin, Kenya.*

River basin	Wetland type	Examples	Threats
Sio River and its tributaries	Riverine, palustrine	Namaloko, Kiwa, Kimwaga dam, and Namasanda dam and Sio-Siteko	Land use change and reclamation of the wetlands, waste disposal (solid and water), burning for dry season farming
Nzoia River and its tributaries	Riverine, palustrine	Chepkoilel, Soin, Kiptoror, Kaplogoi, Sosiot, Kaptule, Kapkis, Sergoit, Ziwa-Sirikwa, Maji Mazuri, Kipsaina, Saiwa, Kerita, Kholera, Saf, Anyiko, Ukwala, Budalangi, Bunyala Swamp	Encroachment for agriculture, soil erosion and siltation, over harvesting of the wetland materials, sand harvesting, deforestation, lack of awareness on conservation efforts by the locals, invasive weeds
Yala River and its tributaries	Lacustrine, palustrine and riverine	Kingwal, Kajuok Swamp and Yala Swamp and its related swamps such as Gomro, Wathding, Daraja, and Aram and satellite lakes Namboyo, Sare and Kanyaboli	Drainage for agriculture, overgrazing, waste disposal, rice farming at Yala Swamp and the potential for wastewater and pesticides pollution, overexploitation of wetland resources, burning for dry season farming, hunting
Nyando River and its tributaries	Riverine, palustrine	Kepseon swamp, Ombeyi Swamp, Koyo Swamp, Okana wetland, Awach swamp and Oroba swamp, Nyando Delta Wetlands (Nyangande, Singida, Kabondo, Okonyo-Muofu and Wasare Nam)	Soil erosion from farming, sedimentation from sand harvesting, deforestation and recurrent drought, overharvesting of wetland resources, overgrazing during the dry season and dry season burning for fishing and farming
Sondu-Miriu River and its tributaries	Riverine, palustrine	Kapsoit, Kabianga, Kapkatet, Serwer, Kapgot, Motata, Chagware, Chemawoi, Bargiro, Kororet, Daraja Mbili, Chepkolon, Biribei, Kapsewa and Osodo.	Upper reaches: Human-wildlife conflicts, reclamation for agriculture and tree planting (Eucalyptus spp.), waste water and solid waste disposal from tea factories, sedimentation Lower reaches: human-wildlife conflicts, over-exploitation
Kuja-Migori and its tributaries, including South Nyanza wetlands	Riverine, palustrine	Sironga, Etora, Marani, Nyabioto, Kemera, Rianyatundo, Riambase in the upper reaches; Ondago, Kimira, Simbi Nyaima, River Kuja Delta wetlands (Sere, Nyora, Kabuto, Anyugo, Modi, Nyamfua, Mariwa, Manywanda, Kabodho, Kudisa, Wang' Migori, Kombuor Oiro, Kudbo and Kagua), Nyamanga, Samanyalo, Kadhiambo	Most of these wetlands are in the upper reaches where the main threats are reclamation for agriculture, brick making and livestock grazing. Planting of Eucalyptus spp. has lowered the water table and caused drying of many unrecorded wetlands in Kisii and Nyamira counties
Lake Victoria Shoreline, river-mouth wetlands and lakeshore streams	Lacustrine, palustrine and riverine	Kusa, Dunga, Nduru, Kibos and the many river mouth wetlands, Oruch-Kimira, Bunyala, Kuja, Osodo, Yala Swamp, Nyando Wetland, Ngegu (south Nyanza) and Mara Swamp (Mosirori wetland)	Siltation, conversion, overharvesting of papyrus, burning, grazing, urbanization and human settlement, drainage for irrigation (e.g., Nyando, Yala, Budalangi and Oluch Kimira)
Mara River and its tributaries	Riverine, palustrine	Napuyapui Swamp (source of Mara River), Ngusero Swamp, Kugini Swamp, Olenyapi Swamp, Tinet Swamp, Sotiki Swamp, Nyanyawet Swamp and Mara River Swamp (Mosirori wetland)	Loss of forest cover in the upper catchment and along rivers, unsustainable agricultural expansion and intensification (including irrigation), population growth, poorly planned water abstractions, pollution from urban settlements and agriculture, over grazing and over-exploitation of wetland resources

1.4 The role of major water towers

There are three major water towers that are the source of rivers that drain the Kenyan side of the LVB. These are, Mt Elgon, Cherengani Hills and the Mau Forest Complex which form part of the five major water towers in Kenya, the other two being Mt Kenya and the Aberdares. Changes in land use and land cover and overall degradation of these water towers have been subject of heated debate in the country. To save these towers from further degradation and encroachment, the government has evicted squatters/settlers living there as part of a major drive to protect and rehabilitate the water towers. Land use change in many of the river basins is associated with illegal logging, excisions and invasion of forests for subsistence farming, settlement, fuel-wood harvesting and livestock grazing. In the upper Mara River basin, 32% of the forest was lost between 1973 and 2000 alone (Mati *et al*., 2008). In the upper reaches of the Sondu-Miriu River Basin, 21% and 10% of forests and bushland, respectively, were lost to farms and settlement between 1986 and 2009 (Masese *et al*., 2011). Similar trends characterize other river basins in the region, including the Njoro, Nyando, Yala, Nzoia and Simiyu (Matiru, 2000; Raini, 2009; Twesigye *et al*., 2011). Wetland areas have also been targeted and some already encroached upon and drained for farming, forestry, settlement and grazing (Njuguna, 1996; Bavor and Waters, 2008; Muyodi *et al*., 2010; Twesigye *et al*., 2011).

Changes in land use in the upper reaches of important river basins have caused numerous negative impacts on wetlands. In the LVB, many wetlands have reduced in size or become seasonal as a result of drying up of springs that were once the only source of water. In eastern Mau Forest, some streams that have dried up include Kipkaigei, Gungdap Toritik, Sibiling, Ingoet, Tirintap Mendet, Kiptogoswa, Isawait, kipombo, Makalia, Oindo Sagat, Pasiriat/ Sirontit, Utetenik and Kipkeigeiye (Mau Task Force, 2009). The story is the same for many streams across the expansive forest and adjoining areas where forests have been cleared and replaced by agricultural farms, grazing fields and settlement areas (Raini,2009; Mau Task Force, 2009). However, in some cases, some wetlands have been reported to increase in size. Examples include the Mara River Swamp (Mosirori Wetland) in Tanzania which have increased in area by a factor of 131%, a situation caused by increased silt loading due to degradation and erosion factors in the upper catchment, a situation which is unwelcome (Mati *et al*., 2005). Such changes in wetland hydrology and physical condition have long term effects on the surrounding wetland ecology, biodiversity and riparian community's livelihood.

1.5 Modes of exploitation and conservation efforts

Modes of exploitation of wetlands in the LVB vary from small to large scale, based on the nature and extent of extraction for domestic and other uses. In most LVB wetlands, overexploitation of wetland resources is evident in places where ready markets for key wetland products is available. Very often, this happens in complete disregard to the impact of the immediate and downstream users, or even without knowledge of the effect this would have on indigenous biodiversity and migratory species. Some extractive practices are gender based. For instance, while men harvest sand, fish, graze animals and make bricks in wetland areas, women mostly engage in macrophyte harvesting, small-scale vegetable growing and gathering fuel-wood. Where livelihoods are at risk, the messages of wise use tend to be drowned out by monetary considerations. Conservation efforts for wetlands within protected areas are better than in unprotected area. The wetlands around Lake Victoria do not fall under protected areas and are therefore prone to overexploitation and continued degradation. Here the role of the protection agencies e.g. Kenya Wildlife Services (KWS), is to handle cases of human–wildlife conflicts only and the issues of wetlands protection/conservation is almost exclusively in the hands of NGOs and CBOs in collaboration with some state agencies and non-state actors.

1.6 Challenges facing Lake Victoria wetlands

Wetlands are among the world's most important natural resources but on the contrary, they are least understood and most abused assets (Maltby, 1990). For centuries, wetlands were considered as wastelands only fit for reclamation and disposal of waste. Throughout human history, wetlands have been reclaimed for agriculture in many parts of the world (Verhoeven and Setter, 2009). Wetland ecosystems reclaimed in this way have lost much of their character, leading to reduced biodiversity and reduced performance of functions other than crop productivity (Hassan *et al*., 2005). For the global resource of freshwater wetlands, it is certain that substantial wetland areas have been lost because of drainage and development. About 50% of the area of peatlands, depressional wetlands, riparian zones, lake littoral zones and floodplains have been lost, mostly through conversion to intense agricultural use, in North America, Europe and Australia (Millennium Ecosystem Assessment, MEA 2005). However, the extent of impacts on African wetlands are unknown because data is limiting (MEA, 2005), but threats abound as can be evidenced by a number of studies in the Lake Victoria Basin (Kairu, 2001; Balirwa, 1998). In spite of many countries ratifying the Ramsar Convention, wetlands continue to be under threat of being drained and reclaimed (Verhoeven and Setter, 2009). However, there is increased awareness about the importance of wetlands and the need for their conservation. Because of this, many stakeholders are now interested in their sustainable management and conservation.

Human activities in the LVB have accelerated the rate of ecological change and increased threats to the existing natural resources. In the last fifty years, wetlands in the LVB have been facing serious problems of degradation and their ability to continue providing valuable ecological services is threatened (Kairu, 2001, Kansiime *et al*., 2007). About 80% of the human population living in the LVB derives its livelihoods from subsistence agriculture (GIWA, 2006). Thus, agriculture, which is intensifying on most catchments, will continue to have significant impacts on the environment. This has created a challenge among wetland scientists. For instance, there is confusion on how to interpret the wetland ecosystem as a functioning unit within the complex human and often dynamic natural environment, to evaluate their tolerance to various uses and advise on optimum management strategies to maintain functional integrity (Mwakubo and Obare, 2009).

The main driver of changes in Lake Victoria ecosystem are human population pressure, especially its increasing size, rapid growth rate and increasing urbanization and immigration. In the upper reaches of many rivers, the main threats to wetlands are reclamation for agriculture, overgrazing, human settlement and encroachment, siltation, pollution (mainly from agriculture and industrial sources), introduction of exotic species such as blue gum trees (*Eucalyptus* spp.) and overharvesting of water dependent plants. The degree of threat varies from one county to another. For instance, wetlands in Kisii and Nyamira Counties are highly threatened with encroachment due to high population pressure (above 500 persons per km^2). Socio-cultural factors, such as traditions, lifestyles and informal natural resource abstraction by local communities have also influenced perception of wetlands, their use and management. Lack of adequate and appropriate knowledge about the functions and values of wetlands have hindered active management, including rehabilitation of degraded areas by local communities. Lack of national wetland policy and weak legal and institutional frameworks have also contributed towards unfavourable environment for wetland conservation and sustainable use in Kenya (see chapter 8 for more details).

In the lower reaches of major rivers, a drive for economic growth, agricultural practices and development continue to threaten papyrus dominated wetlands and their biota. Among the major threats facing papyrus wetlands are drainage, clearing, filling and reclamation for subsistence crop production, overgrazing, road building, construction of dams or barrages for water storage, flood

protection, irrigation and hydroelectric schemes, construction of waterways and irrigation. Exploitation of papyrus plants is sometimes done unsustainably (Morrison *et al*., 2012) and this has led to complete loss of some wetlands and causing cascading negative impacts on wide range of biodiversity in these important ecosystems. Past aerial surveys on changes in papyrus cover around the lake shows a remarkable loss. A comparative aerial survey between 1969 and 2000 showed 50% loss in Dunga and 47% and 34% loss in Koguta and Kusa respectively (Mafabi 2000). Papyrus height and density are inversely related to human disturbance including footpaths, cutting, burning, grazing (Plate 1) and farming (Owino 2005). Further within the wetlands, there exists human-wildlife conflicts in addition to conflicts over papyrus and agricultural space which to the local communities is a common resource (Hardin, 1968). According to Mafabi (2000) land use activities around papyrus swamps of Lake Victoria are dominated by cultivation, livestock grazing and settlements.

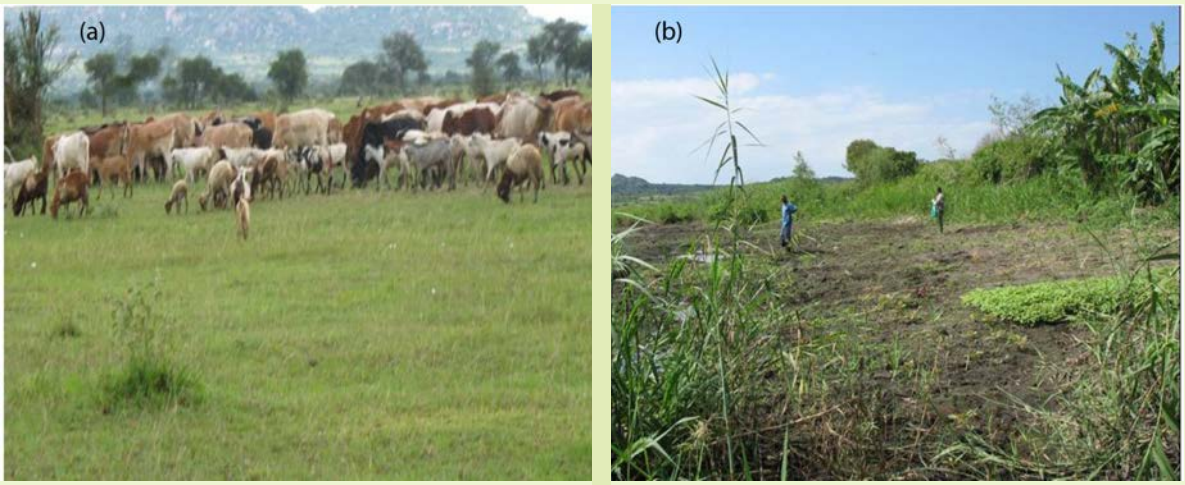

Plate 1: *Activities in the Mara River Swamp that are a major threat to wetlands in the Lake Victoria Basin, (a) overgrazing (b) farming in the wetlands. (Photo by PKT Minishi)*

1.7 Research on wetland conservation

Wetland science is a young discipline and in the case of LVB wetlands there is still inadequate information. However, it is important to note that wetlands have immense potential for research, education and training to enable future protection and sustainable management of these fragile ecosystems. The wetlands in the region are largely natural and rich in biological diversity, thus providing greater opportunities for research in aquatic flora and fauna as well as both biological and physical processes. They also serve as suitable field laboratories for study of biological and landscape processes. In a review of wetland research in the Lake Victoria by ViCRes of IUCEA, it was reported that the wetlands have been the subject of some research in different aspects of their biology, ecology and environment. Ecological studies have been driven by the need for an inventory of wetland resources and their seasonal dynamics. Research on factors that threaten fisheries resources, such as water pollution, habitat modification and fishing malpractices have been conducted but no detailed investigations pertaining to wetland fisheries exist. The educational potential of wetlands is linked to the opportunities for studying natural history and observing botanical, ornithological or environmental phenomena and processes. Lake Victoria wetlands have been used for field education and many adjacent institutions use them for teaching ecological processes. Information is lacking

on the role of Lake Victoria wetlands as a tourism resource even as there are numerous charismatic habitats, biodiversity and other touristic sites.

Past wetland research in East Africa has rarely combined the issues of wetland ecology, hydrology and socioeconomics in an integrated manner, making it difficult for policy makers and other stakeholders to appreciate wetland functions and the issues relating to their degradation (Kansiime, *et al*., 2007). Since wetlands play an important role in the hydrological cycle, and since the biggest threat to wetlands is posed by human activities, it is important to intensify hydrological, ecological and socioeconomic research as already initiated by the Ecology of Livelihoods of East African wetlands (ECOLIVE) project using the Nyando Wetland as a case study (van Dam *et al*., 2011). Information generated through this research will be incorporated into decision making processes at local, national and regional levels to facilitate sustainable management of papyrus dominated wetlands. For better management of wetlands in the East African region, integrated studies are likely to produce useful results compared to individual disciplinebased studies (Kansiime, *et al*., 2007; van Dam *et al*., 2011).

1.8 Conclusion

This chapter has reviewed the importance of Lake Victoria wetlands and its ecology. It observes that majority of people living around LVB wetlands and beyond are directly or indirectly dependent on the goods and services provided by wetlands. Many wetlands provide food in terms of suitable soil for agriculture and wild fruits; they also provide protein source through the use of bush meat, fish and grazing of livestock. The wetlands also provide water for domestic use, irrigation and animal husbandry. Apart from that, people do obtain energy source through the use of fuel wood and charcoal. A large variety of goods and services provided by the Lake Victoria Basin wetlands are seen as essential for human survival. This implies that, according to the ecosystem functions and services framework by de Groot *et al*. (2002), a large variety of wetland ecosystem functions need to be conserved, managed and maintained to enable the wetlands provide these goods and services for posterity. Due to the significance of wetlands in sustaining people's livelihoods, there is need to create awareness on their importance and the need for concerted effort in their conservation by the local community, policy and decision makers. More research should also be done on the link between ecosystem services and functions and the effect of the drivers on the wetland ecosystems in order to allow the continuous supply of the services in which people depend in sustaining their livelihoods.

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