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Edited by:
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Community Based Approach to the Management of Nyando Wetland, Lake Victoria Basin, Kenya

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LIST OF ABBREVIATIONS

AFC	Agricultural Finance Corporation
AIDS	Acquired Immune Deficiency Syndrome
AEWA	African-Eurasian Water Bird Agreement
BMU	Beach Management Unit
CBCRM	Community-Based Coastal Resource Management
CBNRM	Community Based Natural Resource Management
CBO	Community Based Organization
CBS	Central Bureau of Statistics
CDF	Constituency Development Fund
CPAP	Country Programme Action Plan
CSO	Civil Society Organization
CVM	Contingent Valuation Method
DFS	Decentralized Financial Services
EAC	East African Community
ECOLIVE	Ecology of Livelihoods of East Africa
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
FAO	Food and Agriculture Organization
GBV	Gender Based Violence
GIPA	Greater Involvement of People with AIDS
GIS	Geographic Information System
GoK	Government of Kenya
HIV	Human Immuno-Deficiency Virus
ICT	Information Communication Technology
IGA	Income Generating Activity
IMR	Infant Mortality Rate
IT	Information Technology
ITCZ	Inter-Tropical Convergence Zone
JICA	Japan International Cooperation Agency
KDC	Kenya Disaster Concern
KDHS	Kenya Demographic Household Survey
KEBS	Kenya Bureau of Standards
KFS	Kenya Forest Services
KFSN	Kenya Forest Service Network
KLA	Kenya Land Alliance
KMFRI	Kenya Marine and Fisheries Research Institute
KNBS	Kenya National Bureau of Statistics
KWS	Kenya Wildlife Service
KWSTI	Kenya Wildlife Service Training Institute
LBDA	Lake Basin Development Authority
LVB	Lake Victoria Basin
LVBC	Lake Victoria Basin Commission
LVEMP	Lake Victoria Environment Management Programme
LVFO	Lake Victoria Fisheries Organization
MDG	Millennium Development Goal
MEA	Millennium Ecosystem Assessment
NCCRS	National Climate Change Response Strategy

NGO	Non-Governmental Organization
NEMA	National Environment Management Authority
NRM	Natural Resource Management
NWCP	Nyando Wetland Community Programme
PES	Payment of Ecosystem Services
PRA	Participatory Rural Appraisal
RDWSSP	Rural Domestic Water Supply and Sanitation Programme
RTDA	Regional Transboundary Diagnostic Analysis
SLA	Sustainable Livelihood Approach
TVM	Travel Value Method
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USD	United States Dollar
VACC	Village Anti-Corruption Commission
VAT	Value Added Tax
VIRED	Victoria Insitute for Research on Environment and Development
WCK	Wildlife Clubs of Kenya
WRMA	Water Resources Management Authority
WRUA	Water Resource Users Association
WTP	Willingness to Pay

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FOREWORD

The United Nations Development Programme is committed to helping Kenya build capacities to manage natural resources including wetlands and biodiversity there-in, in line with national priorities and needs. This is done through the provision of sound policy advice and development and implementation of programmes that demonstrate sound wetlands management practices. UNDP has continuously helped the country to secure wetlands ecosystem services that are vital to human welfare and their development efforts.

Kenya's wetlands occupy about 3% to 4% of the total landmass, which is approximately 14,000Km^2 of the land surface and fluctuates up to 6% in the rainy seasons. Throughout the tropics, these wetlands provide important goods and services to local people. They are considered to be important ecosystems, which contribute considerably to the national economy and rural livelihoods. Wetlands offer provisioning, regulating, cultural and supporting services. There is increasing evidence that the economic returns from natural or sustainably used wetland habitats exceed those that are degraded or converted to other uses.

From the above, it is evident that sustainable management of wetlands is critically essential in achieving the Millennium Development Goals (MDGs). Destruction and loss of wetlands threatens to increase poverty and to undermine development because the destruction results in loss of livelihood-generating natural resources. The objective of UNDP's wetlands work is maintaining and enhancing the beneficial services provided by wetlands in order to secure livelihoods, food, water, health and security; to reduce vulnerability to Climate Change, sequester carbon and avoid greenhouse gas emissions from land use change.

UNDP works through strategic partnerships with governments, universities, national and regional research institutions, private sector and civil society among others. In doing so, UNDP identifies needs and gaps and addresses these gaps through specific interventions that strengthen policies, institutions and staff capacities, and leverage necessary financing. In the Nyando Wetland Resource Utility Optimization Project, from which this book originates, UNDP collaborated with the Kenya Disaster Concern (KDC), VIRED International, universities and research institutions, government departments, CSOs and the private sector, particularly in promotion of value addition and income generating activities (IGAs) that depend on wetlands.

Currently, UNDP supports various capacity building wetlands management initiatives that are geared towards improving or sustaining the biodiversity in Kenya's wetlands. These initiatives include securing of wetlands through boundary demarcations, support to legislation, policy review and development. This is done by promoting participatory management with communities neighbouring wetlands and those who live in riparian zones to ensure sustainable use and management of wetland resources. Central in all these areas of support is partnerships, development and mobilization of institutional capacity with special focus on communities in wetlands. The aforementioned project was implemented using various community-centred approaches leading to successful rehabilitation and conservation efforts through tree planting, bamboo zoning, water retention pans, flood evacuation drills, canal and earth road.

Climate Change is causing terrestrialisation of wetland areas and excessive flooding in others. One of the most important roles of wetlands may be in the regulation of global Climate Change through sequestering and releasing a major proportion of fixed carbon in the biosphere. The hydrological, nutrient and material cycles of Nyando Wetland may also help to stabilize climatic conditions such as temperature and humidity in the area. The services provided by this function relate to the maintenance of a favourable climate, both at local and global scales, which in turn are important for, among others, human health, crop productivity, recreation and even cultural activities. Current and future changes in water availability arising from Climate Change will have the greatest influence on the functioning of freshwater wetlands. There is, therefore, need to protect wetlands as the vital part of the natural water infrastructure from human disturbance; restore and maintain hydrological cycles, flood mitigation, water supply, food provision and biodiversity conservation; recognize the natural infrastructure of wetlands as a major asset in combating and adapting to Climate Change at the national level and be proactive for collaboration among international technical bodies involved in Climate Change.

It is my hope that this publication will be used as a knowledge product towards meeting the MDG7 to ensure environmental sustainability.

Aeneas Chuma
Resident Representative
UNDP

ACKNOWLEDGEMENTS

This book is the culmination of research and engagements with people living within the Nyando Wetland, key stakeholders and development partners who have been working towards sustainable management of the resource-rich Nyando River wetland in Kenya. The book links closely to UNDP's and Government of Kenya's Country Programme Action Plan (CPAP). UNDP has for long been supportive of initiatives aimed at sustainable management of environment and natural resources in Kenya, key components of which have been addressed by the River Nyando Wetland Resource Utility Optimization Project ---the main springboard of this publication. The topical authors and editors are thus heavily indebted to UNDP for its immense support in the publication of this book. In particular, Mr. Aeneas Chuma, UNDP Resident Representative in Kenya, provided a befitting Foreword for the book and we highly thank him for this. We are also indebted to Dr. Christopher Gakahu (UNDP-Kenya) and Dr. Charles Nyandiga (UNDP-New York) who spared time to inject invaluable impetus and momentum for the book's preparations.

This work also results from the long partnership between two Kenyan NGOs-- Kenya Disaster Concern (KDC) and Victoria Institute for Research on Environment and Development (VIRED International) --that have worked closely with the Nyando Wetland community in generating the necessary information. We are grateful for the gallant efforts of the two organizations. The material was researched, written and edited by a team of distinguished environmental scientists and project management consultants whose contributions we highly appreciate. In this respect, we thank Dr. P.O. Raburu (VIRED International), Prof. J.B. Okeyo-Owuor (VIRED- International), Paul Ongoro Wa'Munga (Kenya Disaster Concern) and Ms. Foulata Tabitha Kwena (UNDP- Kenya); Messrs Ben O. Opaa, Frank Onderi Masese, Joseph Okotto-Okotto, S.N. Omari, P. Khisa, K. O. Obiero and F.O. Onyango.

The Nyando Wetland community, *to whom this book is dedicated,* and the project staff were a great inspiration; we acknowledge them for working to conserve the valuable wetland resources. We also recognize the support of various government departments and ministries operating around the Nyando River basin. These include the Kenya Wildlife Service (KWS), National Environment Management Authority (NEMA), Office of the President (Provincial Administration), Local Authorities and line ministries.

Finally, we are grateful to the Almighty God for granting us life, knowledge, the will to act and good health for the same; for bestowing on us the biodiversity-rich Nyando Wetland and the opportunity to publish this book.

--(Editors and Topical Authors)

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.

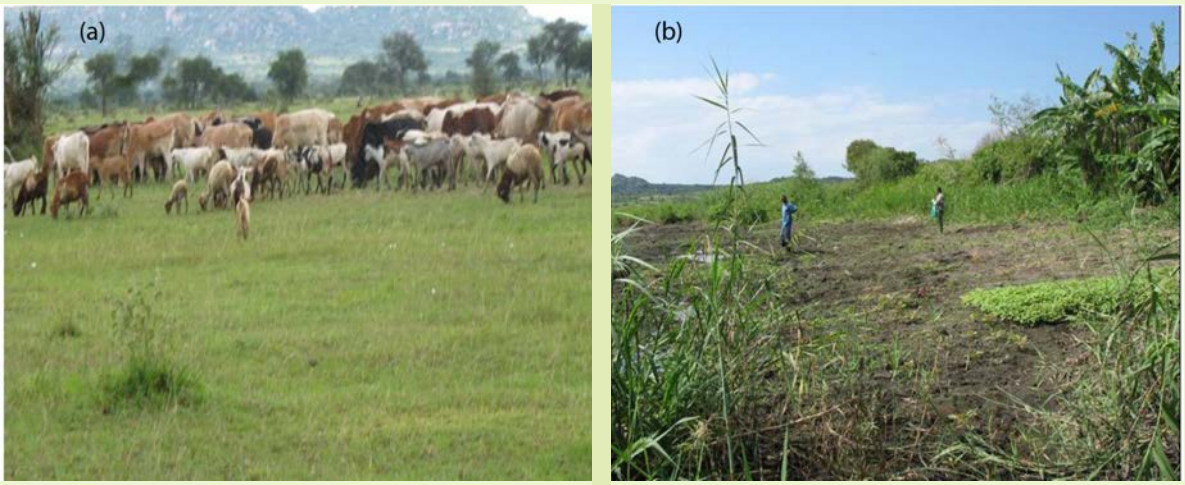

Plate 1: *Activities in the Mara River Swamp that are a major threat to wetlands in the Lake Victoria Basin, (a) overgrazing (b) farming in the wetlands. (Photo by PKT Minishi)*

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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CHAPTER 2

Background information on Nyando Wetland

Raburu P.O., Khisa P. and Masese F.O.

Summary

This chapter addresses the geological, geomorphological, climatic and hydrological conditions prevailing in the Nyando Wetland and the surrounding area. Nyando Wetland is part of the many papyrus dominated wetlands in the Lake Victoria Basin. The wetland is located at the mouth of Nyando River but it is contiguous with other lakeshore wetlands forming the second largest wetland (14,400ha) on the Kenyan side of the Lake Victoria Basin. Within it are a number of small wetlands whose major sources of water include direct precipitation, runoff from upland areas, inflow from rivers, recharge from aquifers and backflow from the lake during flooding. The wetland is incised within the Kano Plains, which is a floodplain riparian zone transitional between the surrounding upland areas on one end and the Lake Victoria at the other extreme end. Land-use activities in the upper Nyando River Basin have a strong bearing on the Nyando Wetland through their influences on water quantity and water quality. Because of deforestation activities in the upper basin, water quality has been deteriorating and quantity fluctuating in the river, with increased peak flows during the rains resulting in widespread flooding in the lowlands. During the dry season, base flows in the rivers and streams are considerably reduced, resulting in the drying up of large sections of the wetlands. The wetlands are rich with diverse plants and animal life. The common species of macrophytes, macroinvertebrate, amphibians, reptiles, fish, birds found in the wetlands are also presented together with their conservation status. The Nyando Wetland has undergone changes as a result of climatic and human-induced perturbations within the wetlands themselves and in the catchment of rivers draining into or through the wetlands. These activities continue to compromise the ecological integrity of this fragile ecosystem. The sustainable conservation and management of the wetlands would benefit greatly from concerted efforts by all stakeholders.

2.0 Introduction

The Nyando catchment in the eastern sub-catchments of the Lake Victoria Basin is located in the Lake Victoria South Catchment Area in Kenya. It covers an area of 3,600 km^2 and is situated within the Winam Gulf between longitudes 34°47″E and 35°44″E, and latitudes 0°07″N and 0°20″S (Figure 2.1). The main land use activities in the catchment include indigenous and plantation forests, agriculture and shrub land. On the upper reaches of the catchment, agricultural activities include subsistence farming of food crops (e.g. maize, millet, sorghum, potatoes) and cash crops (e.g., tea, coffee, and sugarcane) and dairy farming. This area has suffered extensive deforestation in the past to create room for human settlement and farming, mostly without regard to best land use management practices, putting severe environmental strain on the lower catchment, including Nyando Wetland. On the lowlands within the Kano Plains, large-scale sugarcane plantations, rain-fed food crops and rice production, as well as cattle grazing are common. However, about 75% of the plains

are unsuitable for economically viable small-scale farming (Jaetzold and Schmidt, 1982). The extremely heavy soils combined with a warm climate, relatively low rainfall and repeated flooding make farming to be unattractive as an economic venture. Urban centres and industries in the catchment include Nandi Hills and Kericho on the upper reaches, Chemilil, Muhoroni and Londiani on the middle-reaches and Ahero near the river mouth.

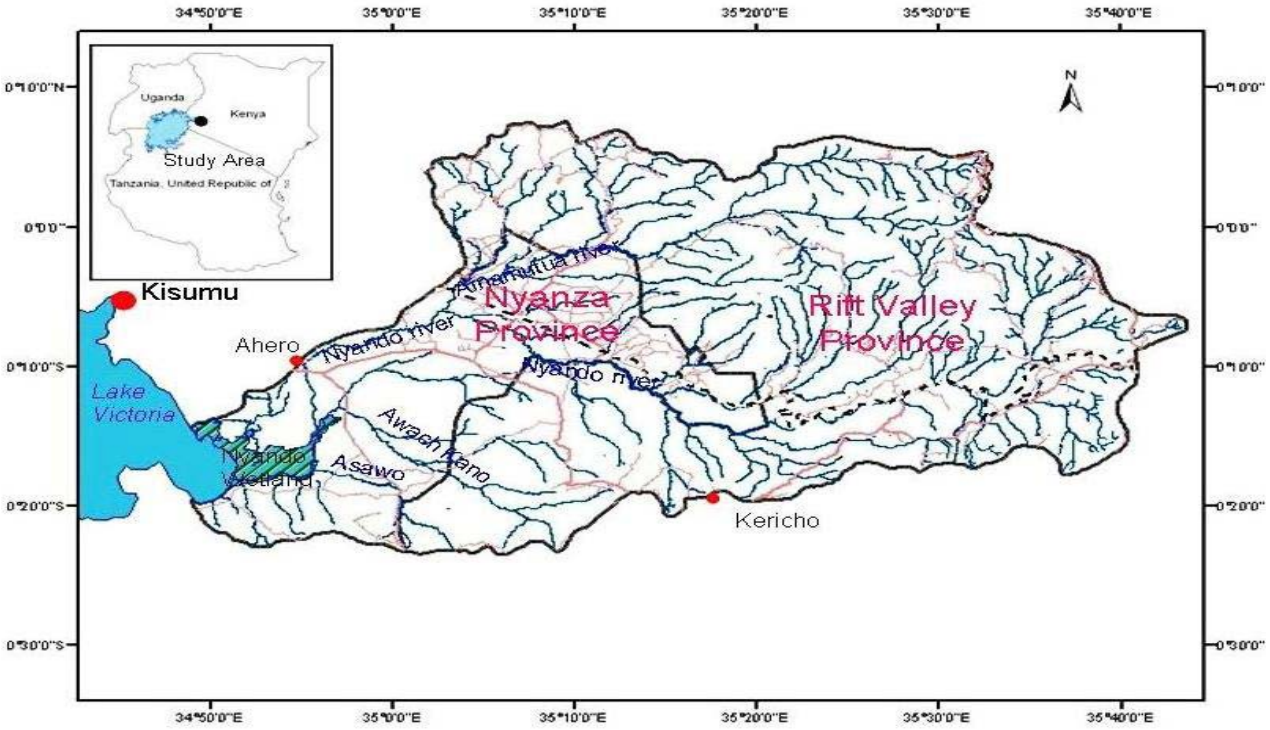

Figure 2.1: *Location map of Nyando River Basin*

Administratively, the catchment is situated in Kenya's Rift Valley and Nyanza Provinces. The Nyando Wetland is located in Kisumu County and is a large deltaic wetland which is approximately 14,400ha in size. The wetland, which is at the mouth of the River Nyando, fringes Lake Victoria. It covers three administrative districts of Nyando, Nyakach and Kisumu East. Apart from the deltaic wetland which is the focus of this book, several isolated wetlands that depend on seasonal floods of rivers and subsurface water flow are found in the basin. In the Kano Plains for instance, it is estimated that there are approximately 483 small manmade wetlands in addition to the rice paddy fields of West Kano which cover an area of 436ha (Katua and M'mayi, 2001).

2.1 Types of wetlands in the Nyando Basin

Kenya's wetlands occupy about 3% to 4% of the total landmass, which is approximately 14,000km^2 of the land surface and increase up to 6% in the rainy seasons (Draft Wetland Policy, 2008). Wetlands are often the zone of transition between dryland and a water body. According to Ramsar Convention on Wetlands (1971), wetlands are defined as *"areas of marsh, fen, peatland or water, whether natural or artificial, with water that is static, brackish or salt including areas of marine water, the depth of which at low tide*

does not exceed 6 metres". This is an international definition and encompasses a wide range of diverse landscapes whereby three inherent components of a wetland are manifested: water, hydric soils and hydrophytic vegetation. The Ramsar definition of wetlands was domesticated by the Kenya National Wetlands Standing Committee (1994) to take into account the unique wetlands found in the region as *"Areas of land that are permanently, seasonally or occasionally waterlogged with fresh, saline, brackish or marine waters, including both natural and man-made areas that supports characteristic biota"*. This definition is the one adopted for the purposes of this book.

River discharge has profound influence on the size and stability of the floodplain and deltaic wetlands like Nyando. Wetlands in the Nyando River Basin can be grouped as Lacustrine Wetlands (lake like), Riverine Wetlands (those associated with the rivers and streams), Palustrine Wetlands (swamps), a combination of Riverine/Palustrine Wetlands and Manmade Wetlands (created by man). Nyando is one of the deltaic fringing wetlands on the shores of Lake Victoria. Table 2.1 gives a summary of the different types of wetlands found in Nyando River Basin.

Wetland Type	Sub -Types	Examples (where found)
Lacustrine	Lake Victoria Fringing Wetlands	Entire shoreline swamp in Kadibo, Nyando and North Nyakach Divisions
	Lake Victoria Littoral Zone (Up to 6 metres)	Entire littoral zone in Kadibo, Nyando and North Nyakach Divisions
Palustrine	Swamps	Okana Wetland, Miruka Swamp, Nyamware, Rang'ul
Riverine	Rivers	River Nyando and its tributaries (Ainobgetuny, Mbogo, Kundos,
	Streams (Seasonal and Permanent)	Ombeyi, Asawo, Awach, Nyatini, Nyalbiego, Ombeyi, Oroba, Aguko, Obuso,
Manmade	Rice Irrigation Schemes	Ahero and North West Kano Irrigation Schemes, SISO, Small Scale individual rice irrigation schemes in Rae, Kabonyo, Kochogo, Wawidhi, Kakola, Rang'ul
	Irrigation Canal	Siso, Nyatini, Ahero Irrigation Scheme and North West Kano Irrigation Scheme
	Wastewater Stabilization Ponds	Chemelil, AFC Foods Industry, Muhoroni Sugar Company
	Fish Ponds	Kabonyo, Okana, Rang'ul, Kochieng', Kochogo, North Nyakach locations
	Water Pans	Rang'ul, Ogenya, Kochogo, Kochieng'

Table 2.1*: Types of wetlands in Nyando River Basin*

2.2 Physiographic features

The Nyando River system is divided into seven distinct physiographic units: (1) the lowlands in the east dominated by Kano Plains; (2) the scarp-foot zones of the Nandi and Nyabondo Escarpments; (3) the broken hill and scarp-foot, zones east of Chemilil; (4) the lava plateaus east of the Kano Plains; (5) the Kendu Escarpment and Nyabondo plateau in the south; (6) the Nandi Escarpment in the north, and (7) the volcanic hills and plateau comprising the Mau Forest Complex (North Tinderet Forest, Tinderet Forest, Masaita Forest, South-West Mau Forest and Londiani Forest in the headwaters).

The Kano Plains occupy the floor of the Kavirondo Rift Valley, which branches from the main north-south oriented Kenyan Rift Valley systems, trending east-west and east-northeast to west-southwest towards the Winam Gulf and Lake Victoria. The Kavirondo Rift Valley is marked by the Nandi and Kendu Escarpments in the north and south, respectively. It measures 250km in length and 25 to 30km in width, forming a graben structure bounded by normal faults. The Kano Plains occupy two-thirds of the lower half of the Nyando River catchment. The plains are characterized by intractable, alluvial soils which have very poor drainage, and suffer periodic drought and flooding (Millman, 1973). The Nyando Wetland occurs on the Kano Plains at the mouth of the Nyando River and along the shores of Lake Victoria. Other wetland patches occur on the plains in areas fed by small streams, some seasonal, and in areas with elevated groundwater levels. An example is the Okana Wetland that is part of the Nyando Wetland.

The relief of the Nyando River catchment ranges from 1134m at Lake Victoria to 3000m in the Mau ranges. The general slope runs from north-east to south-west, with lowlands/plateau having a slope range of 0 - 4° and the escarpments a slope of 19 - 43° (Figure 2.2a). The relief of the Kano Plains is subdued, ranging from 1135 m to 1170 m and the general slope of the land runs from east-north-east to west-south-west (Figure 2.2b). Over the plains the micro-relief consists of broad swellings and troughs with the meandering channels of Nyando River crossing the lower areas. The highlands are characterized by a fine dendritic drainage pattern formed by the two main tributaries of Nyando River, Pararget (Nyando) and Ainamutua.

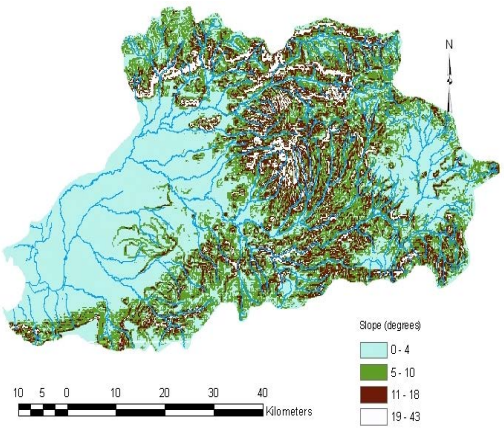

Figure 2.2a: *DEM of Nyando catchment*

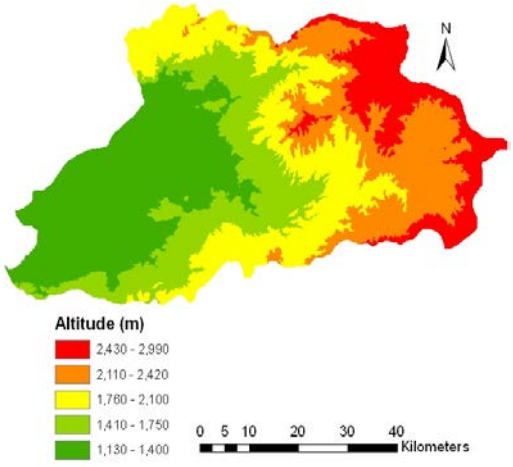

Figure 2.2b: *Slope map of Nyando catchment*

2.3 Geological setting

The geology of the Nyando catchment has not been extensively studied. According to Saggerson (1947), the oldest rocks are found in the Nandi Escarpment, which were formed during Pre-Cambrian times and later intruded by granites and granitized rocks during subsequent geological periods. The highlands were developed upon great outpourings of volcanic material which accompanied the widespread rifting and faulting that occurred in East Africa during the Tertiary and Quaternary times. Many layers of basic lavas and tuffs accumulated in the Tinderet forest area, together with lava plateaus on the eastern edge of Kano Plains and over the Nyabondo plateau. The whole area was once part of a Pre-Miocene peneplain which stretched far across Africa (Saggerson, 1947). During this time, rivers drained westwards across this erosion surface through the present site of Lake Victoria. Former river channels can still be traced down the trough of Kavirondo Rift Valley and across the floor of Lake Victoria.

According to Shackleton (1952), deformation and fracturing movements began in the Kano Plains in the Lower Miocene period with gentle warping and development of shallow lakes. The deposits which accumulated in the lake consisted of diatomite that forms a stratum underlying large parts of the Kano Plains. During the Pliocene to Pleistocene periods, there was intense deformation of the Kavirondo rift zone, followed by eruptions which gave rise to the tuffs and agglomerates that cover large areas on the landward sides of the Kano Plains. At the same time, rifts and fault scarps developed to the north and south of an area that was downwarped to become the site of Kano Plains. However, it is evident that a larger lake existed in the pluvial periods of the Pleistocene Age before the drainage outlet at the Owen Falls in Uganda was eroded down (Shackleton, 1952). Field evidence of raised beach deposits suggests the presence of several shorelines from this phase of which the 20m above the present lake level is prominent.

During the pluvial period, silt and clay were deposited in Lake Victoria and these became interbedded over the Kano Plains area with river and hill wash material brought down from the surrounding highlands (Millman, 1973). Since Pleistocene times, river and hill wash deposits have covered the whole of the Kano Plains to a considerable depth. Hill wash material has since accumulated at the foot of the Nyabondo and Nandi Escarpments. In the most recent phase of development, the rivers crossing the plains are eroding and reworking their own silt deposits while also bringing new material down the surrounding hills (Shackleton, 1952). This causes river channels to block and there is a tendency for river outfalls to shift gradually southwards.

The most recent geological event is the evolution of the Nyando River drainage characteristics at its old stage. The river once reached Lake Victoria by a more direct course than at present, flowing westwards through a series of swamps to share a common outfall with Nyamasaria River at the point southeast of Kisumu City (Millman, 1973). The Nyando River, finding its course blocked by the detritus from streams flowing southwards from Nandi Escarpment, forced an outlet southwards via a maze of distributaries which, one by one, became silted and finally abandoned except in times of flooding. Today Nyando River flows out into the Miruka Swamp, south of the plains, finding its course hindered further by ever growing area of papyrus reeds, which promotes silting conditions and dam up a backlog of waters during flooding times (Millman, 1973).

The Kano Plains are characterized by a complex succession in the soil profile. The northern, southern and eastern parts of the plains are dominated by deep accumulations of hill wash that have been sorted by local flash floods and become mixed with lenses of alluvium. Almost all soils distributed in Kano

Plains are fine-textured except for some soils in the piedmont plain that are coarse to moderately coarse textured. Soils in the Nyakach Plain also show a broad variation. Soils at the fan base and lacustrine are finer while that at the piedmont plain are coarse-textured. The pH of the soils in this region ranges from 4.5 to 10.4. In the cuspate delta, a high pH of 9.0 or more is observed, while humic gleysols near swamps indicates low pH values of 4.5 (JICA, 1992). Most of the soils are non-saline.

Dark coloured clays and clay loams are the most widespread of the alluvial soil types; their colour vary from brown to black, which corresponds to a variation in clay content of between 35% and 60% respectively in the top soil and of between 40.5% and 70% in the subsoil (Millman 1973). Blackness of soils is not due to large amounts of organic content, only a small portion of organic nutrients are present in the top soil and characteristic blackness is due to the presence of unoxidised minerals in the soil matrix which are a result of prolonged waterlogging on the plains, during times of floods. When moistened these soils become plastic, slightly sticky and lose any semblance of a structure, and crack on drying to form a weak, angular, blocky structure. Clay soils are usually impervious at depth; consequently, top soils sock up water like a sponge in the rainy season until they are saturated. These soils are usually termed 'black cotton' and represent considerable problems for agricultural development (Millman 1973). They occur at depth ranges of 77cm to 1.2m in most places and are underlain by clay silt sediments.

2.4 Climate

The Nyando River Basin experiences a bimodal rainfall pattern with long rains in March-May and short rains in September-November (Figure 2.3a). The mean annual rainfall ranges from about 1,100 to 1,600mm with a minimum and maximum mean monthly rainfall of 72mm and 243mm respectively (JICA, 1992). The amount of rainfall is greatly influenced by altitude and relief features (Figure 2.3b). The upper reaches of Nyando River Basin experience higher amounts of rainfall as compared to the middle and lower basin. Rainfall averages 1800mm/y in the highlands and is associated with the south-easterly winds carrying warm air masses from the Indian Ocean causing orographic rainfall on the highlands. The Kano Plains experience a sub-humid to semi arid climate and receives rainfall in the range of 600-1100mm/y (FAO, 1996). The presence of convective currents in the Lake Victoria region is responsible for most of the rain at the shorelines. The Nyando Wetland is a zone of low rainfall experiencing semi-arid conditions (Jaetzold and Schmidt, 1982).

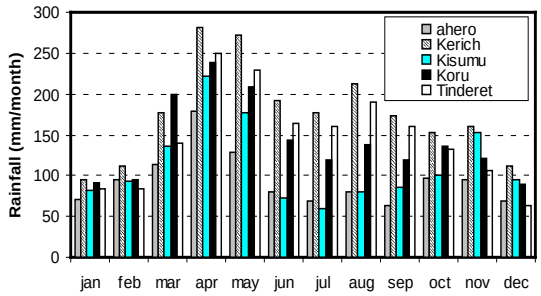

Figure 2.3a: *Mean monthly rainfall distribution at key stations in Nyando River Basin (1950-2000)w*

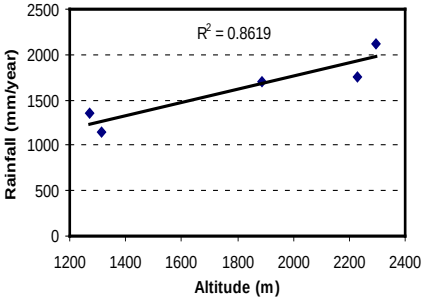

Figure 2.3b: *Comparison of mean annual rainfall and altitude of key stations*

The relative humidity in the middle and lower basin varies between 55% and 75% in the dry and rainy seasons, respectively, peaking in May and July with the minimum occurring in January during the short dry season and October, during the long dry season. The mean minimum annual temperature peaks are recorded in August through September and ranges from 14^{0}C to 18^{o}C. Highest temperatures are recorded in June through July with annual mean maximum ranging from 27^{o}C to 32^{o}C. The monthly A-pan evaporation far exceeds monthly rainfall in the basin throughout the year (JICA, 1992). Annual mean A-pan evaporation ranges from 1900 to 2200mm while the monthly mean evaporation ranges from 1300mm to 2200mm. The monthly minimum and maximum evaporations are recorded during June/July and March, respectively. Water stress occurs especially after the second rains which are feeble and unreliable (Jaetzold and Schmidt, 1982).

2.5 Hydrogeological setting

The most notable hydrogeological studies conducted in the Nyando catchment focused on the Kano Plains. These studies were undertaken by DHV Consulting Engineers (The Netherlands) in 1987 and 1988, under the Rural Domestic Water Supply and Sanitation Programme (RDWSSP) of the Lake Basin Development Authority (LBDA) (DHV Consulting Engineers, 1987a,b; 1988a,b). Results indicate that groundwater occurrence in Kano Plains is associated with three different types of aquifers: (1) semi-consolidated alluvial sediments, (2) volcanic rock types with primary porosity, and (3) faults and fracture zones. The first two types of aquifers may vary considerably in thickness and are usually subject to seasonal fluctuations of groundwater level. The hydrogeological conditions of the plains are such that Pleistocene deposits which accumulated in the Kavirondo Rift Valley store large volumes of groundwater. There are two separate groundwater systems in the Kano Plains: a deep groundwater system in the lower Pleistocene deposits and a shallow system in recent colluvial and alluvial sediments. The two systems are separated by an aquaclude, which comprises clayey material.

The shallow unconfined aquifer system comprises thin interconnected water bearing layers below a depth range of 0-15m and comprises alternating layers of silt, clay and sands (Figure 2.4). The aquifer is recharged by rainwater percolation and the river system. Most of the shallow wells in the Kano Plains tap water from the shallow groundwater system. The contours of the shallow groundwater table show a flow in north-south direction towards the rivers. However, it is not clear whether the rivers at some point recharge groundwater at spatial and temporal scales. The upper portion of the Pleistocene deposits which consist of finer grained sixty clayey of more than 15m thickness forms the main aquiclude in the plains.

The lower part of the Pleistocene deposits which comprise a higher portion of coarser sediments such as sands and gravels are considered to be the major aquifer zone in the Kano Plains (DHV Consulting Engineers, 1987a,b; 1988a,b). The aquifer is composed mainly of silty sands that are found at depths of between 50-250m and is overlain by the aquiclude and underlain by the Tertiary volcanics. According to the reports, these aquifers do not crop out and are likely recharged by shallow unconfined aquifers. The most probable groundwater recharge is the zone bordering the Nandi escarpment, where extensive coarse grained and permeable alluvial fan deposits cover Pleistocene sediments and the fault contact between the basement rock and Pleistocene sediments. The deep aquifers are also recharged by influent streams which flow from the escarpment and precipitation. The geophysical findings also show areas where shallow aquifers appear to make hydraulic contact with deeper Pleistocene aquifers.

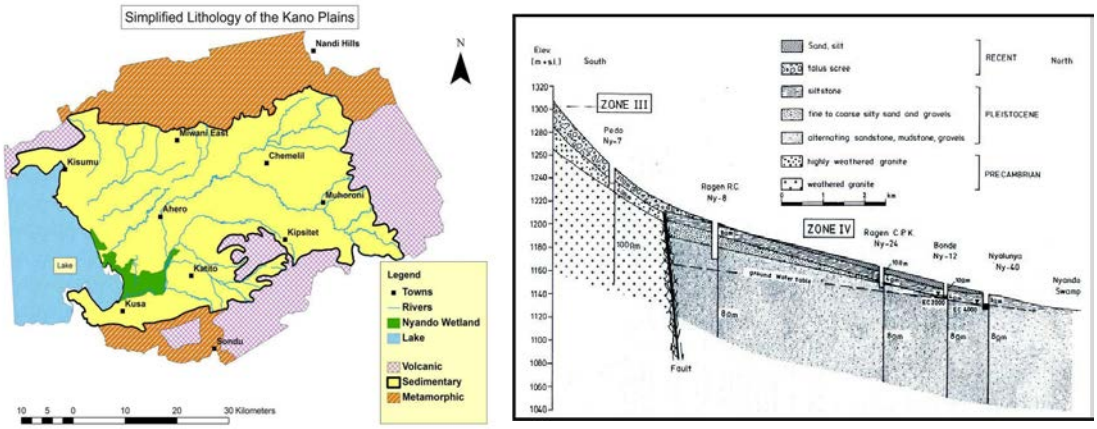

Figure 2.4: *A geological map of Kano Plains (top panel) and a hydrogeological cross-section along A-A (Source: DHV Consulting Engineers, 1988).*

Groundwater withdrawals from the Pleistocene aquifers continue to rise, going by the number of boreholes sunk every year. Groundwater is generally struck at various levels between 35 to 90m depth, with average borehole yields of 17,500 l/h for the whole of Kano Plains. From limited pumping test data, average transmissivity values were estimated at 30 to 60m^2/d. A storage coefficient of $5x10^{-4}$ was used to estimate groundwater potential within the Kano Plains. The total volume of annual recharge was estimated at $12x10^6 m^3$/y, which was a factor of ten times the water demand in the 1980s. Water quality analyses undertaken for physical quality parameters show that electrical conductivity values ranged from 920 to 1,300 μS/cm for deep groundwater, 170- 800 μS/cm for surface water (rivers), 190-210 μS/cm for springs, and 800-5,600 μS/cm for shallow wells. Values for pH had a range of 6.0-7.0 for all the water sources.

2.6 Hydrology

The hydrology of the catchment is strongly influenced by the north-south movement of the Inter-Tropical Convergence Zone and local winds (lake/land breezes), which influence the spatial and temporal variations of hydro-meteorological parameters (Millman, 1973). Climate and hydrological data is collected from hydrometric (Figure 2.5a) and meteorological (Figure 2.5b) networks, by WRMA, KMD and private institutions (Khisa *et al.*, 2012).

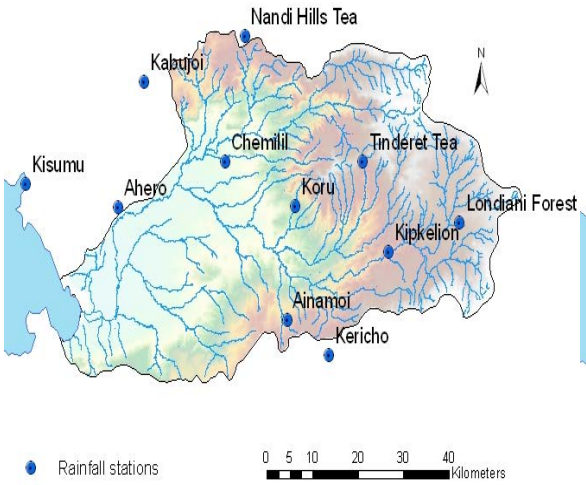

Figure 2.5a: *Meteorological network in the Nyando River Basin*

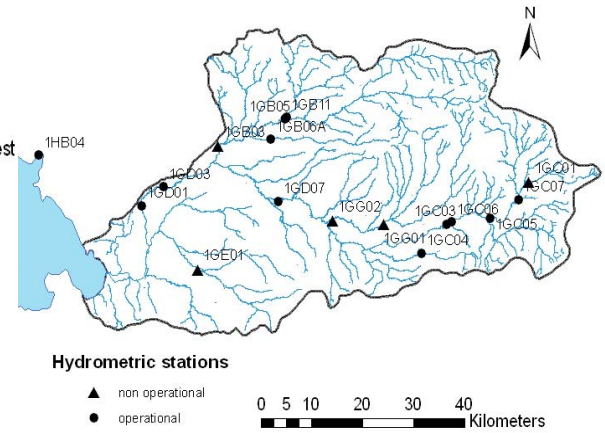

Figure 2.5b: *Hydrometric network in the Nyando River Basin*

The Nyando River has its headwaters in the Mau Forest complex situated on the eastern shoulder of the Kenyan Rift Valley and pours its waters into Winam Gulf of Lake Victoria after traversing the Kano Plains. Run-off accumulates in the upper Nyando River and peak discharge occurs in April or early May. In the last 50 years, annual discharge has averaged 22.22 m^3/s, varying from a mean monthly of 6.26 to 29.07 m^3/s (Nicholson and Yin, 2001). The recorded highest peak was experienced during the disastrous floods caused by abnormally prolonged '*Uhuru rains*' in the 1961-62 periods when the entire Kano Plains was flooded (Millman 1973). The arrival of seasonal floods from the upper catchment through the main tributaries of Ainamutua and Nyando causes a stage rise of up to 8m at Ogilo Bridge in the northern part of Kano Plains. At this stage the river channel is able to confine water levels of up to 10m high and therefore the flood wave only inundates the flanking seasonal plains downstream. At the southern end of the Kano Plains, at Ahero (20km from the river mouth), the lateral confinement of the flood in the channel ceases and floodwater overtops the river bank (Ongwenyi *et al.,* 1993). Dykes running 8km downstream from Ahero town were constructed in 1975 to contain the floods. Consequently, the river commonly overtops at Gem Rae spreading out in the Nyando Delta wetland. Additionally, a flood wave from the last two tributaries of Awach Kano and Asao quickly spread out from the south-eastern portion of Kano Plains into the Nyando Wetland.

The sources of water for the Nyando Wetland includes direct precipitation, runoff from upland areas, inflow from rivers, recharge from aquifers and backflow from the lake during flooding. The wetland is incised within a floodplain riparian zone which is the transition between the surrounding upland areas on one end and the Lake Victoria at the other extreme end (Figure 2.6). The exchange between the wetland into and out of the rivers and the lake has not been investigated to date. What is not known is whether there is groundwater exchange between the wetland and surrounding ecosystems, which include the uplands, the streams and rivers in the Kano Plains. All these ecosystems are potential sources of water into the wetland and at the same time they can benefit from ground water recharge from the wetland. However, this depends on the season (wet or dry), elevation of the water table in the wetland and the surrounding ecosystems and soil moisture.

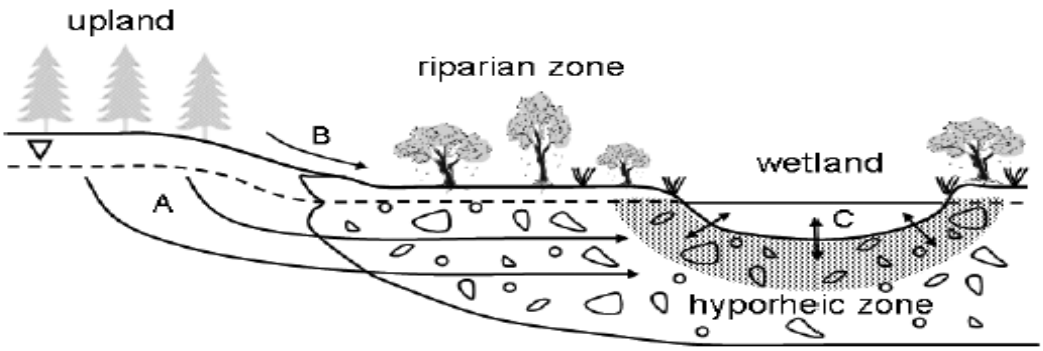

Figure 2.6: *Schematic cross-section of a wetland, hyporheic zone (shaded), riparian zone and upland. Major pathways of water exchange are indicated by (A) groundwater flow, (B) overland flow, and (C) hyporheic exchange {derived and modified from Hayashi and Rosenberry (2002)}.*

In an average year, rain causes localized surface flooding during the rainy season, but this is short lived as it evaporates and infiltrates slowly into the waterlogged ground. During periods of exceptional rain, surface flooding is widespread and may persist until the seasonal flood arrives. Consequently, Winam Gulf experiences an occurrence of intense sediment plumes after the flushing of the Nyando Wetland. The lake levels also show fluctuations at different time scales (Figure 2.6), with a distinct jump from 1133.8m and highest recorded level of 1136.3m during the 1961-62 rains (LVBC, 2006). Since this period, the lake level has not dropped to this value, although there has been notable recession of the lake since 2000 (Obiero *et al.*, 2012), attributed largely to climatic factors and excessive withdrawals of water from the lake through the White Nile that is above the 'Agreed Curve'. In recent times the lake levels have dropped by more than 2m since the El Nino rains of 1997-98.

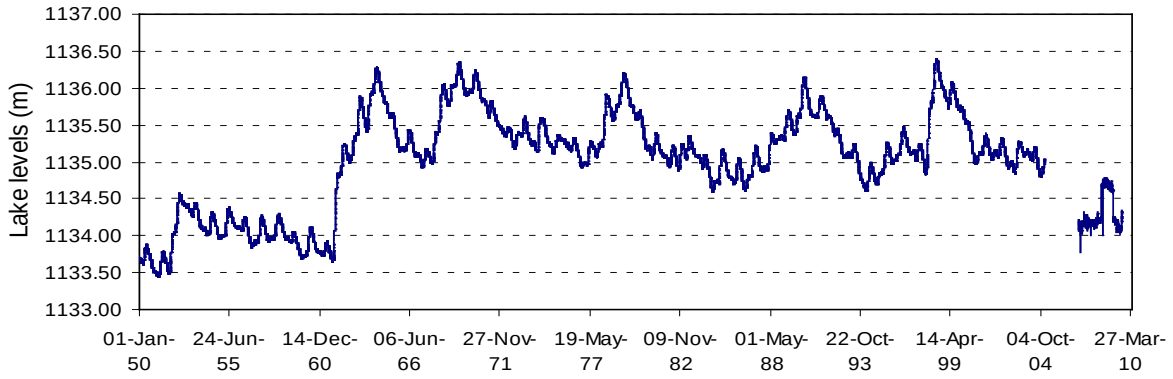

Figure 2.7: *Daily lake level fluctuations at Kisumu bay in the period 1950-2009*

The highest monthly mean lake level is usually observed in June, with a time lag of 3-4 weeks after the peak discharge in May (Figure 2.7). The lake levels exhibit two peaks in May-June and December-January, coinciding with the dominant rain bearing south easterly monsoon winds (May-June, September-November) and the westerlies (Dec-Feb), blowing across the Indian Ocean and Congo Forest respectively. The river flows show higher variability with several peaks in a year, a clear manifestation that the Nyando sub-catchments receive rainfall at different times of the year.

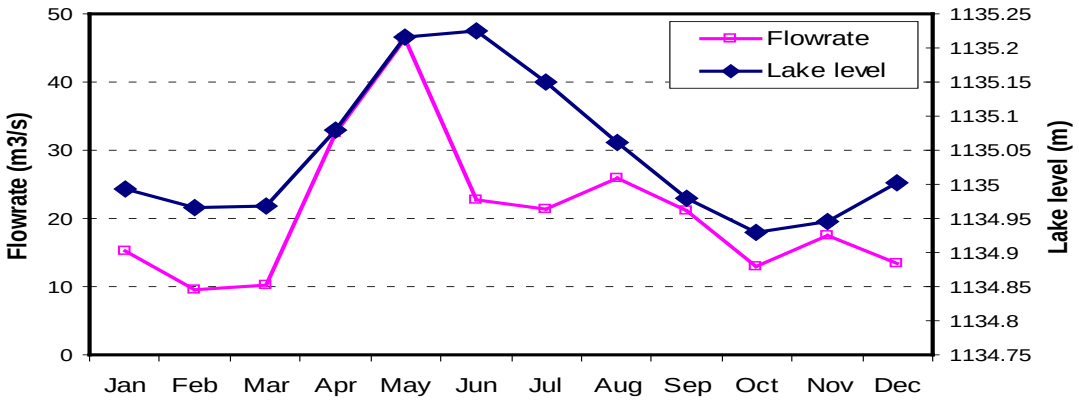

Figure 2.8: *Comparison of monthly mean lake levels (1950-2004) and monthly mean discharge (1967-1997)*

2.7 Biodiversity

Nyando Wetland is home to a diversity of organisms which inhabit the diverse microhabitats provided by the wetland ecosystem. This section presents a brief overview of some of the biodiversity recorded during a wetlands inventory and other related biodiversity surveys carried out in the wetland in the past (Bennun and Njoroge, 1996; Raburu,2003; Obiero *et al.,* 2010; Orwa *et al.,* 2012).

2.7.1 Mammals

Mammals, reptiles and amphibians are abundant in the wetland areas. Amongst the mammals are the endangered *Tragelaphus spekei* (Sitatunga), *Hippoppotamus amphibius* (Hippos), *Viverra civetta* (African sivete), *Lutra maculicollis* (spotted necked otter). The numbers and diversity of these mammals in the wetland have changed over time due to several anthropogenic factors.

2.7.2 Ichthyofauna (fishes)

Wetlands play a crucial role as habitats in the sustenance of lake fisheries since different fish species use it as breeding ground, nursery and feeding grounds. In addition, it supports most of the surviving native tilapiine species that are virtually extinct in Lake Victoria (Balirwa, 1998). According to Chapman *et al* (1995) areas deep in the fringing swamp are less rich because the dense fringing swamps act more as a biological filter, limiting colonization and survival of species that can tolerate these extreme conditions.

Several fish species have been recorded in the Nyando River and the associated wetlands (Raburu, 2003). These include Cichlidae (*Oreochromis niloticus, Oreochromis variabilis, Oreochromis leucostictus, Haplochromis multicolour* and other *Haplochromine species).* The Cyprinidae are represented by

several species including *Barbus alternialis, Barbus numayeri, Barbus nyanzae, Barbus cercops, Barbus kerstenii, Brabus jacksonii, Barbus amphigrama, and Barbus paludinosus.* Other Cyprinids include *Labeo victorianus, Labeo cylindicus and Gara johnstoni.* The Bagridae are represented by *Hipopotamyrus grahami*, Schilbidae by *Schilbe mystus*, Mochidae by *Synodontis victoriae and Synodontis afrofishcheri*. Other families include Protopteridae (*Protopterus aethiopicus),* Claridae (*Clarias gariepinus, Clarias theodorae and Clarias alluaudi)* Mastacembelidae (*Afromastacembelus frenatus), A*nabantidae (*Ctenopoma murerei),* Momyridae (*Marcusenias grahami, Gnethonemus longibarbis Petrocephalus castostoma)* and the introduced Centropomidae (*Lates niloticus).*

Table 2.2 shows different fish species found in Nyando Wetland and nearby lake shores. Studies on the distribution of fishes along the River Nyando and associated wetlands show that more fish species occur in the river mouth wetlands than in the influent rivers upstream (Raburu, 2003). Juveniles and riverine species are restricted to wetlands and the adults may develop a pelagic life but return to wetlands for breeding. However, recent studies in Nyando Wetland reveal that lake fisheries and the post-wetland fishery is characterized by a marked decline, probably due to conversions and drying up of beaches as a result of lake recession (Obiero *et al.*, 2012). The shallow waters are the most fruitful in terms of fish catches, thus when water level is receding, fish catches also decrease. This has led to loss of biodiversity, thus threatening wetland ecological integrity, food security and household economic gain of the local communities.

Scientific name	Common (English) name	Local (Luo) name
Lates Niloticus	Nile perch	Mbuta
Oreochromis niloticus	Nile tilapia	Nyamami
Protopterus aethiopicus	Lung fish	Kamongo
Schilbe mystus	Silver Catfish	Sire
Rastineobola argentea	Sardines	Omena
Haplochromis spp.	Haplochromines	Fulu
Clarias gariepinus	Common Catfish	Mumi
Barbus altianalis	Ripon Fall barb	Fuani
Barbus cercops	Luambwa barb	Adel
Alestes sadleri / jacksonii	Sadler's robber	Osoga
Labeo victorianus	Victoria labeo	Ningu
Mastacembelus fretanus	Longtail spiny eel	Okunga
Synodontis afrofischeri	Marbled Victoria squeaker	Okoko rateng'
Synodontis victoriae	Lake Victoria squeaker	Okoko rachar
Bagrus docmac	Sudan Catfish	Seu
Xenoclarias spp.	Lake Victoria Deepwater Catfish	Ndhira

Table 2.2: *Common fish species found in the Nyando Wetland*

2.7.3 Avifauna

Nyando Wetland is rich in avifauna. A total of 167 species belonging to 50 families have been recorded in the wetland area. Of these species, 111 and 123 species were encountered in the managed (rice irrigation schemes) and the natural wetlands respectively. The Ploceidae and Sylviidae families recorded the highest number of species, with 19 and 11 species respectively. However, this diversity is very dynamic as it varies, depending on whether the managed wetlands are under irrigated rice crop or not.

The dominant families in selected Lake Victoria wetlands include Sternidae 36.12% and Scolopacidae (18.23%) with diversity indices of 0.71 and 0.64 respectively and a total of 49 bird species. The highest diversities and densities are in the irrigation schemes within Nyando Wetland. These are the main feeding grounds for aquatic fowl, most of which concentrate in the primary ponds. Gulls dominate in the main Lake and in the interface zone while hamerkops, egrets and kingfishers are dominant in the inshore areas and the littoral fringes.

Bird distribution in Nyando Wetland is influenced by human activities, availability of food and seasons. Bird species that are endemic to papyrus swamps include vulnerable Papyrus yellow warbler (*Chloropeta gracilirostris)*, the endangered Papyrus gonolek (*Laniarius mufumbiri)* (Collar *et al.* 1994), the Papyrus canary (*Serinus koliensis),* Carruthers's Cisticola (*Cisticola carruthersi)* and white-winged warbler (*Bradypterus carpalis)*. These birds are contained in the East African Red Data list of birds (Bennun and Njoroge, 1996).

2.7.4 Amphibians and reptiles

Amphibians are a class of vertebrates, comprising three living orders: Anura/Salientia (frogs and toads), Gymnophiona/Apoda (caecilians -worm-like amphibians), Caudata/Urodela (newts and salamanders); forms that are phylogenetically intermediate between fish and reptiles. Only anurans (frogs and toads) have been recorded in the Lake Victoria Basin. The common amphibian species in Nyando Wetland include *Chiromantis petersi* (great gray tree frog) and *Hyperolius viridiflavus* (common brown tree frog), *Cassina senegalensis* (running frog), *Zanopus laevis (*Clawed frog).

Many amphibian species inhabit wetlands around water bodies. Any negative impact on an aquatic system emanating from inshore must first affect amphibians before affecting the organisms in the water, such as fish. Although largely overlooked, amphibians can act as excellent indicators for assessing the impact of environmental changes on biodiversity in wetlands (Heyer *et. al.,* 1994). Amphibians are probably the least studied vertebrate group in East Africa. The only detailed studies done in a few places of the basin to-date have been those carried out by Kigoolo (1994) and Schiøtz (1999). In general, amphibians are not among the most threatened species in Kenya.

Information on herpetology in Nyando Wetland is very scanty. However, isolated surveys show that the dominant reptile species in the Wetland are *Naja melanolevia* (forest cobra) *Philothamnus hoplogaster* (green water snake) and *Python sabae* (Python).

2.7.5 Macroinvertebrates

The Nyando River and the floodplain wetland are rich in macroinvertebrates. According to Raburu (2003), the orders found along the river and associated wetlands include Ephemeroptera, Plecoptera, Hemiptera, Trichoptera, Coleoptera, Diptera, and Odonata. Others which occur in lower numbers include Lepidoptera, Arachnida, Malacostraca, Gastropoda, Decapoda, Pelecypoda and Oligochaeta. A total of 97 genera were recorded in the entire basin, with 33 genera being found within the river mouth of the Nyando Wetland, the most abundant being *Syncaris* (Mysidaceae), and *Notonecta* (Notonectidae). A recent study (Orwa *et al.*, 2012) on the abundance and distribution of macroinvertebrates in Nyando Wetland reported a total of 45 genera belonging to 11 orders and 38 families in permanently and seasonally flooded areas. In this study, the majority were from the order Hemiptera that accounted for 23.68% while Pulmonata and Isopoda, with two families each, accounted for only 5.3% of the total number of families. The families Gerridae, Baetidae, and Gyrinidae were widespread within the wetland with Gerridae dominating at 14.7% and lowest abundance with 0.57% and 0.6% being recorded for the families Psychomyiidae and Hydroptilidae respectively.

Invertebrates constitute a significant part of the food chain and litter transformation as well as ecosystem engineering. Apart from beneficial roles, some invertebrates have some harmful effects in the environment, namely transmission of disease-causing organisms such as *Leishmania* by sandflies, schistosomiasis by aquatic snails and release of toxic chemicals (such as cantharidin by blister beetles). However, the role macroinvertebrates play in a wetland ecosystem cannot be underestimated.

2.7.6 Macrophytes

General accounts of the aquatic macrophyte communities in Lake Victoria have been provided by many authors, including Denny (1993), Hughes and Hughes (1992); and Harper and Mavuti (1996). The widest zonation of wetland vegetation occurs along the shallow Lake edges, particularly in sheltered inlets, deltas and shores of rivers flowing into the Lake. The delta of Rivers Nyando and Sondu-Miriu provide good examples of sites with a wide zonation of wetland plants.

Natural vegetation in the area is largely comprised of grass, shrubs and indigenous trees including Acacia and other semi-arid species in the drier parts. The entire Nyando River floodplain is generally plain grassland with *Acacia* spp. *Lantana* spp. and other shrubs in patches. *Cyperus papyrus* is the most common constituent plant of the littoral swamps in the area. Others include *Pennisetum* spp., *Panicum* spp., *Phragmites* spp., *Typha* spp., *Pistia* spp., *Nymphaea* spp., *Salvinia* spp., etc. The ground cover of the upper portion of Kano floodplain is rather poor with more than 75% of ground being bare due to cultivation and overgrazing. Along the Nyando River bank trees are scattered and dominated by *Cassia siamea* (Caesalpiniaceae) and *Ficus sycomorus* (Moraceae). Littoral aquatic macrophytes include *Plaraguite pluagmatoides* (Poaceae) accounting for over 50% of vegetation coverage. The others are *Centella asiatica* (Apiaceae), *Acasia polycartha* (Mimosaceae), *Aeschenomene schimperi* (Pappilionaceae) and *Polygonum pudehrum* (Polygonaceae) (Raburu, 2003).

The Nyando Wetland is composed of different types of macrophytes. The most abundant emergent macrophyte are *Cyperus papyrus* (Cyperaceae), *Typha domingiensis, Pycreous nitidus, Pennisetum purpurium*, *Cyperus pectinatus* , *Phragmites australis, Prhagmites phragmatoides Aechenomene mimosifolia, Kyllinga bulbosa, Centella, asiatica, Sphaeranthus suaveolens and Letonis laxa* (Raburu, 2003). The free-floating macrophytes are represented by *Pistia stratiotes*, *Echornia crassipes* (Pontedeliaceae), *Azolla pinnata* (Aspidiaceae) and *Nymphae lotus* (Nymphaeaceae). On the other hand, submerged macrophytes are represented by an algae *Spyrogyra* sp (Chlorophyceae), *Ceratophylum dermnosum* (Raburu, 2003).

The wetland plants have a number of uses to the local people. *Kyllinga bulbosus, Sporobolus pyramidalis, Typha* sp *nitidus* and most of the *Cyperus* spp and *C. papyrus* are used for making mats and baskets as well as thatching houses. They are also harvested for commercial purposes. Some plants are also used as food: *Commelina africana* as a vegetable and *Maranta* sp tubers as a source of starch. The plant species in Nyando Wetland have been seriously disturbed due to increased anthropogenic activities in the area. The most important and threatened wetland plant is *Cyperus papyrus*. However, in some parts of river banks constituting this basin are patches of *C. papyrus*, *P. australis, P. nitidus*, while along the lakeshore wetlands and at the river banks there is rapid expansion of invasive species such as *Mimosa pigra and* the herbaceous creeper (*Ipomea aquatica*) (Raburu et. al., 2002) which may change the composition of macrophytes with time if appropriate management measures are not put in place. Other plant species within this basin which are exploited by the riparian communities include *Typha domingensis*, *Aeshinomene elaphroxylon* while in open waters are aquatic weeds that include water hyacinth (*Eichornnia crassipes*) and *Azola nilotica*.

2.8 Conclusion

The Nyando Wetland has undergone serious environmental degradation from a multiplicity of anthropogenic activities within the basin. These activities continue to compromise the ecological integrity of this fragile ecosystem. A complete overview of the threats to Nyando Wetland is given in Chapter 5 of this book. It is however prudent to point out here that sustainable conservation and management of this ecosystem would benefit greatly from a concerted effort by all stakeholders.

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CHAPTER 3

The people of Nyando Wetland: socioeconomics, gender and cultural issues

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Summary

Nyando Wetland is endowed with rich biological diversity and supports the livelihoods of many people in the Lake Victoria Basin. It provides ecological services (climate modification, water purification, waste water treatment, flood control and water storage and distribution in space and time); direct uses such as water for domestic purposes, livestock watering, source of fish, medicinal plants and animals and various materials. Despite the intricate link between human well-being and wetland functions, the wetlands are threatened by high and increasing population density of both humans and livestock, unsustainable agricultural practices, effects of Climate Change (prolonged droughts and floods), pollution of surface water sources, unpredictable and low rainfall, deforestation, unplanned human settlement, overgrazing, limited access to clean water, poor sanitation, inappropriate and degrading fishing practices, among other factors. Since the livelihoods of the people largely depend on the utilization of wetland resource, it is important to ensure sustainable use of natural capital by striking a balance between its utilization and conservation. The underlying message of this chapter is that long-term human development cannot be achieved without prioritizing environmental conservation and management. It is therefore incumbent upon all Kenyans to value wetlands as the "kidneys of the earth" and support their sustainable use for the benefit of present and future generations. This is especially true for Nyando Wetland resources that are vital to the local and regional socioeconomic development but are easily accessible to the poor. This chapter articulates the socioeconomic, gender and cultural contexts in which the inhabitants of Nyando Wetland operate in meeting their livelihoods. It is organized to include a contextual narrative of the origin of the people of Nyando Wetland, their demographic characteristics and selected social indicators with a focus on implications to sustainable resource management. The interaction of people with resources and the influence of gender and cultural issues to natural resources use are also articulated. The chapter concludes with a discussion of the policy framework for the community based management of Nyando Wetland resources.

3.0 Introduction

The Nyando River and its associated drainage basin cover about 3,590km^2. The area has two distinct characteristics, the Kano floodplains and the Nyando River Wetland. The wetland provides enormous resources and support livelihoods to many people within the basin. They provide food, store carbon, regulate the water flows, store energy, and are crucial for biodiversity. These benefits are essential to the livelihoods of the people of Nyando Wetland as an intricate link exists between human well-being and the health/functions of wetlands (Box 3.1). Sustainable management and the wise use of Nyando Wetland resources are essential for the improvement of people's livelihoods, especially the rural poor whose daily life relies on the exploitation of natural resources.

The wetland resources in Nyando River Basin are threatened by diverse environmental problems, ranging from over- exploitation of the resources to unsustainable agricultural practices leading to pollution. These include poor agricultural practices, direct and indirect pollution from both point and non-point sources, overgrazing, unplanned human settlement and deforestation. All these, coupled with the rapid population and climate variability, has led to depleted resources, negatively impacting human well being and livelihoods of the riparian-wetland-dependent communities.

The low economic status of the riparian communities has increased their drive to overexploit the wetland resources and to open up land for crop and livestock farming. According to the Government of Kenya statistics, over 70% of the population living around the Nyando River wetland live below poverty level (<US$ 1.00), which catalyzes the overexploitation and degradation of these fragile ecosystems. Nyando Wetland are a 'microcosm' of the complex natural resource utilization challenges currently facing the Lake Victoria Basin as a whole. To benefit the entire lake basin, it is imperative that a critical analysis of the people of Nyando and how they interact with the wetland ecosystem be done. This would inform the coming up of a Sustainable Integrated Wetland Management Plan. This is the objective of this chapter.

The information presented in this chapter was collected from published literature, government reports, research projects, and information generated from observations, surveys and research activities conducted within Nyando Wetland during the life of the Nyando Wetland Resource Utility Optimization Project funded by UNDP Kenya.

Box 3.1: Linkage between the people and sustainable wetland management

Human well-being depends on many benefits provided to the people by ecosystems, such as those derived from healthy wetlands. Wetlands are known to provide food, store carbon, regulate the water flows, store energy, and are crucial for biodiversity. Conservation and the wise-use of wetlands are therefore vital for people, especially the poor. The Changwon Declaration (2008) confirmed the intricate linkage between human well-being and the health of wetlands. The Declaration identified five priority areas and two cross-cutting delivery mechanisms as outlined below.

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I. Priority Action Areas

1. *Water and wetlands*

i. Improve water governance by treating wetlands as our "natural water infrastructure", integral to water resource management at the scale of river basin.
ii. Close the widening gap between "water demand and supply".

2. *Climate Change and wetlands*

i. Protect wetlands as the vital part of the natural water infrastructure from human disturbance for addressing Climate Change
ii. Restore and maintain hydrological cycles in response to addressing Climate Change, flood mitigation, water supply, food provision and biodiversity conservation.
iii. Recognize the natural infrastructure of wetlands as a major asset in combating and adapting to Climate Change at the national level.
iv. Be proactive for collaboration among international technical bodies involved in Climate Change.

3. *People's livelihoods and wetlands*

i. Maintain the integration of wetland benefits into economic development (poverty reduction strategy, policy and plans) and the livelihoods of people, especially the poor.
ii. Always use the ideas of wise use, management and restoration of wetlands as opportunities to improve people's livelihood.
iii. Document and analyze the linkages between wetlands and livelihoods.
iv. Support sustainable wetland management by indigenous knowledge, traditional norms

and values, diversifications, stewardship promoted by economic incentives, and diversification of the support base for livelihoods.

4. ***People's health and wetlands***
   i. Assess the impacts of national and international policies, plans and strategies on the interrelationships between wetland ecosystems and human health.
   ii. Identify and implement interventions that benefit both wetland ecosystem "health" and human health.

5. ***Land use change, biodiversity and wetlands***
   i. Integrate wetland benefits and values into cost and benefits of changes to wetlands while making decision on land use change.
   ii. Give priority to safeguarding naturally functioning wetlands, whenever possible.
   iii. Provide multiple actions to address the root causes of the loss of biodiversity and to reverse these losses.

II. Cross-cutting delivery mechanisms

6. ***Planning, decision-making, finance and economics***
   i. Make a trade off across policy objectives from multiple sectors
   ii. Recognize fully the significance of wetlands in spatial planning, especially the Ramsar sites.
   iii. Undertake the comprehensive cost-benefit analysis to reflect the economic values and investment in the maintenance of wetland ecological characters.
   iv. Make provision for the use of innovative financial instruments and partnerships between those sectors and stakeholders outside the Ramsar Convention.

7. ***Sharing knowledge and experiences***
   i. Develop an effective mechanism to share basic information on the global extent and characterization of wetlands.
   ii. Motivate organizations to intensify their efforts to seek common, harmonized and accessible approaches in sharing knowledge and experiences.

3.2 The people of Nyando Wetland: who they are and where they came from

The Nyando Wetland in the Lake Victoria Basin straddle the geographical environment where the Luo community are the predominant inhabitants and have over time lived and been engaged in fishing, farming, hunting and livestock keeping. One interpretation of the meaning of the word 'Luo' manifests a close affinity between the people, the lake and fishing activities. In Luo language, Jo- means 'people of'. So *Jaluwo* means he who fishes (Ochola-Ayayo, 1976). Hence the term Luo could mean people who follow (a lake or river or cows). In their migrations and settlements, the Luo had strong attachments to their cattle which had great social and cultural significance for them. They have always settled in the vicinity of a lake or river, thus explaining why many have called them river-lake people. Luos are "nilotes", a name which is derived from the Nile River, where it is believed the Luo lived since the dawn of history (Ochola-Ayayo, 1976).

Many studies have been done on Luo socioeconomic and political organization (Ochola-Ayayo, 1976; Okello-Ayot, 1977). The proto-Luo migrated in three groups of jok-Owiny, jok-Omolo and Luo-Basuba from Southern Sudan in the 14th century. They settled along Lake Victoria and throughout what is today Western Kenya. In their migration, they followed the River Nile up to Nyanza, around the shores of the Lake Victoria. However, their settlement around the lake was not motivated by the search for fish, although fishing later became an important economic activity (Ochola-Ayayo, 1976). They were basically cattle keepers who wanted water and grazing for their livestock and land for

farming (Okello-Ayot, 1977). Numerous rivers assured the people of abundant water for watering their livestock, while the rich soils deposited by the rivers from upstream also allowed for the cultivation of crops (Butterman, 1979).

According to Ogot (1967), the Luo "had always fought to occupy lowlands where they could get access to water and pasture grounds because of their pastoralism which was reflected in the almost religious esteem in which they had held their cattle". Not all Luos, however, were fishers as some settled far from the beaches and concentrated on agriculture and farming. Geheb and Binns (1997) have discussed the duality of the Luo economy by analyzing how it straddles both peasant farming and fishing at different seasons of the year. Ocholla-Ayayo (1976) states that "the Luo of Kenya inhabited the territories bordering Lake Nyanza to the north and south of Nyanza gulf, extending into Tanzania". Due to their preference for lowlands, the Luo settled along the Lake shore. That enabled them to partake in fishing in tandem with pastoralism and cultivation (Opondo, 2011).

Geheb and Binns (1997) noted that the dividing line between fishers and farmers on the Kenyan shores of Lake Victoria is as difficult to demarcate as that between certain cultivating and pastoral groups in other parts of Africa. While Luo fishers were also farmers, fishing was prioritized in areas where farming was difficult due to poor soils. Thus Geheb and Binns's argue that for the contemporary Lake shore communities, 'farming [was] also generally regarded as being more reliable and more easily monitored, whereas fishing was increasingly perceived as a 'hit and miss' activity. The land is now felt to offer more security than the lake, given the problems of declining fish yields, the greater incidence of theft and the rising prices of fishing gear'. This may also have been true for the post-colonial peasant-cum-fisher community that inhabited the Nyando River Wetland.

3.3 Socioeconomic and demographic profiles

3.2.1 Demographic characteristics of the Nyando Wetland communities

The Lake Victoria Basin in Kenya, Tanzania and Uganda has an estimated population of 23.7 million, representing about 30% of the total population of the three countries. In all of these countries, the population density in the lake basin is higher than the national average (LVBC, 2007). The Kenyan part of the basin is the most populated, with 12.5 million people and a population density of 257 people per km^2. The basin population is experiencing rapid growth at approximately 2.6% per annum (LVFO, 2007). According to the Kenya Population and Housing Census report of 2009, Nyando District population stands at 350,353 (170,270 males; 180,083 females) occupying an area of 1,168.4 km^2 with an average population density of 316 persons per km^2. Upper Nyakach Division has the highest population density of 434 persons per km^2 followed by Kadibo with 372 and Nyando at 321 persons per km^2. Muhoroni division has the lowest density of 201 persons per km^2 followed by Miwani and Lower Nyakach with a density of 310 and 316 respectively. The population of Kadibo Division, in Kisumu East District is 61,326 (29,252 males; 32,074 females) occupying an area of 164.8 km^2, putting the density of its population at 372 persons per km^2 (KNBS, 2009) (Table 3.1).

The settlement pattern is determined by physical set-up of the district and relative agricultural potential of the divisions. Muhoroni division has high agricultural potential and falls in the sugar-belt, thus attracting large farms. Upper Nyakach also has high agricultural potential but the sizes of farms are relatively small, with food crops and livestock-keeping being the main agricultural activities, thus the high population density of 434 persons per km^2. The overall population structure is skewed

towards the youth, with about 42% under 25 years, while about 75% of the population fall below 30 years (GoK, 2009). Due to high poverty levels, unfavourable socioeconomic conditions and disease prevalence in the wetland areas, life expectancy is low, with an average of 37.7years for males and 42.9 years for females. The situation is worsened by high dependency on natural resources and small land holdings, where 75% of the population subsists on one hectare or less. These extreme demographic characteristics translate into high and increasing pressure on Nyando Wetland resources.

Division	Area	1999		2009		2012 Projections[1]	
		Census	Density	Census	Density	Population	Density
Miwani	225.7	58,029	257	70,066	310	76,572	339
Muhoroni	334.8	63,450	190	67,535	201	83,725	250
Nyando	249.3	64,511	259	79,711	321	85,125	341
U. Nyakach	176	64,693	367	74,252	434	85,365	485
L. Nyakach	182	49,246	271	58,789	316	64,982	357
Nyando District	**1167.8**	**299,929**	**257**	**350,353**	**326**	**395768**	**339**

Table 3.1: *Population distribution and density per division in Nyando District*

The lower parts of the Nyando River Basin comprise of Nyando, Kadibo, Lower Nyakach and Miwani divisions, with a total population of 284, 091 people (139, 013 men; and 145,078 women). The total number of households, area (km^2) and density are 65,325, 820.3, and 270 respectively (KNBS, 2009). Table 3.2 summarizes the population by sex, number of households, area and density of the locations within each division in the lower catchment of Nyando River Basin. These locations have been selected on the basis of their proximity to the wetlands and the exploitation of the wetland resources by the residents. The majority of the population relies on subsistence agriculture for its livelihood. The rapid increase in population coupled with high population density particularly in high agricultural potential areas puts pressure on land. This pressure on land is manifested in environmental degradation, encroachment on wetlands and water catchment areas, which will have contra effects on the ability of the Nyando Wetland to sustain livelihoods and adversely affect its productive capacity.

In addition, the rapidly growing population structure is in the active working group, especially the youth in Nyando district. According to the Nyando District Development Plan (2009), the youth population in the district is projected to grow from 101,589 in 2010 to 117,863 by the year 2012 (GoK, 2009). Since the majority of this age group are still dependants, they will continue to place heavy pressure on the wetland resources and socioeconomic activities of the rural communities. The problem of the youth has been a major challenge that the district must address effectively. The high increase in the population of the youth in the face of dwindling employment opportunities in the country and in the district in particular could lead to further degradation of the wetland resources.

The pressure that a rising population exerts on a dwindling absolute and *per capita* resource base chains off a vicious cycle where the worsening environmental degradation gradually erodes the economic base of the formal and informal sectors of the economy. This in turn forces a sizeable proportion of the economically active population out of work and business, effectively coercing them to join the multitudes that are solely dependent on, and over-exploit the natural environment. These are likely to reverse the gains made in poverty alleviation and economic development and interfere with the attainment of the Vision 2030 goals.

Division	Location	Male	Female	Total	Household	Area(km²)	Density
Nyando	Kakola	10,355	11,324	21,679	4,878	22.1	982
	Kikolo/E. Kano	3,684	4,158	7,842	1,754	49.8	158
	Kochogo	4,742	5,019	9,761	1,971	17.1	552
	Wawidhi	4.563	4,929	9,492	2,036	52.1	182
	Total	23,344	25,430	48,774	10,369	141.1	346
Kadibo	Kawino North	4,180	4,413	8,593	1,821	27.7	310
	Kawino South	3,218	3,421	6,639	1,381	23.8	279
	West Kochieng	5,194	5,972	11,166	2,280	16.5	678
	East Kochieng	5,259	5,767	11,026	2,377	28.3	389
	Bwanda	2,821	3,089	5,910	1,260	12.2	484
	Katho	2,826	3,127	5,953	1,288	12.9	480
	Kanyagwal	1,911	2,012	3,923	820	23.3	168
	Total	25,409	27,801	53,210	11,227	144.7	368
Lower Nyakach	Asao	1,021	1,188	2,209	502	10.5	211
	E. Nyakach	2,729	3,024	5,753	1,271	15.9	362
	N.E Nyakach	6,839	7,729	14,568	3,350	30.4	480
	N. Nyakach	2,977	3,228	6,205	1,339	23.9	260
	Nyalunya	3,682	4,164	7,846	1,692	39.6	198
	Pap Onditi	4,369	4,848	9,217	2,108	25.5	361
	Rangu'l	2,320	2,452	4,772	1,001	29.8	160
	Total	23,937	26,663	50,570	11,263	175.6	288
Miwani	Ombeyi	12,752	13,555	26,307	5,732	92.5	284

Table 3.2: *Population distribution by Sex, Number of Households, Area, Density and Administrative Units in the Lower catchment of Nyando River Basin*. **Source:** *Adapted from Census data (KNBS, 2009)*

3.2.2 Poverty incidence and inequality

Nationally, the poor are defined as those who are unable to afford minimum basic needs comprising of food and non-food items (GoK, 2001). Nyando District is estimated to have about 199,318 individuals below the rural food poverty line (GoK, 2001). The Welfare Monitoring Surveys of 1994 and 1997 indicate that poverty levels have been increasing in Nyando Wetland region overtime (GoK, 2002). Despite the abundant land and fisheries resources, the inhabitants of the surrounding divisions are among the poorest in the region. According to "Geographic Dimension of Well-Being in Kenya, Who and Where are the Poor?" (CBS, 2003), the highest poverty incidences are found in Nyando Division (64%) with the lowest incidence in Lower Nyakach Division at 59% (Table 3.3). The result shows the poverty dimension by division and also by location level. The figures show Miwani, Nyando and Upper Nyakach Divisions having higher poverty incidence of between 60 and 70% with Lower Nyakach division showing poverty incidence in the range of 50 to 60%. Though Lower Nyakach shows a little better situation as compared to other divisions, it is now believed to be higher due to the impact of persistent drought and frequent flooding.

Perennial floods have ravaged most parts of lower Nyando catchment for too long and caused great economic loss in terms of lives and property (CBS, 2004). This implies that the poverty stricken

rural communities living around the wetlands depend exclusively on its resources for subsistence, income generation and employment. The major causes of poverty in Nyando district include poor agricultural technologies, lack of proper storage facilities, erratic and unreliable rainfall, gender disparity, poor marketing of agricultural commodities, poor and inaccessible road network, frequent floods, mismanagement of rural industries such as sugar, rice, cotton and fish industries, insecure land tenure systems, poor water and sanitation systems, impact of HIV/AIDS and low accessibility to health services (GoK, 2009).

Division	Location	Poverty Incidence (%) 2003	Poverty Gap (%)	Census count (1999)	No. of Poor individuals (1999)
KADIBO	Kombura	54 (10.74)	19 (5.86)	11,443	6,154 (1,228)
	Bwanda	61 (10.88)	22 (6.25)	7,103	4,297 (772)
	Kochieng'	62 (9.930)	24 (6.40)	16,596	10,271 (1,647)
	Kawino	64 (8.20)	25 (5.28)	12,041	7,759 (987)
	OVERALL	**60 (5.86)**	**22 (3.57)**	**47,183**	**28,337 (2,764)**
NYANDO	Kakola	37 (11.69)	11 (4.90)	9,037	3,365 (1,056)
	Kochogo	57 (10.83)	19 (5.85)	7,702	4,402 (833)
	Wawidhi	67 (8.55)	26 (5.78)	6,964	4,671 (595)
	Kikolo/E. Kano	72 (11.58)	28 (7.92)	6,634	4,785 (767)
	Awasi	73 (6.67)	31 (5.48)	13,158	9,658 (877)
	Onjiko	78 (10.33)	33 (8.08)	8,085	6,288 (834)
	OVERALL	**64 (4.74)**	**24 (2.91)**	**51,580**	**32,839 (2,444)**
LOWER NYAKACH	Nyalunya	47 (13.96)	15 (6.30)	6,376	3,021 (889)
	Rang'ul	49 (15.32)	16 (7.62)	3,503	1,702 (536)
	E. Nyakach	54 (12.58)	19 (6.11)	5,414	2,920 (680)
	Asao	55 (12.71)	19 (6.76)	3,250	1,802 (413)
	N. Nyakach	55 (13.60)	19 (6.69)	4,841	2,685 (658)
	N.E. Nyakach	65 (9.40)	25 (5.99)	9,311	6,077 (875)
	Pap Onditi	68 (11.35)	27 (7.45)	7,966	5,442 (904)
	C. Nyakach	69 (14.47)	28 (9.55)	5,024	3,487 (726)
	OVERALL	**59 (6.30)**	**21 (3.60)**	**35,685**	**26,776 (2,878)**
MIWANI	Ombeyi	63 (7.95)	23 (6.10)	20,658	13,084 (1,642)
	Nyangoma	64 (10.02)	23 (3.75)	17,055	10,832 (1,708)
	OVERALL	**60 (6.36)**	**22 (3.75)**	**56,604**	**34,037 (3,600)**

Table 3.3: *Rural poverty estimates for locations of Nyando Wetland* . **Source:** *CBS 2004*
(Notes: 1. Std Errors in brackets. 2.The poverty incidence (headcount index) measures the share of the total population in a given area whose consumption is below the poverty line. 3.Poverty gap provides information on how much poorer the poor are, relative to the poverty line)

3.3 Selected socioeconomic indicators and their implications on wetland management

Socioeconomic status is an individual's relative social and economic standing in society based on an amalgamation of three main variables, namely: educational achievement, economic activity (which encompasses livelihood pursuits and occupational prestige) and income. The links between these variables are briefly discussed within the context of sustainable use of Nyando Wetland.

3.3.1 Education standards and conservation awareness

Education is a major asset in any national development and in implementing conservation activities. It provides appropriate manpower training in environmental management and elicits positive mindsets towards wetland conservation and population control. The transformation of environmental conservation has been identified as crucial to the attainment of Vision 2030 (GoK, 2007) while family planning ensures less future population pressure on the environment. In addition, education improves the wetland communities' employment and business prospects and concomitantly makes them less directly reliant on the wetland resources, thereby preventing overexploitation/over-capitalization. The educated are also better able to appreciate contemporary environmental problems such as Climate Change, to internalize and apply environmental ethics and to be more attuned to wetland considerations when weighing the pros and cons of operational options. However, the state of the environment also affects education. Indeed, a barren and harsh environment implies that children, particularly girls, have to walk long distances in search of scarce natural resources such as water, leaving little or no time to attend school.

The riparian communities in Nyando are served by many poorly constructed primary schools and only a few secondary schools. Yet schools are important channels through which dissemination and demonstration of sustainable conservation efforts in any community can be achieved. The status of education in this area is far below the national standards and few pupils, if any, from these schools reach university level. The literacy level for the district stands at 65.7% with the Adult Education Department recording enrolment in adult classes of 771 males and 2,143 females (GoK, 2009). There is high rate of school drop out at the primary level, especially the girls who seek either early marriage or child labour as housemaids in urban centres. Similarly, many boys drop out of school in favour of fishing and working in rice and sugarcane plantations. Other academic problems in the area include poor accessibility to schools, under-staffing, inadequate sanitary facilities, lack of health facilities, and temporary periodic closure of schools due to floods, low school enrolment, hunger and poverty. In addition, deficient infrastructural facilities such as roads and rural electrification also lead to poor performance since schools do not have lights for studying and conducting scientific experiments.

Consequently, development programmes that would have been brought about through educated community members are few and scanty. Moreover, the school age children do not see any incentive or reward to learn due to lack of employment opportunities in the area. Parents often argue that they have no economic base to either build schools or raise school fees for secondary and university education. Their dependence on the exploitation of wetland resources always results in fabrication of low quality products which have low market value. Thus involving communities and schools to participate in conservation of Nyando Wetland is always an uphill task and needs deliberate efforts to raise the standards of education in the area. However, because of efforts by Nyando Wetland Resource Utility Optimization Project, significant progress has been achieved in the project area as outlined in Chapter 6 of this book. Some of the schools indicated good enthusiasm to participate in the conservation of Nyando Wetland. The teachers continue to be active in organizing joint awareness and education programmes in the area. There has been a lot of interest in the annual International Wetlands Day celebrations attended by leaders, schools and the community. Training on the wise use of wetlands and production of quality wetland products is one of the activities of the programme, which has raised a lot of interest amongst the schools. The schools' agro-forestry and small-scale horticulture are part of the activities where schools have shown great interest.

During the implementation of the aforementioned project, funding limitations, lack of rural Information Technology (IT) facilities and inaccessibility to some schools slowed down the progress made. Despite all these, a great deal of progress will not be achieved unless a Community-Based Management Plan is put in place and sufficient funding support is solicited. The wetland management plan needs to incorporate increased education, awareness creation and demonstration of best practices of conservation strategies to pupils/students, parents and teachers to ensure sustainable management of wetland resources. To promote community based wetland conservation, there is need to intensify and expand activities such as open days, celebration of wetland days, and use of multimedia information dissemination techniques to enhance short and long term conservation strategies and achieve significant results.

3.3.2 Socioeconomic issues

The Nyando Wetland plays an important role in the livelihood and subsistence economy of local communities. There are several occupational activities practiced by local communities living around the wetlands. These include farming, fishing, trading activities, beekeeping, brick making, harvesting of macrophytes, mat making, sand/stone mining, pottery (GoK, 2009). The major economic activities come from the primary industry sector; mainly subsistence and commercial agriculture. Specifically, residents of Nyando Wetland draw their livelihood mainly from agricultural activities, the majority being subsistence farmers who grow food crops such as maize, sorghum, finger millet, cassava, sweet potatoes, fruits, vegetables and keep livestock. The livestock kept include cattle, goats, sheep and poultry which serve as a source of income for farmers. There is a high degree of dependence by rural households on wetland resources for economic benefits. For instance, Kipkemboi (2006) reported that wetland vegetation --especially papyrus, grasses and water hyacinth --provide materials for making mats, baskets, furniture and other marketable products. These economic activities contribute to poverty alleviation and job creation in rural areas. This is especially true within the 100m buffer ring around the lake which provides a wealth of natural resources and economic benefits. The results are consistent with the findings of Schuyt (2005) in Yala Swamp, which reported a similar high dependence of local riparian communities on natural wetland resources.

Plate 3.1: *A sugarcane plantation within the Nyando Wetland*

Apart from food crops, sugarcane, cotton and rice are also grown in the area as cash crops. Sugarcane (Plate 3.1) covers the largest area of land, followed by rice, maize, sorghum and cowpeas. The sugarcane is marketed through the two sugar processing factories of Muhoroni and Chemelil in Nyando district and the newly built Kibos Sugar factory in the neighbouring Kisumu East District. In the natural resources utilization, the Nyando Wetland inhabitants also indulge in beekeeping for livelihood and commerce. For instance, the beekeeping project initiated by the Nyando Wetland Resource Utility Optimization Project was considered a success story since it

generated significant incomes to the rural communities involved in the project.

Besides agriculture, there are residents within the Nyando Wetland who depend on fishing, especially those along the shores of Lake Victoria, although Nyando district has only a small shoreline (11km bordering Lake Victoria) compared to other riparian districts. Fishing is done in the swamps and some open beach sites mainly for subsistence and commercial purposes. Most of the fisher-folk have been fishing over the years as a source of their livelihood. In the past decade, fishing became increasingly commercialized, thereby threatening even the nutrition source for the local inhabitants. Most fish, particularly Nile Perch, is sold to fish processing plants or other agents, resulting in increased prices that are out of reach of most poor to average households. There are several beaches which are located in Nyando Wetland in Kisumu East, Nyando and Nyakach Districts. Fish catch is also declining due to increased fishing effort and illegal fishing methods. However, the contribution of the wetland fishery to household economies has not been well documented to date as it is characterized by seasonal variability and remains mostly at the subsistence level (Kipkemboi, 2006). The first attempt to value the fisheries resources is given in Chapter 4 of this book.

There are very few employed people and small scale traders in the area. However, there exists rural centres where people sell and buy goods. Economic activities such as carpentry, commerce, small trading take place in these rural centres. Many kiosks, defined as smaller retail shop, are also operated. Other businesses such as restaurant, tailoring (both in shop and on veranda), shoe repair, hardware, bicycle repair, textile/cloth, carpentry, metal work and barber shops are found in the area (GoK, 2009). Like other parts of Nyanza Province, the region is a net exporter of labour force to urban centres and other parts of the Great Lakes Region, as employment opportunities in the area become rare. Thus more than half of the population lives below the national poverty line, with a mean monthly income of less than Kshs. 3,000. This subsistence economy has made it difficult for the area to develop and for the rural communities to understand and participate in national conservation initiatives, leading to overexploitation of wetland resources and its environmental degradation.

Nyando Wetland also provides opportunities for tourism and recreational activities. The wetlands lie in the western Kenya tourism circuit just below the Equator and are located about 20km from Kisumu, the third largest town in Kenya. The region has other tourist attractions sites around the lake. The western tourist circuit is well served by national and international trunk roads as well as Kisumu International Airport that was recently expanded and improved to international standard so as to accommodate large body aircrafts. There are still many wetlands that retain their natural beauty and can be attractive to visitors. The region is also inhabited by friendly communities with rich cultural heritage that make it suitable for the promotion of culture tourism. Consequently, there is great potential for community and eco-tourism that include protection of natural environment and its resources for the future benefit of the country without impacting negatively on the eco-system. There is also a diversity of beautiful landscapes and sceneries, wildlife, culture, historical sites and suitable beaches along Lake Victoria that provide enormous potential for tourism growth in the region.

Other tourist attractions include recreational sailing and sport fishing on Lake Victoria which is the world's second largest fresh water body. Facilities required to boost the tourism industry include the establishment of high-class hotels and lodges in nearby towns or on-site for overnight stay for tourists; camping sites, water sports and tourist resorts. However, transport and communication improvement needs to be undertaken so as to enable nature lovers to enjoy the wealth of tourism resources offered by the wetlands in the Nyando River Basin. There is also need to declare Nyando Wetland a protected area for purpose of preserving the rich biological and cultural diversity for tourist attraction.

3.4 Socioeconomic issues

3.4.1 Land use activities

Wetlands are an important component of land use in the lake basin since they are among the most productive ecosystems (Barbier *et al.,* 1997). The Nyando Wetland is about 5000 hectares and is characterized by high agricultural productivity. The main factors that make the wetlands particularly attractive for agriculture are high soil humidity, resulting from sediments and nutrients transported by runoff and rivers during floods that fertilize the soil (Terer *et al.,* 2005) and the presence of freshwater, especially during the dry season. Over the past decades, land use changes in the Nyando River Basin have impacted negatively on wetland ecosystems, causing habitat degradation and loss of wetland values and services (Swallow *et al.,* 2008). The domination of the land use practices in the Lake Victoria wetlands by agricultural activities has been driven by exposure of large tracts of fertile lands along the lake/land interface as a result of Lake Victoria water recession (Obiero *et al.,* 2012).

In recent years, there has been a shift in land use activities from subsistence to commercial economy as intensification of agricultural crop production took advantage of the fertile agricultural land. Several studies have reported a progressive shift of farming system enterprises from terrestrial to wetland-based production systems by households in close proximity to wetlands (Kairu, 2001; Kipkemboi, 2006; Swallow *et al.,* 2008; Obiero *et al.,* 2012). For instance, findings by Obiero *et al* (2012) show that there is rapid proliferation of small scale horticulture activities within and along the wetlands of the lake using water from shallow hand dug wells, permanent streams and exposed lands due to lake recession. However, while overall production appears to be relatively stable at the basin level, there have been shifts in the geographic locus of production toward the upper parts of the basin (Swallow *et al.,* 2008). The encroachment and extensive conversion of the emergent wetland vegetation zone and its associated environmental impacts may compromise the buffering processes and capacity of individual wetlands (that is, their ability to absorb sediments, nutrients and pollutants) within the Lake Victoria Basin (Terer *et al.,* 2005).

Apart from changes in land use practices, other anthropogenic activities which increased in intensity include overgrazing by livestock, burning of the wetlands, overharvesting of macrophytes which play a synergistic role in setting inertia of degradation likely to interfere with the hydrological cycle and macroclimate regulation in the area. Livestock owners in lower Nyando catchment area rely on the wetland to supply essential fall-back fodder for their herds when other pastures fail. Papyrus, reeds, sedges and grasses are important in provision of materials for roofing, mat and basket making and fish traps. Overexploitation and destruction of wetland vegetation curtail the filter function of wetlands as pollutants and nutrients are carried directly into the lake when the vegetation of wetland macrophytes is destroyed (Okeyo-Owuor, 1999; Odada *et al.,* 2004). Furthermore, uprooting of papyrus rhizomes by the community for use as fuel wood from the burnt and overgrazed areas may make it impossible for the papyrus to regenerate even after the water level increases in future (Obiero *et al.,* 2012).

3.4.2 Food Security

Despite being considered 99% cultivable (GoK, 2009), Nyando district is a food deficit zone. This is partly due to unreliable rainfall. The district produced 33,892 metric tonnes (mt) of cereals in 2005 as compared to its annual cereal demand of 51,465mt. Nyando Wetland contributes directly to food security by providing products that people can utilize or sell to provide them with cash for purchasing food. Crops that contribute directly to food production in the area include maize, sorghum, beans,

millet, and wild vegetables (e.g. *Crotalaria* spp., black night shed, *Amaranthus spp.*, cowpeas and spider flower (*Cleome gynanendra*). The major cash crops grown in the wetlands are rice, cotton and sugarcane that provide an income that is used for purchasing food from local markets. In recent years, the residents have initiated growing of horticultural vegetables such as tomatoes, onions, pepper, kales, watermelon and other fruits to satisfy expanding rural and urban markets. Subsistence farming of food crops supplements households with food throughout the year.

A study by Swallow *et al*. (2008) reveals that the lower Nyando basin has become even more dependent on maize and maize mixtures over the last 15 years, with accompanying drops in area covered by minor crops such as millet, cassava, pyrethrum, potatoes and wheat. Marketing constraints may have been the main cause of this shift toward maize, the major food crop. There were expansions in the agricultural area devoted to vegetables, rice and sorghum, with a particularly large percentage increase in the area of sorghum in the lower Nyando (Swallow *et al.,* 2008).

It is worth noting that the main crop harvested from the wetland areas is always ready throughout the growing season when the supply of food from the upland fields and other regions is running out for many families as the "hungry season" is starting, hence the produce from the wetland areas supplement their food security. Therefore, wetland cultivation can be seen as a critical survival mechanism (Silvius *et al.,* 2000) and as a source of food security, (i.e. food security 'safety nets' available to impoverished people), especially for those people whose upland harvest are poor as a result of recurrent droughts in major parts of Kenya (KFSN, 2006). However, large-scale agricultural production is likely to be unsustainable, hence there is need to come up with efficient land use policies to guide utilization of farm lands. Other sources of food include wild animal protein such as antelopes, hare, gazelle and birds like ducks and geese that are an important supplement to local diet. Nonetheless, wild game meat is now rare since most of the wild animals have been driven out by anthropogenic activities (Kipkemboi, 2006).

Livestock production is practiced in the district, with Zebu Cattle being the main breed reared in the district. Small stock such as goats, sheep and poultry are also kept. The total stock of cattle, sheep and goats in the district was estimated at 388,000 animals in 2005. Some members of the Luo community practice fishing along river Nyando, Sondu and in Lake Victoria. Poor breeds, low productivity and inadequate control of livestock diseases, as well as lack of water for animal use and poor fishing methods are the most important constraints experienced in the sector (MoLFD, 2005).

The riparian communities have always depended on the wetland fishery for their subsistence activities, generating food for consumption and as a source of income. Wetlands play a crucial role as habitats in the sustenance of lake fisheries since different fish species usually breed there or act as nursery grounds and feeding grounds, in addition to supporting most of the surviving native tilapiine species that are virtually extinct in Lake Victoria (Balirwa, 1998). A study by Raburu (2003) on the distribution of fishes along the River Nyando and the associated wetlands revealed that several fish species occur in the wetlands. Juveniles and riverine species are restricted to wetlands and the adults may develop a pelagic life but return to wetlands for breeding (Okeyo, 1992). Recent studies in Nyando Wetland reveal that lake fisheries and the post-wetland fishery posted a marked decline, probably due to conversions and drying up of beaches as a result of lake recession (Obiero *et al.,* 2012). The shallow waters are the most fruitful in terms of fish catches; thus when water level is receding, fish catches also decrease. This threatens the food security and household economic gain of the rural wetland communities.

3.4.3 Public health, water and sanitation

The communities living around and using Nyando Wetland are prone to numerous environmental health problems, often caused by unsafe water contaminated by microbial and chemical pollutants, poor disposal of human waste and malnutrition. This situation is worsened by the lack of medical facilities and poor access roads in the area. Water supply in the area is poor. Most community members source water for their domestic use from the polluted rivers, streams and wetlands, which is more often than not used without prior treatment. According to the Kenya Integrated Household Budget Survey (KIHBS, 2005, 2006), 53.3% of the households in the district take at least 10 minutes to fetch drinking water. Only 26.7% of the households have access to piped water, with the rest relying on other sources such as boreholes, wells, ponds, rivers, streams and rain water. These sources are also polluted from the up-stream industries and urban centres (Raburu and Okeyo-Owuor, 2005). Some of the health problems in the area are exacerbated by climatic conditions such as occasional flooding.

Generally, unsanitary conditions are closely associated with scarcity of clean and potable water. It is estimated that only about 20% of Kenyan rural population has access to safe water, but for both Nyanza and Western provinces, it is only 8% (LBDA 2004). Sanitation is a major problem in the Nyando Wetland area which endures heavy wastes discharged into it from upstream during flooding. Solid wastes and other pollutants are loaded into the wetland areas, causing severe environmental health problems. There may be little data to buttress this state of affairs, which could be used to mitigate these environmental problems, and yet the evidence is there from the presence of empty pesticide containers and poor water quality in the river and wetlands. The situation is worsened by the black cotton soils around the wetlands that make poorly constructed latrines to collapse all too frequently, especially with heavy rains and floods, if no reinforcement with culverts is done. Conditions at beach landing sites are unsanitary, and there is fear of widespread faecal material contamination and pesticide residues in fish, water and sediments. Most communities dispose of human waste directly onto the ground or surface water during floods. These and other occurrences enhance the increase or outbreak of vector borne and water-related diseases in the area. The main vector borne disease in the area is malaria and there are also numerous cases of bilharzia and typhoid. Community members are not well prepared to deal with disease outbreaks such as diarrhea and cholera due to the limited medical facilities and lack of drugs in the area.

HIV-AIDS is the biggest health threat in Nyando district. The lower Nyando basin has one of the highest rates of HIV/AIDS in the whole of Kenya (http://www.faces-kenya.org/photos/hivmap.php). HIV/AIDS prevalence rate which was 29% in 2002 has reduced to 18% through a number of strategies. This is still high, considering that the national HIV/AIDS prevalence has dropped to about 5% (KDHS, 2003). The life expectancy was actually reduced by about 10 years during the last two Kenya national population censuses, probably due to the HIV/AIDS pandemic. Many people are infected, affected and die from the disease despite the awareness created by the government and local NGOs. It has been established that factors that lead to the spread of HIV and AIDS in Nyando are socioeconomic in nature. Poverty and unemployment, gender inequalities, communication barriers between youth and elders on issues relating to sexuality as well as drug and alcohol abuse are the basic determinants of the spread of this pandemic. This therefore poses a challenge for the entire population in the district (GoK, 2009).

As a consequence, Nyando district exhibits exceptionally high mortality rates as compared to the national level; infant mortality rate (IMR) in Nyando is 116 per 1000 live births. This is 50% higher than the national figure while under-five mortality rate for the districts is 212, about double the

national average. This implies that about one in every 5 children in Nyando cannot live to see his or her fifth birthday. Influenced by these high infant and under-five mortalities, the crude death rate for the district is 44.1, about twice the national level. Life expectancy is no exception either. According to the 2009 Census, male life expectancy at birth was 37.7 years only, compared to the national average of 52.8. Women showed longevity than men, given that their life expectancy was 43 years, which is still very low compared to the national average of 60.4. Wise use of wetland resources can only thrive in an environment where the people are healthy. This is due to the fact that labour is one of the important factors of production. In Nyando, where disease incidences are relatively high, productive activities are adversely affected.

3.4.4 Infrastructure and energy resources

The Lower Nyando catchment is divided by the main Kisumu and Nairobi road with a deviation to Kisii, Homa Bay and Migori which are the major communication network serving the region. There are only a few feeder roads which are inaccessible for most parts of the year. This situation makes transportation and marketing of the agricultural and wetland products difficult. The area is not served with telecommunication network, except in major urban centres.

Since the area is poorly served with electricity, wood-fuel and kerosene are the major energy sources used. The wood-fuel is usually obtained from floodplain and wetland vegetation. This situation has led to deforestation of the floodplains and degradation of the wetland ecosystem. There are however great potentials for developing other energy sources from solar, wind and hydroelectric power which could be harnessed to serve the area and the country at large. Most of the hilltops in the region are bare and forest excision for charcoal burning is extensive and continues unabated.

A crop of agro-based industries exist in the area; especially those processing sugarcane, rice and molasses. The effluents and by-products from these industries are a major environmental problem in the lower Nyando River Basin. Potentials exist for the establishment of other new industries and expansion of urban centres associated with them. This may lead to further environmental degradation if a management plan is not put in place. Therefore, establishing a sustainable management plan to integrate conservation and such development projects is a necessity.

3.4.5 Information, communication and outreach

For faster exchange of information, there is need for reliable ICT infrastructure. Nyando District lacks reliable landline telephone connections in most centres and in the rural areas. Fixed line telcom services are still unreliable in most parts of the district. However, over 90% of the district is covered by GSM services provided by Safaricom and Airtel companies. These have gone a long way in improving communication and making these services accessible and affordable to the ordinary person. According to a socioeconomic baseline survey by LVFO (2006), most of the respondents own a radio receiver and listen to the popular channels throughout the week, making it an ideal medium that could be used to reach the fishing communities. Most people in the region listen to radio programmes about wetland conservation and therefore it would be greatly beneficial to use this medium for information dissemination, share community outreach activities, and promote linkage activities and livelihood training programmes.

While the above developments have improved accessibility of information through voice services, a lot still needs to be done to encourage the use of computers for data transfer through the internet. The government has done its bit to make computers cheaper by removing value added taxes (VAT),

but due to poverty and literacy levels, they are still not accessible to many in the rural areas. The other challenge is lack of electricity in most parts of the district that would be important in powering computers. Consequently, internet and email for access to information and communication is limited to few public offices, institutions and individuals in the district. It is important to note that a good knowledge base exist for Nyando Wetland. Therefore, using ICTs to enhance environmental conservation efforts and economic development of vulnerable communities may increase income in the short and long-term and thus provide additional means of adaption. They may also contribute to the preservation of wetlands that will increase socioeconomic benefits in the longer term.

3.5 Gender issues in the Conservation of Nyando Wetland

Gender consciousness in development is becoming increasingly important as it is critical to achieving all the primary development objectives. Gender refers to the social relations between women and men, determined by the different social roles and attributes allocated by societies and communities (March *et al.,* 1999). It is widely acknowledged that "Development if not engendered is endangered" (Global Human Development Report, 1995). As a concept, gender marks a fundamental axis of power relations in society. It is used to design and define activities, access and control of resources and participation in decision-making. Despite being the majority, with a 50.3% of the total population (GoK, 2009), Kenyan women still carry an inordinate burden of work as providers of family food, fuel and water, which bring them into direct contact with the environment (particularly wetlands) on a daily basis. However, they are disproportionately affected by environmental crises and are more vulnerable than men to natural disasters such as prolonged drought and lack of water for both domestic and household uses, situations aggravated by Climate Change. Moreover, Kenyan women fare badly because they wield little socioeconomic power, have a lot fewer economic opportunities and resources than their male counterparts. They are also largely excluded from the country's informal sector, a key source of livelihood among many wetland communities because men are able to carry out the associated manual tasks.

Wetland ownership, access to and control of resources, type of products harvested and the environmental incomes derived from such products must be analyzed through the gender lens to provide a picture of resource utilization and allocation, needs and priorities of both women and men. This analysis will provide valuable information of the impacts of climate and vulnerability of the two genders due to wetland degradation and the resultant services and goods. Gender analysis is important since the way people consume resources is to a large extent dependent on their income, property, age and perception of welfare (WWI, 2004). In addition, there is marked lack of knowledge of women's critical inputs in agriculture and natural resource management, particularly wetlands, which leads to inequalities in access to information and resources, and lowers the efficiency and effectiveness of women's contributions in sustainable wetland management. Improving the gender sensitivity and effectiveness of risk assessment and management requires greater understanding of women's and men's different use and management of wetlands resources. The sorry state of affairs is that women bear the greatest brunt of the consequences of 'degradative' actions, mainly by men, on wetland ecosystems.

3.5.1 Relationship between gender and access to and control of wetland resources

Gender consideration in the use, management and conservation of natural resources has gained considerable focus in recent times. This is with the understanding that different gender groups utilize wetland resources differently and hence conserve or degrade them in varying degrees depending on resource allocation and use. Given these differences in roles, women and men have different needs for and use of natural resources. Sustainable use and management of ecologically, socially and economically valuable resources will need to pay attention to the differences between men and women's resource use and roles, and how these shape their respective needs and responsibilities.

Experience in the implementation of development and conservation projects in Kenya has shown that participation of all gender groups is essential for achieving success and sustainability (KNBS, 2000). However, in the lower Nyando catchment areas, traditional ownership and inheritance patterns continue to marginalize women and girls and prevent them from having access to, and gaining control of productive resources such as land. Gender analysis has shown that women who lack access to land also lack access to inputs such as credit (World Bank, 2000). In addition, the traditional division of labour overburdens women and blocks them from positions of power and influence. The girl child is disadvantaged in areas of education where preference is given to boys, in cases where parents are faced with a problem of choice between the two sexes. Even when they are left in school, the girls spend a lot of their time performing household chores like drawing water, fetching firewood and cooking, leaving them with very little time for studies. Special needs of the girl-child, such as access to sanitary towels, should also be taken into account while she is in school sessions.

3.5.2 Wetland resource utilization by different gender groups

A number of socioeconomic studies have shown that there are gender differences in utilization of natural resources in the Nyando Wetland (Adede, 2009). Degradation of wetlands tends to affect men and women differently as evidenced by the impact of wetland degradation in Nyando area. Nyakaana (2008) discovered that declining wetland resources are affecting women because, traditionally, division of labour among gender prescribes and charges women with the responsibility to certain social and economic chores for the family. In this case then, they are naturally the ones to utilize wetlands more than men do for their households' food and medicinal resources. In most rural communities, socially constructed attributes determine the different roles and entitlement of men and women.

Nyando Wetland resources are used differently, depending on socio-demographic attributes, especially gender and age. Grouped by gender, Table 3.4 illustrates the different resource use benefits from the wetlands. Community development processes depend on the different roles, responsibilities and socioeconomic status of both men and women. Survey findings by NWCP (2006) indicate that males play a greater role than females in the utilization of wetland resources for commercial a purpose, which is opening virgin lands for crop farming; especially cash, food and horticultural crops, charcoal burning, hunting, grazing livestock, fishing and mining of clay and sand. While men are engaged in clearing of wetland vegetation for agricultural expansion, the women perform labour intensive activities such as weaving papyrus mats, agricultural production and local trade. Women are also directly involved in household food provision and interact with the wetland on a daily basis. The male and female youths are mainly responsible for fetching firewood and water for domestic use. Male youth do what men do to a lesser extent. This is because they are involved mainly during off-school days.

Wetland Resource	Benefits/Products/Values	Resource user Groups by Gender**	Level of Utilization
Water	Domestic use for cooking, washing, bathing, Livestock watering, Irrigation	F, MY, FY M, MF M, F	High Very high High
Fish	Local consumption Income	M, F, MY, FY M, F	Very high High
Crops	Tubers (Cassava, yams, potatoes) Maize, Millet, Sorghum, Beans Rice and sugarcane Vegetables and fruits e.g. tomatoes, kales, cowpeas, water melon, carrots	M, F, MY M, F M, F M, F, MY	Very high Very high High Very high
Papyrus/reeds and sedges	Building and construction e.g. roofing Crafts (Mats, ropes, Tables, Baskets) Fuel wood	M M, F F, MY, MF	Very high Very high Very high
Grass	Pasture for livestock Thatching	M, MY M, MY	Very high Very high
Wild animals	Food Skins for sale	M M	High High
Trees	Fire wood Charcoal Construction poles and Timber	F, MY, FY M, M	Very high Moderate Very high
Wild fruits and vegetables	Food Income Medicine	M, F. FY M, F M, F	Very high High High
Medicine	Wild vegetables, trees, fish Income	M, F M, F	High High
Clay and Sand	Building and construction (bricks) Pots and plates	M M, F	Very high High

Table 3.4: *Wetland resource use in Nyando Wetland by various user groups/gender*

** *M - Male adults, F- Female Adults, MY – Male Youth, FY – Female Youth*

Food production and home maintenance chores are usually undertaken by women while men are entrusted with the decision making process as heads of households. Several reasons explain the observed differences in gender roles in Nyando Wetland. First, men usually cultivate virgin wetlands

for crop farming while women are involved in home-and market-based activities to obtain household income and for nutritional security. Second, some gender roles are socio-culturally sensitive. For example grazing, fishing, hunting, harvesting of materials and medicinal herbs are considered the role of men and male youth while fetching of water and fuel wood is carried out mainly by women and female youth. Thirdly, traditional beliefs also influence the utilization of wetland resources. Rural communities believe that evil spirits live in the wetlands so there is a time beyond which one must vacate the wetlands. Normally, it is women who leave the wetlands early compared to men. Men also believe their forefathers were buried in what are now wetlands so it belongs to them by lineage.

3.6 Cultural issues and wetland conservation

The sustainable management of the Nyando Wetland depends on the commitment of the riparian communities to foster the long term established coexistence with the wetland ecosystems which is intertwined with their cultural beliefs. Some of these beliefs had conservation values and should be reinforced. Some of the cultural values are attached to the use of wetland resources. For instance, the wetland plants such as *Phragmites* "Odundu" are used to stop hailstones from destroying the crops by putting the plants stuffed with some traditional medicines at the corner of every farms. Apart from *Phragmites*, the umbel of *Cyperus papyrus,* dipped in some traditional medicines and sprayed in the farms, is also believed to protect the crops from hailstones.

Drinking the water from wetlands directly is believed by the community to cure some diseases. It is believed that when the evil spirits are cast they move and hide in the wetlands. Wetland ecosystems were therefore considered sacred thus offering them protection. The traditional healers would direct their clients to bath in the wetlands to get cleansed of certain diseases as the areas are considered as cleansers (*Manyasi*). This made the wetland ecosystems such as streams to be used by the community as areas they would go for cleansing. For instance, adulterous members of the community would bathe in a flowing stream after committing adultery to protect their children from dying as it is believed direct contact with the a child after the act would lead to death of the child. Similarly, lactating mothers would also bathe in the streams before suckling their children as it is believed suckling after a fight would kill the child. Wetland ecosystems were also regarded as areas where curses could be transferred (*Loko dhoch*) from one person/community to the other by medicine men.

Dead animals found in the house in the morning (e.g. dogs or monitors) were thrown in the wetland to avoid bad omen. Wetlands were considered shrines where special ceremonies would be done; like appeasing the spirits of the dead ("*Tero buru*") as spirits causing calamities such as death are believed to come from the wetlands and praying sites for their gods. Wetlands also have several religious uses as Christians do use these habitats for baptism of their faithful while some sects like Legio Maria also use water from special springs as sacred water ("*pi hawi*") in performing special rituals. Poverty-driven wetland degradation has been exacerbated by the erosion of traditional knowledge caused by Westernization. Traditionally, cultural norms and practices regarding respect of taboos and totems, reverence of wetlands as sacred sites and rituals regulate resource harvests and buffer zone maintenance. These ensure sustainable use of valuable plant and animal species for the common good of entire communities living within and around wetland eco-tones.

3.7 Conclusion and Recommendations

The Nyando Wetland system is of great socioeconomic value to the local community. The wetlands provide a number of consumptive products needed by the surrounding community, including fishing, grazing, water abstraction for domestic use, handcraft materials, hunting for wild animals and harvesting of wild vegetables. However, as is the case with most wetlands in the Lake Victoria Basin, the wetlands resources are currently undergoing rapid transformation due to increasing human settlement, reclamation for agricultural production and other forms of consumptive community livelihood strategies. Current ongoing land use and other human induced changes within the wetland threatens the ecological integrity and socioeconomic values of this highly dynamic ecosystem. This situation is fuelled by increasing levels of poverty, underdevelopment and high unemployment rates among the riparian communities as well as the unsustainable encroachment upon wetland ecosystems.

For the wetlands to continue supporting communities at the edge of the swamps, effective resource utilization and management techniques have to be put in place. To prevent further encroachment upon them, the productivity of farming needs to be increased to add value to the existing biomass harvesting. This has a potential significance particularly in a region beset by high poverty, hunger and malnutrition. It is therefore imperative that proper management and conservation measures are put in place to protect the wetlands. Furthermore, the high economic potential of the Nyando Wetland, its status of being a non-protected area and the lack of a proper wetland policy make the wetland a vulnerable ecosystem. In order to maintain the ecological integrity and environmental functioning of the wetland, sustainable wetland utilization approaches must be embraced by all stakeholders.

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CHAPTER 4

The Value of Consumptive Goods and Services of Nyando Wetland

Raburu P.O., Onyango F.O and Obiero K.O

Summary

Wetlands provide a range of goods and services and possess a variety of attributes of value to society. They offer provisioning, regulating, cultural and supporting services that generate economic value from their direct, indirect or potential use. Despite legislation designed to protect wetlands, they continue to be degraded and lost at an alarming rate. This is partly because of lack of understanding of their ecological and socioeconomic importance, which leads to distorted policy and decision making regarding their use and management. The value of a wetland can be partly assessed in terms of the direct use of its resources for the satisfaction of human needs. In the Nyando River Basin, many wetlands have been lost or degraded as a result of increasing demands for land and water. An understanding of the socioeconomic value of the wetlands is crucial when deciding on conservation and development priorities related to land use and the allocation of finite resources. Therefore, the value of the natural resources that wetlands provide to communities is a critical consideration. This chapter provides such knowledge, which would enable policy makers to set up appropriate wetland conservation programmes at the community level in Nyando and other related wetlands in the Lake Victoria Basin. It highlights the key direct consumptive wetland goods and services, estimates the value of direct consumptive use and investigates the determinants of the direct consumptive value of the resources in the Nyando Wetland.

4.0 Introduction

Wetlands are among the world's most productive environments. They have been famously described as "biological supermarkets" because of the extensive food webs and rich biodiversity they support and as "kidneys of the landscape" because of the functions they perform in the hydrological and chemical cycles (Mitsch and Gosselink, 1993; Barbier *et al.,* 1997). In addition, wetlands provide a range of goods and services and possess a variety of attributes of value to society (Barbier, 1993). They offer provisioning, regulating, cultural, and supporting services that generate economic value from their direct, indirect, or potential use (MEA, 2005). Wetlands throughout the tropics provide important goods and services to local communities. They are considered to be important ecosystems, which contribute considerably to the national economy and rural livelihoods (Ogutu *et al.,* 2003). There is increasing evidence that the economic returns from natural or sustainably used wetland habitats exceed those that are degraded or converted to other uses. However, loss and degradation of remaining natural wetland habitats continue largely unabated (Turner *et al.,* 2000). In the Lake Victoria Basin, extensive reclamation and conversion of wetlands has occurred to permit agriculture and the remaining swamps have been degraded by overharvesting (Abila 2005; Schuyt, 2005). This is partly due to a lack of understanding of their ecological and socioeconomic values, which leads to distorted policy and decision making regarding their use and management (Terer *et al.,* 2005; de Groot *et al.,* 2002).

Important decisions concerning the management and use of wetlands can best be made only if the functions wetlands perform and how these functions are linked to the provision of goods and services are considered. Unfortunately, relative to other forms of natural resources, few studies have attempted to economically value wetland ecosystem services. The goal of this chapter is to (i) highlight the importance of Nyando Wetland in the provision of ecosystem goods and vital services, (ii) provide an estimation of the economic value of direct consumptive uses, and (iii) explain the determinants of the direct consumptive value of the resources. The information presented in this chapter was collected from published literature and PRAs, contributions by the local community during the Nyando Wetland Management Plan workshops and valuation study spearheaded by Onyango (2012) during the UNDP-Kenya funded Nyando Wetland Resource Utility Optimization Project.

4.1 Wetland functions, goods and services

Wetlands are composed of a number of physical, biological and chemical components such as soils, water, plant and animal species and nutrients. Interactions among and within these components allow the wetland to perform many vital functions, for example water storage, storm protection and flood mitigation; shoreline stabilization and erosion control; groundwater recharge and discharge; water purification through retention of nutrients, sediments and pollutants; stabilization of local climatic conditions, particularly rainfall and temperature (Lambert, 2003). The Millennium Ecosystem Assessment (2005) defined ecosystem services as "the benefits people obtain from ecosystems" whereby services are defined broadly and include both goods (i.e. resources) and services in the more narrow sense (i.e. benefits from ecosystem processes and non-material uses). Ecosystem functions have also been defined as 'the capacity of ecosystem processes and components to provide goods and services that satisfy human needs, directly or indirectly' (de Groot *et al.* 2002). Ecosystem goods and services provided by wetland ecosystems are essential for sustaining livelihoods (Costanza *et al.* 1997).

4.2 Classification of wetland functions, goods and services

There exists a wide body of literature on wetland functions, goods and services and one approach is provided by the Millennium Ecosystem Assessment (2005) that distinguishes four main categories of services that are provided by or derived from wetlands. These are (1) provisioning services which are often the most directly and easily visible services from which human populations benefit in wetlands (2) regulating functions including the regulation of processes related to water, sediment and climate (3) cultural services provided by wetlands such as spiritual and inspirational, recreational and educational services (4) supporting services which include soil formation (accumulation of sediment and organic matter) and nutrient cycling. Table 4.1 provides an overview of the main functions, goods and services that can be attributed to wetland ecosystems and their associated ecological processes and components. The first column indicates a list of 20 functions, the second lists the ecological processes and components underlying these functions while the third provides a more detailed list with examples of specific goods and services derived from these functions.

Ecosystem Functions	Ecosystem processes and components	Goods and services (examples in Nyando Wetland)
Regulation functions	**Maintenance of essential ecological processes and life support systems**	
Climate regulation	Source of and sink for greenhouse gases; Carbon sequestration	- Maintenance of favourable micro-climate (temperature, precipitation) and other climatic processes that determine human habitation, health and cultivation. - Reduce global warming in Kenya
Water regulation (hydrological flows)	Groundwater recharge/discharge	- Role of wetland vegetation in regulating runoff and River Nyando discharge.
Water purification and waste treatment	Role of vegetation and biota in removal or breakdown of toxic compounds and pollutants	- Water discharge for domestic, industrial and natural irrigation e.g. rice irrigation project in Kano Plains.
Erosion regulation	Retention of soils and sediments	- Retention, recovery, and removal of excess nutrients and other pollutants - Maintenance of natural productive soils
Natural hazard regulation	Influence of ecosystem structure on dampening environmental disturbances	- Storm protection by papyrus, reeds, sedge - Flood prevention (e.g. by wetlands and forests)
Provisioning functions	**Products obtained from ecosystems**	
Food	Conversion of solar energy into edible plants and animals	- Production of fish, wild game, fruits, and grains
Freshwater	Groundwater recharge, storage, retention	- Storage and retention of water for domestic, industrial, and agricultural use
Fiber, fuel and fertilizer	Presence of species or abiotic components with potential use for fuel or raw material	- Production of logs, fuel wood, organic matter, peat, fodder, leaves, litter
Biochemical	Conversion of solar energy into biomass for medicinal uses and other materials	- Extraction of medicines and other materials from biota
Genetic resources	Genetic material and evolution in wild plants and animals	- Herbal drugs and pharmaceuticals. - Test and essay samples - Genes for resistance to plant pathogens and ornamental species
Raw materials and Medicinal resources	Variety in bio(chemical) substances in with potential ornamental use, and other medicinal uses of natural biota	- Resources for fashion, handicraft, jewelry, pets, decorations and souvenirs, e.g. fur, feathers, ivory, aquarium fish and shells
Cultural functions	**Non-material benefits obtained from ecosystems**	
Spiritual and inspiration	Variety of natural features with spiritual and historic value	- Use of nature for religious or spiritual purposes (i.e. heritage value of natural ecosystems and features)
Recreational	Variety in landscapes with (potential) recreational uses	- Travel to natural ecosystems for ecotourism, outdoor sports - Opportunities for recreational activities
Aesthetic	Attractive landscape features	- Enjoyment of scenary because many people fine beauty or aesthetic value in aspects of wetland ecosystems
Educational	Variety in nature with scientific and educational value	- Use of nature for scientific research, informal education and training. - Use of wetland ecosystems for school excursions, fieldwork and
Cultural and artistic information	Variety of natural features with cultural and artistic value	- Use of nature as motive in books, film, painting, folklore, national symbols, architect, advertisement etc
Supporting functions	**Services necessary for the production of all other ecosystem services**	
Soil formation	Weathering of rocks, accumulation of orgamnic matter	- Maintenance of productivity in arable land - Sediment retention and accumulation of organic matter
Nutrient cycling	Role of nutrients in storage and recycling of nutrients e.g. Nitrogen (N), Phosphorus (P), Sulphur (S)	- Maintenance of healthy soils and productive ecosystems - Processing, and acquisition of nutrients
Biodiversity and nursery: Habitats for resident or transient species.	Importance of ecosystems to provide breeding, feeding or resting habitat to resident or migratory species	- Number of resident organisms, either exotic or endemic spp. - Maintain a certain ecological balance and evolutionary process - Habitat integrity

Table 4.1: *Functions, goods and services of wetland ecosystems*

Adapted and modified from Constanza et al. (1997); de Groot et al. (2002) and Millennium Ecosystem Assessment (2005),

4.3 Ecological functions and services of Nyando Wetland

Nyando Wetland performs both important socioeconomic and ecological functions. It is rich in natural resources on which the riparian communities depend. The benefits rural people derive from these wetlands are supported by the variety of environmental functions performed by these complex and sensitive environments. For instance, the fertile soils in the surrounding plains and a constant supply of freshwater by River Nyando have enabled the establishment of a thriving irrigation system for rice, sugarcane and horticultural crops. These resources include rich, moist soils for cultivation; grazing for livestock, fisheries, reeds, sedges, and grasses for crafts and timber; water for domestic use, watering livestock and irrigation (Gichuki *et al.,* 2001; Ogutu *et al.,* 2003). The functions or services of Nyando Wetland are normally not measurable in monetary terms but benefit all wetland inhabitants, and those using a wetland site. The various functions, goods and services provided by this unique ecosystem heritage are discussed here-below.

4.3.1 Regulatory functions

i. *Climate regulation.* One of the most important roles of wetlands may be in the regulation of global Climate Change through sequestering and releasing a major proportion of fixed carbon in the biosphere. The hydrological, nutrient and material cycles of Nyando Wetland helps to stabilize climatic conditions such as temperature and humidity in the area. The services provided by this function relate to the maintenance of a favourable climate, both at local and global scales, which in turn are important for, among others, human health, crop productivity, recreation and even cultural activities.

ii. *Recharge and discharge of groundwater.* Wetlands deliver a wide array of hydrological services that assist in promoting groundwater recharge, and play an important role in regulating River Nyando discharge. Excess ground-water moves into the underground aquifer, or underground water moves upward and becomes surface water. These functions stabilize ground and underground water supplies. Water is usually purified during these processes. Ecosystem services derived from the water regulation function are, for example, maintenance of natural irrigation and drainage, buffering of extremes in discharge of rivers, regulation of channel flow and provision of a medium for transportation.

iii. *Water purification and waste removal.* The Nyando Wetland has been shown to play an important role in the reduction of sediment load and nutrients to the lake (Raburu and Okeyo Owuor, 2005; Terer *et al.,* 2005). The retention and storage capacity depend on the vegetation cover, soil (biota) topography and sub-surface characteristics of the wetland ecosystem. The encroachment and extensive conversion of the emergent wetland vegetation zone and its associated environmental impacts may compromise the wetlands buffering capacity of Nyando Wetland (Obiero *et al.,* 2012). The wetlands act as sinks of nutrients and toxicants as they are absorbed by the macrophytes. The nutrients retained in wetlands support the growth of other wetland organisms.

iv. *Natural hazard regulation and flood control.* Flooding is a natural phenomenon that is important for maintaining the ecological functioning of wetlands. For instance, they serve as a means for the natural transport of dissolved or suspended materials and nutrients into wetlands and in particular for sustaining the delivery of many of the services they provide to millions of people. The main beneficiaries are those whose livelihoods depend on floodplains for flood-

recession agriculture and pasturage and for fish production. The Nyando Wetland reduces the destructive nature of flooding by absorbing the energy of waves and currents, thereby preventing potentially catastrophic effects of storms, flash floods and droughts through its storage capacity and surface resistance; as well as protecting adjacent shoreline from storm damage. In recent years, floods in the Nyando River Basin have resulted in negative impacts, ranging from loss of human lives and livestock to widespread destruction of crops, houses, public utilities and disruption of various economic activities. Nearly half a million people live in areas of high flood risk within Nyando River Basin—a risk likely to increase if these wetlands are lost or degraded (JICA, 2005).

v. *Sediment retention.* The soil retention function mainly depends on the structural aspects of ecosystems, especially vegetation cover and root system. Roots of trees stabilize the soil and foliage intercepts rainfall, thus preventing compaction and erosion of bare soil. Plants growing along Lake Victoria shorelines and submerged vegetation in near-shore areas contribute greatly to controlling erosion and facilitating sedimentation. The services provided by this function are very important to maintain agricultural productivity and prevent damage due to soil erosion from landslides.

4.3.2 Provisioning goods and services

i. *Food resources.* Although today most foods are derived from cultivated plants and domesticated animals, a substantial part of the human diet still comes from wild plants and animals. Nyando Wetland is a vital source of edible plants and animals that feature in the diet of the local communities, ranging from game/bush meat, fish and water fowl, to vegetables, insects and fruits. 72% of the people in the wetland use fertile agricultural grounds for growing agricultural crops (Obiero *et al.*, 2012). The main crops grown are kales, tomatoes, maize, millet, sorghum, beans, peas, cassava, sweet potatoes and onions. Certain forms of small-scale subsistence farming and horticulture have also been initiated in recent years. The wetland ecosystem is also partly being used or converted for food production during periods of drought. However, large-scale commercial exploitation is very likely to be unsustainable.

ii. *Freshwater.* Water, which is one of the most important wetland resources is used for drinking, cooking, washing and irrigation, and has a dependence ratio of almost 100% among the local people. In one part of the wetland, water is freely collected from River Nyando and from boreholes dug in homesteads. In other parts of the wetlands, water is obtained directly from the lake or bought from water sellers who transport it using donkeys. The dependence on lake waters for domestic use varies with seasons. During the dry season, a number of households experience water shortage and have to travel long distances to the water points.

iii. *Raw materials.* Nyando Wetland abounds in natural products and a variety of renewable raw materials such as wood, papyrus, reeds, sedges, grass, sand, clay for building and construction. Over 80% of people in the Nyando Wetland live in traditionally built huts made of materials gathered from the wetlands, such as clay, sand, wood and papyrus. The wood makes the framework of these huts, the clay is used for the walls while the vegetation, especially papyrus, grasses and water hyacinth provide materials for making mats, baskets, furniture and as well as thatching (M'mayi and Katua, 2001).

iv. *Fuel, fibre and fodder.* The wetland also provides energy resources in the form of biomass (fuelwood, dung) and animal-feed (e.g. grass, leaves, litter). Livestock grazing ranks highly as an activity in the Nyando Wetland, where 78% of the people graze animals mostly for subsistence (Obiero *et al.,* 2012). Cattle, sheep and goats are often bought for food but sometimes also as a form of banking as reported elsewhere by Schuyt (2005).

v. *Genetic resources.* Nyando Wetland forms an important genetic bank since many biotic resources which were once collected in the wild are now obtained from cultivated plants and domesticated animals e.g. wild rice. Usually, many important crops cannot maintain commercial status without the genetic support of their wild relatives. In order to maintain the productivity of these cultivars, or to change and improve certain qualities such as taste, resistance to pests and diseases, and adaptation to certain environmental conditions, regular inputs of genetic material from their wild relatives remains essential.

vi. *Medicinal resources.* Harvesting of medicinal plants from the Nyando Wetland is ranked highly by 65% of residents living around the wetland (Obiero *et al*, 2012). These plants contribute to the maintenance of people's health in many ways by treating various ailments and as a source of income from herbal medicines sold by traditional healers.

vii. *Ornamental resources.* Wetlands provide many kinds of raw materials which are used for fashion and clothing (notably animal skins and feathers), handicrafts (e.g. wood and stones for carving), and objects of worship (i.e. products associated with cultural, tribal and religious ceremonies). Wild plants and animals are also collected and traded as pets or for decoration (e.g. ornamental plants, fish) in private households or to supplement the collections of zoological and botanical gardens.

4.3.3 Cultural functions

i. *Spiritual and historic information.* Cultural function of Nyando Wetland is outlined in section 3.6. of this book. In summary, these areas are used for baptism either by immersion or by using water from the wetlands, appeasing evil spirits, cleansing, as shrines, and a source of historical lineage among others.

ii. *Recreation and ecotourism.* Wetland ecosystems have an important value as a place where people come for rest, relaxation, refreshment and recreation. With increasing numbers of people, affluence and leisure-time, the demand for recreation in natural areas/eco-tourism will most likely continue to increase in the future. Eco-tourism as an important niche market in tourism industry has embraced environmental conservation, maintenance of biodiversity, a satisfying experience for the visitors, nature study and sustainable community development. Tourism in all its forms is the least developed activity at present in Nyando Wetland. Potential tourist attractions in the wetland include bird watching, wildlife watching, sport fishing, boat-rowing and cultural attractions such as pottery, basketry and traditional cleansing. The wetland could be promoted as a locally controlled, people–centred tourist destination and be included in Kenya's 'western circuit' for tourists.

iii. *Aesthetic information.* Many people enjoy the scenery of wetland areas and landscapes which are reflected in, for example, the preference many people have for living in these aesthetically pleasing environments with suitable micro-climate. Aesthetic information can have

considerable economic importance, for example, through the influence that ecotourism has on housing prices. Houses near national parks or with a captivating lake view are usually much more expensive than similar houses in less favoured areas.

iv. *Scientific and educational information*. Nyando Wetland provides almost unlimited opportunities for nature studies, environmental education (e.g. through excursions) and function as 'field laboratories' for scientific research (e.g. the ECOLIVE Project), leading to the writing of several publications each year. For instance, several government departments and students from several institutions of higher learning visited the Nyando Wetland Resource Utility Optimization Project to learn more about community based wetland conservation. The wetland areas also serve as important reference areas for monitoring environmental changes such as floods, Climate Change and impacts of drought on food security.

4.3.4. Supporting functions

i. *Nutrient cycling*. Many structural and functional aspects of wetland ecosystems facilitate nutrient cycling at local and global scales. For example, soil organisms decompose organic matter thereby releasing nutrients to both local plant growth, but also to the atmosphere. *Pseudomonas* sp. in wetland soils metabolically transform nitrate into nitrogen gas (N_2), a process known as denitrification. In the lower reaches of the Nyando River Basin, both the extensive use of water for irrigation and excessive nutrient loading associated with the use of nitrogen and phosphorus in fertilizers for growing tea and sugarcane upstream (Raburu and Okeyo-Owuor, 2005) has resulted in pollution of riverine and lacustrine wetlands. Therefore, nutrient cycling plays an important role in the gas, climate and waterpurification functions within the basin.

ii. *Soil formation*. Soil is formed through the disintegration of rock and gradually becomes fertile through the accretion of animal and plant organic matter and the release of minerals. Soil-formation usually is a very slow process; natural soils are generated at a rate of only a few centimetres per century and after erosion, soil formation (or regeneration) from bedrock takes 100–400 years per/cm topsoil (Pimentel and Wilson, 1997). Ecosystem services derived from soil formation relate to the maintenance of crop productivity on cultivated lands and the integrity and functioning of natural ecosystems.

iii. *Biodiversity and nursery habitats*. Nyando Wetland acts as a source of biological diversity by hosting a high diversity of fish species, wildlife and plants, many of which are endemic or threatened. The wetlands also play a crucial role as habitats in the sustenance of lake fisheries since different fish species usually breed there or act as nursery grounds and feeding grounds in addition to supporting most of the surviving native tilapiine species that are virtually extinct in Lake Victoria (Balirwa, 1998).

4.4 Wetland ecosystem values and valuation

Valuation is defined by the Millennium Ecosystem Assessment (2005) as *"the process of expressing a value for a particular good or service in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology and so on)"*. Valuation forms a key exercise in economic analysis and provides important information for wetland conservation. The importance or "value" of ecosystems is viewed and expressed differently by different disciplines, cultural perceptions, philosophical views and schools of thought (Box 4.2). The basic aim of valuation

is to determine people's preferences and how much they are willing to pay for, and how much better or worse off they would consider themselves to be as a result of changes in the supply of different goods and services. Valuation provides a means of quantifying the benefits that people derive from wetlands, the costs associated with their loss, and the relative profitability of land and resource uses which are compatible with wetlands conservation *vis-à-vis* those economic activities which contribute to wetland degradation (Emerton, 1998). Wetlands valuation therefore helps to predict and understand the economic decisions and economic activities which impact on wetlands integrity and status.

Box 4.1: Definitions of "Value"

The Millennium Ecosystem Assessment (2005) defined *value* as "The contribution of an action or object to user-specified goals, objectives, or conditions". According to the *Oxford English Dictionary* the term "value" is used in three main ways:

i. **Exchange value:** the price of a good or service in the market (i.e. market price);
ii. **Utility:** the use value of a good or service, which can be very different from the market price (e.g. the market price of water is very low, but its use value very high; the reverse is the case, for example, for diamonds or other luxury goods);
iii. **Importance:** the appreciation or emotional value we attach to a given good or service (*e.g.* the emotional or spiritual experience some people have when viewing wildlife or natural scenery or our ethical considerations regarding the existence value of wildlife).

These three definitions of value roughly coincide with the interpretation of the term *value* by the three main scientific disciplines involved in ecosystem valuation:

i) **Economics,** which is mainly concerned with measuring the exchange value or price to maintain a system or its attributes (Bingham *et al*. 1995);
ii) **Ecology,** which measures the role (importance) of attributes or functions of a system to maintain ecosystem resilience and health (Bingham *et al*. 1995), and,
iii) **Sociology,** which tries to find measures for moral assessments (Barry and Oelschlaeger 1996).

Adapted from Wetland Valuation Workbook by de Groot, 2007

4.4.1 Economic values of Nyando Wetland

A broad range of valuation methodologies have been applied to value wetlands (Constanza *et al.,* 1997; Emerton, 1998; Turner *et al.,* 2000; de Groot *et al.,* 2002). The method most commonly used in the literature has been to observe the market prices of products related to wetland functions and to ascribe the total revenue from the sale of such products as the value of the wetland (Woodward and Wui, 2001). As expected, the different valuation methodologies have been applied to value different wetland functions. Contingent Valuation Method (CVM), Hedonic Pricing and Travel Cost Method (TVM) have been applied to value amenity and recreational value. Replacement cost has largely been used to value the habitats and nursery functions of wetlands (Barbier *et al.,* 1997; de Groot *et al.,* 2002). Only functions that provide goods and services that satisfy human wants directly or indirectly have an economic value (Turpie *et al.,* 2001). Consumptive and non-consumptive direct use values are generally estimated using Market Valuation based on estimates of quantities produced, prices and costs of inputs. Quantification of use can be complex if monitoring data are not available, and many involve informant interviews, focus group discussions and household surveys involving detailed questionnaires about resource use (Turpie, 2010).

In order to determine the economic value of Nyando Wetland, Onyango (2012) used the market price and contingent valuation methods to assess the value of consumptive goods and services essential in sustaining the livelihoods of the community members. An estimate of the value of the wetland over an infinite time frame with a range of discounted rates in the range of 2%-15% was also attempted in the same study. It should however be noted that, valuation which provides the efficient allocation aspects of resource use, is but one aspect for decision for managing the wetlands. Others include the equity and distributional aspects, political and ecological considerations. Valuation of Nyando Wetland provides useful information for sustainable management and policy decisions from the community level.

4.4.2 Consumptive wetland goods and services

The goods and services provided by ecosystems are critical to human welfare and potentially provide an economic basis for preserving biodiversity. Almost all the households living within the Nyando Wetland derive a number of direct uses for their livelihoods. The wetland provides the households with fertile areas for cultivation of various crops; fishing grounds, papyrus which is used to make various artifacts like mats; source of water for human and livestock consumption; grazing land for cattle; source of wood for fuel, building and construction, charcoal production; grass for thatching houses and other activities; source of medicinal herbs and roots, among others.

Maize is the most dominant crop at the locations with 77% of sampled households growing it (Onyango, 2012). It is also the main staple food crop grown for consumption, while the extra is sold in the market. Other crops grown for both subsistence and commercial purposes include sorghum (37%), beans (36%), kales (28%), indigenous vegetables (28%), rice (26%) and tomatoes (18%). Fishing is done by 34% of the households with most of the fish harvested being sold at the landing beaches and nearby markets. Livestock kept include cattle, goat, sheep, donkey, local chicken and other farm animals. Local chicken is the preferred animal reared by 86% of the sampled households because of its low investment capital demand; cattle is kept by 77%, goats (56%), sheep (54%), and donkey (2%). These livestock are kept for different reasons: cattle, sheep and goats are kept as store of wealth, mode of transport and for subsistence.

Forest and non-forest consumptive values are also common. Wood is used as firewood, charcoal and in construction. Others are medicinal plants, indigenous foods, game meat, earth for construction, grass for thatching and fodder, honey, insects and so on. Wood for firewood is the common un-priced benefit derived from the wetland with 85% of households using it as a source of energy. Although firewood is a renewable resource, its demand in the wetland has outpaced ability to regenerate. Papyrus is predominantly harvested by adult females (21% of the sampled households); reeds by adult males (11%), and sand by male youths (6%). Harvesting is done throughout the year and products are sold locally on weekly market days. However, the price of papyrus slumps whenever other resources decline, especially due to drought and the whole community resorts to papyrus harvesting, thus flooding the market. This exposes the local people to economic hardships and hence there is a need to diversify the sources of livelihood.

Nyando Wetland is also important for grazing during droughts and the dry seasons when the water levels have receded. It provides fodder for the livestock. Fodder is consumed by cattle, goat, sheep and donkey. Rice straws were used as proxy of fodder consumption by the livestock. The average

domestic water use per person was found to be 56 litres per day. Livestock water use depends on the number of livestock kept. Most animals consumed water from the wetlands *ad libitum*. The wetland also provides services like recreation sites, clean air, water quality, transport, education among others.

4.4.3 Value of consumptive goods and services

Table 4.2 gives a summary of the value of consumptive wetland goods and services provided by Nyando Wetland. The aggregated value per annum of consumptive wetland goods and resources was obtained by summing up the value of crops, livestock, water, fish, forest and non-forest products and un-priced benefits. The aggregated economic value of consumptive wetlands resources was estimated to be Ksh 143.4 Billion (US$ 1.5 Billion) or Ksh 2.4 Million/acre/year (US$ 25,000/acre/year).

Consumptive Goods and Services		**VALUE (Ksh)**
Crops		2,402,397,584.00
Livestock	Fodder	2,493,744,666.00
	Feeds	320,281,325.00
Water	Domestic	1,365,356,287.00
	Livestock	1,065,259,727.00
Fish		132,241,529,240.00
Forest and non-forest products		3,449,450,739.00
Unpriced benefits		37,787,012.00
TOTAL (Ksh)		**143,375,806,580.00**
TOTAL (US$)		1,509,219,017.00

Table 4.2: ***Value of consumptive goods and services in Nyando Wetland***
Source: *Onyango (2012)*

To account for time preference in valuation and cost-benefit studies, economists use a *discount rate* to weight benefits and costs occurring in different time periods, similar to the payment of interest on bank accounts. Society as a whole would have a lower rate of discount in its collective attitude than the observed market rates, which could reflect individuals' myopia (Dasgupta and Pearce, 1972). A low discount rate encourages investing a high proportion of current income at a present time to provide for the future. The analysis in table 4.3 shows that at 2% discount rate, the infinite present economic value of wetland consumptive resource is about Ksh 7.2 Trillion (US$ 75.5Billion). However, it reduces the welfare of the current generation. On the other hand, a high discount rate may also be favoured since it discourages investment (and by implication environmental damage) in the present. At 15% discount rate, the infinite present economic value of Nyando Wetland consumptive resources is about Ksh. 956 Billion (US$ 10 Billion). However, it is unfair for the future generations.

According to Clark (1973), the high discount (or interest) rates used by individuals to assure short-term profit maximization may cause overexploitation and exhaustion of species characterized by slow growth rates. The short lifespan of humans will result in management practices which favour current values and incomes, even if such practices have a potential to cause high social costs to future generations. Most of consumptive wetland goods and services in Nyando Wetland are public goods and services hence common property resources. It can therefore be argued that the discount rate to be used by the government for public policy decisions on common property resources (like wetlands) should be significantly lower than the rate used by individuals for private investment decisions. The government should have greater interest in the future than individuals currently in the market because continued social existence, stability and harmony are public goods for which the government is responsible, and for which current individuals may not be willing to fully pay (Arrow, 1976). The present value of consumptive resources of Nyando Wetland is therefore discounted at 2% and is about Ksh 7.2 Trillion (US$ 75.5 Billion). This is because nature has an intrinsic value, that it has long-term life support system, hence reason enough to protect it.

Discount Rate (%)	Present Value					
	Period (Yrs)					
	0	**5**	**10**	**25**	**50**	**Infinite Period**
2	143,375,806,580	225,341,747,331	174,775,108,220	235,279,698,597	385,910,320,990	7,168,790,329,000
3	143,375,806,580	166,215,572,567	192,685,613,978	300,200,263,817	628,545,198,466	4,779,193,552,667
5	143,375,806,580	182,990,541,937	233,544,851,338	485,527,831,402	1,644,147,724,375	2,867,516,131,600
10	143,375,806,580	230,908,170,255	371,916,842,268	1,553,433,851,552	16,831,014,972,652	1,433,758,065,800
15	143,375,806,580	288,380,362,322	580,041,163,100	4,719,788,176,807	155,370,259,516,418	955,838,710,533

Table 4.3: *Present values of Nyando Wetland goods and services*

Source: *Onyango (2012)*

4.4.4 Determinants of consumptive wetland resources value

The results in Table 4.4 show that sex of the household head, age of the household head, household size and education level of the household head significantly determine the WTP for wetland conservation in the in Nyando Wetland.

LnWTPmax	Co-efficient	Std. Err.	t	P>t	[95% Conf. Interval]	
Sex	-.6321143**	.2452431	-2.57	0.036	-1.233342	-.087265
Age	-.8158359**	.4408312	-1.85	0.053	-1.683784	.0521117
LnHHSize	-.2645238**	.2821517	-0.94	0.043	-.8324757	.3254305
LnFarmsize	.0523241	.1883486	0.28	0.722	-.3169342	.42115
Duration of stay	-.8013043	.3587421	-2.23	0.225	-1.519994	-.1026223
Education level	1.042552*	.3959569	2.63	0.013	.1979915	1.875315
Monthly Income	.3650071	..2832979	1.29	0.199	-.9227892	.192775
Constant	7.110371*	1.866664	3.86	0.000	3.535117	10.88562
Sigma	2.137479	.1071311			1.92655 2	.348408
n	216					
LR chi^2 (7)	17.16					
Prob> chi^2	0.0163					
Log likelihood	-523.3843					
Pseudo R^2	0.0161					

Table 4.4 *Tobit Regression summary of Determinants of Consumptive Value of Wetland Resources in Nyando.* **Source:** *Onyango (2012)* **Note:** ** indicates significant level at 1% and ** at 5%*

The sex result indicates that women are willing to pay more than men. This is because women are primary users and managers of forests in rural communities in developing countries (Agrawal, 2001). Government's existing concerns in education and women empowerment can bring positive changes in the future. Women are more dependent on wetland products than men; a finding being attributed to the fact that in rural areas, women are more directly involved in household food provision and interact alot more with the environment on a daily basis. For women, wetland ecosystems and the goods they yield sustain rural livelihoods.

Harvesting wetland goods and services is a physically demanding activity that involves walking long distances. The relationship between age and harvesting can also be described as an inverted U, increasing with age and later on declines. Older people may not be able to contribute much due to many reasons like lesser control over a family's budget, dependence on children after their retirements, more expenditure on health and strong preference for alternative use of wetlands like agriculture and so on. The younger generation may be willing to pay for the conservation scheme because of higher anticipation of better settlement in future.

Assuming that income is constant, an increase in household size reduces the ability of households to meet the subsistence needs, especially where land pressure is high and may subsequently lead to higher amounts of natural resources harvested. Thus, if a family has more members, it needs extra income to support extra subsistence requirements, hence lower WP to conserve the wetlands. Larger households may see wetland conservation as a denial of the little income being obtained from it. The larger households extract more resources hence more wetland dependency resulting to lesser WTP for wetlands conservation as the household needs more of the wetland resources to survive. The larger the household size, the less amount of money the farmer can invest in wetland conservation since a higher proportion of his income will be spent on consumption rather than saving for investment.

Education level is an important determinant of WTP as conservation attitude is affected by education level. The results show that the willingness to pay rises with increase in formal education. It suggests indifference to conservation by the relatively educated since they are more likely to have alternative sources of income and, therefore, the conservation of the wetlands matter more to them as a source of livelihoods.

When income is high, it is likely that a rational consumer will spend more on goods and services that give satisfaction. In other words, wetlands conservation may provide satisfaction to a household head with high income. This may also imply that the value they attach to the wetland goes beyond the consumptive value and probably involves other values, such as option and existence value.

4.5 Conclusion and Recommendations

4.5.1 Conclusion

As has been noted above, Nyando Wetland is endowed with several ecological attributes and provide many goods and services. Communities living within Nyando Wetland derive a number of products from natural wetlands for their livelihoods, mainly through farming, fishing, trading activities, bee keeping, brick making, harvesting of macrophytes, mat making, sand/stone mining, pottery, among others. Therefore the value of the wetland covers many domains. The households residing within Nyando Wetland derive considerable value from wetland goods and services in the form of crop production, livestock production, fishing, water, natural resources and un-priced benefits. It is hoped that this consumptive use value will inform management decisions and justify investments of financial resources to promote a more sustainable use of the Nyando Wetland. Despite pro-conservation attitudes of the Nyando Wetland residents, resource use is driven by motivation to meet household subsistence level. The infinite value of Ksh 7.2 Trillion (US$ 1.5 Trillion) need to be conserved, hence appropriate wetland management policy needs to be formulated and developed as a matter of priority.

4.5.2 Recommendations

Increased utilization and conversion of wetlands for farming is bound to result in serious environmental problems in the region. To achieve sustainable agriculture in a fragile ecosystem such as a wetland, long-term solutions to problems must be sought. For instance, it requires development of management practices that minimize the alteration of the hydrological function of the ecosystem.

i. The ability to evaluate wetland resources is vital at the national level, as well as at the farming community level. There is need to involve communities in the establishment of indices and standards for the evaluation of the ecosystems. This should be preceded by aggressive awareness campaigns, using the various mass media available.
ii. Finally, policies must be harmonized to avoid contradictions, and law enforcement ought to be strengthened. In addition, avenues for alternative sources of livelihoods must be created to ensure socioeconomic benefits and environmental conservation.

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CHAPTER 5

Threats to the Nyando Wetland

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Summary

All over the world, wetlands are hot spots of biodiversity and as a result they supply a plethora of goods and services to people living within them and in their adjoining areas. As a consequence, increased human pressure pose the greatest challenge to the well-being of wetlands, with Climate Change and nutrient pollution becoming increasingly important. Globally, the processes that impact on wetlands fall into five main categories that include the loss of wetland area, changes to the water regime, changes in water quality, overexploitation of wetland resources and introductions of alien species. Overall, the underlying threat to wetlands is lack of recognition of the importance of wetlands and the roles they play in national economies and indigenous peoples' livelihoods. Wetlands form a significant component of the land area; covering around 6% of the land area. However, many of the wetlands have been degraded because of a combination of socioeconomic factors and lack of awareness compounded by lack of frameworks and guidelines for wetland conservation and management. In the Nyando Wetland, major threats include encroachment by people and animals for agriculture, settlement and grazing, overharvesting of papyrus, droughts, fire (burning), soil erosion in the uplands that cause siltation in the wetlands, invasion by alien species such as Mimosa pudica and water hyacinth Eichornia crassipes, and resource use conflicts. These threats in the Nyando Wetland are a result of many past and ongoing human activities, both within and outside the wetland area, especially in the upper catchments of streams and rivers draining into the wetland. Many activities are also planned in the basins of rivers that supply water into the wetland, including the Magwagwa Dam on the Sondu-Miriu River for the supply of water for irrigation and a dam planned for on the Nyando River to control floods. These projects are a threat to the well being of the wetland and should be planned while taking care of the negative impacts they may pose to the wetland and other fragile ecosystems in the region.

5.0 Introduction

Increasing human population, coupled with the growing need for increased food production to meet the high demand, have put tremendous pressure on wetlands around the world (IUCN 1999; O'Conell 2003). At the global level, human activities pose the greatest threat to the well-being of wetlands, resulting in either their loss or degradation (Bjerstedt, 2011). Wetland loss is defined as "the loss of wetland area due to conversion of wetlands to non-wetland areas as a result of human activity", whereas wetland degradation is "the impairment of wetland functions as a result of human activities (Moser *et al*., 1996). Other threats to wetlands are natural activities like mass wasting, sea level rise, droughts, hurricanes and overgrazing by wildlife. However, all these natural processes and activities are closely linked to man's activities on the planet. These threats have induced changes that have eroded the ecological and socioeconomic values and services derived from wetlands. Overall, the underlying threat remains the lack of recognition of the importance of wetlands and the roles they play in national economies and indigenous peoples' livelihoods.

The major causes of wetland loss and degradation in the world can be divided into three categories:

1. **Biological alterations-** this includes alteration of the biological communities by removal of wetland flora and fauna and introduction of alien/non-native species
2. **Chemical alterations-** this occurs through the release of pollutants and toxic chemicals into wetlands resulting in change in nutrient balance
3. **Physical degradation-** this includes infilling, draining, dredging, stream channelization, peat mining, development, grazing, waste dumping and damming.

5.1 Damaging processes and activities

Adverse effects on wetlands are as a result of processes that are either natural occurrences or events that are directly or indirectly related to human activities or the absence of such activities (IUCN, 1999). The main processes that impact on wetlands can be placed into five main categories: loss of wetland area, changes to the water regime, changes in water quality, overexploitation of wetland products and introductions of alien species (IWRB, 1993). Such processes cause damage to wetlands where, individually or cumulatively, they lead to the modification of the ecological conditions essential for the existence of a particular habitat type or the survival of a wetland-dependent species.

5.2.1 Loss of wetland area

In many parts of the world, wetlands are drained and reclaimed for development activities, or to create room for forestry and farming or as part of public health and sanitation initiatives (IUCN, 1999; Keddy, 2000). Once developed, wetlands are permanently destroyed and lose their potential to be rehabilitated. In many developing countries, wetland reclamation is often done illegally in areas where population growth causes a shortage of land, especially in and around cities and towns (Ntabirweki, 1998). Ways through which wetland areas are lost include:

- dumping of wastes that claim land and fill waterlogged areas, especially in towns and settlements that lack proper waste management practices
- development activities that cause infilling or draining of wetlands e.g., building of roads, ports and houses and farming
- alterations to catchment hydrology, which impact the quantity and quality of water in wetlands e.g., interbasin water transfers, excessive water abstractions and damming
- excavation or cementing of beds and banks of streams and rivers, in which case groundwater recharge is hampered, thus affecting riparian vegetation
- burning of wetland vegetation, thereby changing its hydrology and composition of biological communities

5.2.2 Changes in the water regime

Hydrological and other wetland functions are closely linked to the maintenance of surface and groundwater flows and sediment flows at their natural level, a characteristic that is often seasonally variable (IUCN, 1999). Infiltration of surface water helps to replenish groundwater supplies and eventually discharge as springs and exfiltrate into surface waters. However, these exchanges and flow patterns can be significantly altered by human interventions e.g., construction of drainage systems, surface and groundwater abstractions, diversions of water flowing into wetlands and siltation.

5.2.3 Changes in water quality

The quality of water flowing into wetlands may be impaired indirectly by alterations to the water regime or directly by pollutants. Changes in water quality in wetlands can occur as a result of:

- discharge of domestic sewage, industrial wastewaters and forestry and agriculture operations
- thermal pollution caused by the operation of thermoelectric power stations, nuclear reactors and industrial operations or the construction of large reservoirs and dams along watercourses, which slow normal water flow
- atmospheric pollution from industrial activities that cause acid rain
- energy generation and transport that can damage upland wetlands and dependent flora and fauna
- recreational activities that use toxic substances or pollutants e.g. the use of lead pellets in waterfowl hunting, application of herbicides and fertilizers on golfing lawns

These land-based activities generate pollutant substances and energy that enter wetlands by runoff from land, rivers and discharge outlets as well as through the atmosphere. Whereas it is possible to control point source pollution, the control of diffuse/nonpoint source pollution presents greater technical and legal difficulties. Activities that generate diffuse pollution to surface and ground water include underground and surface mining operations, timber production and agricultural operations involving the application of pesticides, herbicides and fertilisers, as well as run-off from roads and human settlements. The effects of such contamination are cumulative and can adversely affect wetlands far from the area of application or impact.

5.2.4 Overexploitation of wetland resources

Wetlands are one of the most productive areas on the planet, a characteristic that attracts many different groups of users and stakeholders who seek access to and use of their resources. Pressure on wetland resources has increased in recent years with the expansion of human settlements and farmlands. This has often led to competition between or among mutually exclusive wetland uses. Overexploitation in wetlands may take several different forms but often involves unsustainable harvesting of wetland resources. This includes plant harvesting, overgrazing, overfishing and excess hunting pressure. Overexploitation also involves indirect taking of non-targeted species, for instance when a whole wetland is burnt to create room for fishing, as is the case in papyrus wetlands in East Africa (Morrison *et al*., 2012). Such acts can deplete essential food resources for non-targeted species that depend on wetlands and disrupt whole ecosystems. The cumulative effects of extractive and other activities often threaten wetland biodiversity. Overexploitation can also be non-consumptive in nature, where it takes the form of species or ecosystem disturbance. The presence of boats, recreational activities and even intrusive bird watchers and photographers may impact on other wetland products; causing, for example, migratory waterfowl to abandon a site. They can also drive away some animals that cannot withstand disturbance (IUCN, 1999).

5.2.5 Introduction and invasion of alien species

Over the centuries, there have been several deliberate and accidental introductions of alien species to many wetland areas around the world. Where it is deliberate, the intent is usually to provide new or additional food resources for human consumption, to increase target species available for hunting or angling for recreational or aesthetic purposes or as a form of biological control to get rid of unwanted

species (IUCN, 1999). More recently, pathways for accidental introductions have multiplied as transport links have expanded around the world. Alien species may enter the aquatic environment in a number of ways (discharge of 'foreign' ballast water from ships, releases from aquaculture facilities, engineering projects involving interbasin transfers of water and simple escapes).

There are many documented cases in which the deliberate or accidental introduction of alien species has seriously disturbed the ecological balance of the recipient ecosystem. Without the usual biological controls on their populations, alien species may become invasive and endanger or wipe out indigenous species through predation, competition for the same resource and the spread of disease. Certain introductions of fish species for food purposes have had dramatic ecological and economic impacts on wetlands, as in the well-known cases of the Nile Perch in Lake Victoria and trout in the lakes of British Columbia. Many introductions have also been as a result of accidental escapes from aquaculture facilities, e.g., the common carp in Lake Naivasha, Kenya.

Alien species can also cause problems for wetland habitats and for genetic diversity. The Loussiana red crayfish *Procambarus clarkii* that was introduced into Lake Naivasha has been a major agent for the control of aquatic weeds, resulting in a change in the functioning of the lake. Invasive plants have also threatened native wetland vegetation and plant diversity. Many Italian wetlands have been colonised by the climbing *Syccios angulatus* that covers banks and even trees, as well as the *Amorpha fruticosa* that competes with native trees (IUCN, 1999). Many Asian wetlands are colonised by water hyacinth *Eichhornia crassipes*. The same weed is a major problem in Lake Victoria where it has caused high economic losses because of impairing transportation across the lake and entanglement of fishing gear. The weed has already cost millions of dollars to eliminate without meaningful success.

Box 5.1: Drivers and underlying causes of threats to wetland ecosystems

Several reviews have identified a number of pressures facing tropical wetlands (Finlayson & Moser 1992; Whigham *et al*. 1993; Balirwa, 1995; Kairu, 2001; Mitsch, 2010). It has been noted that in order to prevent further loss and degradation of wetlands, it is necessary to address both their underlying and apparent causes (Finlayson & Rea 1999). The Millenium Ecosystem Assessment (2005) defines a driver as any natural or human induced factor that directly or indirectly causes a change in an ecosystem. The primary indirect drivers of degradation and loss of inland wetlands have been population growth and increasing economic development. The primary direct drivers of degradation and loss include infrastructure development, land conversion, water withdrawal, pollution, overharvesting and overexploitation, and the introduction of invasive alien species (MEA, 2005). For the Lake Victoria basin and the Nyando Wetland, the following proximate and underlying causes have been identified (Odada *et al*., 2009):

Proximate causes

- *Infrastructure expansion*- transport, settlements, public services, private companies
- *Agricultural expansion*- permanent cultivation, land conversion
- *Over-extraction of wetland resources*- harvesting of wetland products for domestic and commercial use, water withdrawals
- *Introduction of alien species*
- *Climate change and variability*- rainfall distribution and variation, temperature rise, water level decline and desiccation
- *Other factors* - predisposing environmental factors (water levels, soil type, topography), bio-physical drivers (triggers e.g., fires and droughts), social trigger events (abrupt displacements, economic shocks, abrupt policy shifts, war)

Underlying causes

- *Demography*- population growth, urbanization, migration and distribution, birth and death rates (health, fertility, households), socio-economics (education and culture)
- *Socio-cultural forces*- land-based cultural practices and values, inheritance arrangements, changing land distribution and wealth, wetland-use conflicts, traditional livelihood strategy, gender relationships, fluidity of land tenure systems
- *Economic changes* - local, regional and international trade changes, growing demand for individual wetland products / ecosystems products, emergence of new economic sectors / livelihoods
- *Policies and governance*- formal policies (e.g., wetland management policy), policy climate (corruption, mismanagement), property rights, conservation policies, international environmental protocol and agreements
- *Regional characteristics*- relative wealth and ecosystems asset value and availability, land availability, transboundary ecosystems factors, regional governance
- *Technological change* - irrigation development, research, science and technology for land use developments

5.3 Threats to wetlands in Kenya

Some parts of Kenya still have a significant number of wetlands that have not been overly impacted by man's activities. However, many wetlands are experiencing immense pressure as a result of human activities within the wetlands themselves or in the catchment areas of the streams and rivers that drain into the wetlands (Kairu, 2001; Osumba *et al*., 2010; Morrison and Harper, 2009; Morrison *et al*., 2012). These activities include:

- drainage for agriculture, grazing, forestry and settlement
- unsustainable extraction of wetland resources, plants and animals (Plate 5.1)
- dumping of wastes, including infilling (Plate 5.2)
- excessive water abstractions
- nutrient enrichment and wastewater disposal
- introduction of alien animal and invasive plant species
- burning
- siltation

These activities are accentuated by land use and land cover changes, recession of lake levels mainly due to water over-abstraction and prolonged droughts, Climate Change that is causing terrestrialisation of wetland areas and excessive flooding in others. Others include weak enforcement of management systems and lack of clear policy framework to guide sustainable wetland management. Moreover, these negative influences are expected to increase as human populations grow, unless deliberate steps are taken to halt encroachment and conserve and restore degraded areas.

For wetlands to thrive, a reliable source of good quality water is a prerequisite, even if seasonally, to support aquatic-dependent animal and plant species. Encroachment of forests that are the major sources of streams and rivers that feed major wetlands in Kenya is a major threat to the existence of

freshwater wetlands. For instance, degradation of the Mau Forest Complex, Mount Kenya, Cherengani Hills, Aberdares and Mount Elgon where many streams and rivers in Kenya originate from has caused siltation and reduced water levels in downstream wetlands. Construction of dikes along the lower reaches of rivers in the Lake Victoria Basin such the Nzoia and Nyando has limited flooding of large areas during the rainy season. This has altered the water regime, threatening the survival of water-dependent plants and encouraging the spread of terrestrial species. Equally, the damming of the Tana, Athi and Sondu-Miriu Rivers has blocked upstream movement of migratory fish species, a situation that is likely to increase with the proposed damming of many big rivers to help abate flooding, supply water for irrigation and domestic use and boost hydropower production.

Plate 5.1: *Bunches of cut papyrus lying in the Nyando Wetland*

Other threats to wetlands in Kenya include changes in water quality due to the effects of municipal and industrial effluents, agricultural nutrients and pesticides, siltation from agricultural areas, unpaved roads and footpaths, and introduction of alien species of flora and fauna. The introduction of the Nile Perch (*Lates niloticus)* and Nile Tilapia (*Oreochromis niloticus)* to Lake Victoria and the subsequent extinction of a large number of endemic cichlids is one of the greatest ecological catastrophes in the region. Similarly, the introduction of the water hyacinth, *Eichhornia crassipies* and water lettuce (*Pistia stratiotes)* into Lakes Victoria and Naivasha continue to threaten their functioning and economic potential.

5.4 Threats to Nyando Wetland

Nyando Wetland is faced with several challenges arising from damaging processes and human activities within the wetland and upstream on the catchments of streams and rivers that drain into the wetland (Kairu *et al*., 2001; Osumba *et al*., 2010; Morrison *et al*., 2012). Many of the impacts and threats on wetlands at the global and national levels also affect the well-being of the Nyando Wetland. However, other threats are more localized and their negative influences are exacerbated by the climatic and socioeconomic conditions of the residents living within and in the adjoining areas of the Nyando Wetland, notably the high poverty levels and the semi-arid conditions. Major threats include encroachment for grazing and agriculture, overharvesting of papyrus, droughts, fire (burning), soil erosion which cause siltation when carried by flood water into the wetlands, invasion by alien species such as water hyacinth *Eichornia crassipes* (Osumba *et al*., 2010; Morrison *et al*., 2012) and *Mimosa pudica*. Some of these threats and the processes and activities that generate them are discussed in detail below.

5.4.1 Water pollution

In the Nyando River Basin, water pollution derives from both point and non-point sources. The agro-based industries in the upper catchment of the basin contribute significant nutrient and organic loads into the wetland (Raburu, 2003). Similarly, herbicides, pesticide residues and fertilizers used in the large scale sugarcane farming in the middle reaches of the river basin and rice and horticultural farming in the lower catchment contribute a significant proportion of pollutant loads (Kairu, 2001). Agro-based factories such as Muhoroni and Chemelil Sugar companies discharge low quality effluents into the wetlands through the Nyando River. Municipal wastes from Chemelil, Muhoroni and Ahero townships also find their way into the wetland through the Nyando River. In addition, ground water contamination by nutrients has taken place in the inhabited sections of the wetland as a result of human and animal wastes.

Plate 5.2: *Disposal of industrial and human waste in the Nyando Wetland, resulting in pollution*

5.4.2 Soil erosion and siltation caused by flooding

The floodplains of Nyando River Basin are characterized by extensive wetland areas with very low gradient (<2 %). These areas of flat land are vulnerable to floodwaters when it rains. The major rivers (Nyando and Awach) have their catchment areas of Nandi Hills with high rainfall. Rivers have a strong influence on flooding in the wetlands. Poor farming practices and deforestation on the upper Nyando River catchment area has led to heavy siltation in the rivers and the silt is eventually deposited in the wetland. The flood situation often occurs during the long rainy season with a peak in April-May. Other streams like Asawo, Obuso, Ombeyi, Oroba, Miriu, Kibos and Nyatini cause flooding of the Kano Plains during the same period. Direct heavy rains and poorly drained soils in the plains worsen the situation and create seasonal calamity to the riparian communities. The flooding situation is also worsened by back-flows of water from the lake into parts of Nyando and Kadibo Divisions which border the wetland.

While flooding is a blessing to wetland plants and animals because of their loads of fertile soils and nutrients, their negative effects in the Nyando Wetland are a result of excessive siltation that is causing loss of wetland area. To the local communities, flooding, which is a common and seasonally predictable phenomenon, is a major cause of food insecurity and poverty because it destroys crops, washes away houses and shrinks grazing and farming areas. Studies by VIRED in 2002 ranked floods as the community's number one priority problem in the project area. The often-seasonal floods make the communities unsettled by causing displacement, loss of property, environmental and human health, waterlogging, inaccessibility and negative effects on education. During the rainy seasons, crop failure is a common occurrence as a result of flooding while droughts following the rains also cause crop failure.

5.4.3 High incidence of poverty

High dependency ratio is one of the manifestations of poverty in the Nyando River Basin. For instance, about 42% of the population is below 15 years and 3.4% is aged 65 years and above (GoK, 2002a). This puts more pressure on the human resource base and exacerbates poverty. The Welfare Monitoring Surveys of 1994 and 1997 indicated that poverty levels have been increasing in the Nyando Wetland Region over time (GoK, 2002). With limited sources of livelihoods, many residents of Nyando Wetland rely entirely on the wetland and papyrus in particular for their livelihoods. It has been estimated that over 60% of community members living in close proximity to the wetland generate over half of their total income from papyrus alone, and 40% have no other means of livelihood support whatsoever (Morrison *et al*., 2012). This poverty-environment trap has been identified as the major cause of ecosystems degradation in the Lake Victoria Basin.

5.4.4 Burning of wetlands

During the dry season, much of the papyrus are destroyed by burning for various reasons (Plate 5.3) , including clearing for agricultural development, keeping birds away from rice paddies, opening up of lungfish habitats for catches and hunting of wildlife, creating space for beach development and creating room for grazing (Raburu, 2005). In the burnt-out and grazed areas, women fetch dry papyrus rhizomes and culms as fuelwood. The burning causes degradation of wetland vegetation, resulting in the loss of biodiversity, fish breeding grounds, bird habitats and livelihoods.

Plate 5.3: *Papyrus and other plants set on fire to allow human encroachment*

5.4.5 Persistent and prolonged drought

Prolonged drought in the wetland leads to food and water shortages (GoK, 2002a). When this happens, people invade the wetlands for farming and grazing. Drought also increases fire incidents in the wetland. Grazing is rampant in the wetland during dry spells when livestock pasture is scarce in upland areas. Large herds of livestock from the uplands are usually taken to the wetlands for grazing and watering during dry spells. This causes overgrazing, leading to severe environmental degradation e.g. destruction of wetland plants and soil erosion. The loss of wetland habitats due to droughts and grazing modifies wetland hydrology, plant succession and possibly the microclimate of the area.

5.4.6 Recession of Lake Victoria

The hydrology of Nyando Wetland is intrinsically linked to that of Lake Victoria (Khisa *et al*., 2012). This linkage has been assessed through piezometres and monitoring wells that measure the levels of groundwater in the wetland in relation to that in the lake. A key feature of this hydrological linkage is that the levels of both surface and groundwater in the wetland depends on wind direction over the lake. When the wind direction is towards the wetland, usually in the late evenings, a peak is observed in the piezometeric heads in the wetland and when the direction changes, the water level reduces. During the same period, back-flows from the lake inundate large areas of the wetland. However, lake recession has had a negative influence on the backflows. Groundwater recharge from the lake into the wetland is also reduced. This is a major threat to the wetland, especially if one factors in the effects of human activities such as farming and grazing that take advantage of lake recession (Obiero *et al*., 2012).

5.4.7 Wetland reclamation and encroachment

High human populations, increasing at an annual rate of around 3%, have been a major impetus for increased and intensified agricultural activities and higher woodfuel consumption rates. This has led to increased deforestation, soil erosion, soil and water contamination and reclamation of wetlands in the Lake Victoria Basin. Degradation of catchment areas, changes in the natural flow regimes of streams and rivers, droughts and siltation have all conspired to either degrade or destroy existing wetlands. Further, wetland reclamations have been done through rice farming that has expanded areas under irrigation into wetland areas (Bennun, 1996). The cultivated area under rice has also expanded due to the promotion of rain-fed rice by LBDA and the construction of a rice mill to process the increased rice output. Similarly, the establishment of sugarcane factories in the middle catchment of the Nyando River Basin and adjoining areas, namely Kibos, Muhoroni, Miwani and Chemelil, has expanded commercial sugarcane which has led to the loss of wetland areas in the basin. Further loss of wetland area is as a result of horticultural farming to meet the growing demand for food in towns and cities in the Lake Victoria Basin and beyond.

5.4.8 Overexploitation of wetland resources

Overexploitation of wetland resources is a major threat to the sustainability of the Nyando Wetland. Due to the use of destructive fishing techniques, degradation of the wetland environment and invasion by alien species, indigenous fish catches are declining. The current fishing practices involve clearing of the wetland to catch fish migrating upstream to spawn, Juvenile fish, especially *Clarias* spp., are also targeted for use as bait for the Nile Perch fishery in the lake. This has resulted in decreased recruitment among most migratory fish species that include *Schilbe mystus* (Sire), *Mormyus kanume*, *Clarias gariepinus (mumi)*, *Labeo victorianus* (Ningu), *Barbus altinialis* (fwani) among others.

The most over-exploited macrophytes within the Nyando Wetland is papyrus (*Cyperus papyrus* L). They are harvested for handicrafts-making, fuelwood and construction of shelters. Currently, the situation has been worsened by harvesting of its rhizomes for firewood, thereby reducing its regeneration potential. *Phragmites australis* (Odundu) which is mainly used for making fish traps, boats and rafts is also targeted. Other wetland macrophytes threatened by overexploitation include *Sesbania sesban* (Asao) and *Pycreus nitidus* (*Se*) mostly used as building materials.

5.4.9 Conflicts

Frequent alterations in the river course and water levels result into frequent human-human and human-wildlife conflicts in the wetland. The migration of the river mouth between Nyakach and Kano communities bordering the wetland leads to boundary disputes for a long time. Apart from this, the destruction of papyrus swamps displaces wildlife such as the hippopotamus (hippo), causing human-wildlife conflicts. Further, burning of wetland habitats causes migration of birds into rice paddies in pursuit of new sanctuaries and feeding grounds.

Apart from the human-human and human-wildlife conflicts arising from the use of wetland resources, other conflicts arise because some wetland uses are in conflict with protection priorities. These uses include:

- Harvesting of immature fish for food and bait for Nile Perch fishery
- Papyrus harvesting for mat making and other handicrafts
- Sand harvesting for building construction
- Water for livestock, domestic use and irrigation
- Wildlife hunting for food and sale.

5.4.10 Food insecurity

Occasioned by the ever increasing human population and unpredictable climatic variations, food insecurity in the region has made riparian communities to opt for wetland farming, especially during dry season, leading to destruction of wetland habitats and loss of biodiversity. Conflicts have occured within the wetland as people scramble for pieces of terrestrialised land to grow rice, sugarcane and other horticultural crops.

5.4.11 Climate Change

Current and future changes in water availability arising from Climate Change will have the greatest influence on the functioning of freshwater wetlands. At the local level, the extent of impact will depend on the interaction between natural conditions and human factors such as changes in land use, land cover, and the demand for and use of water (see chapter 7).

5.5 Past, on-going or planned activities that are a threat to Nyando Wetland

Degradation and loss of large areas of the Nyando Wetland is as a result of many past and ongoing human activities both within and outside the wetland areas, especially in the upper catchments of streams and rivers draining into the wetland. Many more activities are planned for the future (Table 5.1). It is thus necessary to examine these activities in terms of their potential to either degrade the wetland so that appropriate intervention can be put in place to minimize the would-be negative effects to wetland ecological integrity.

Past, present and proposed activities	Experienced and likely effects on wetlands
Expansion of existing rice irrigation schemes	-Loss of wetland area -Source of nutrients and herbicides -Loss of biodiversity -Water quality degradation -Increased groundwater recharge -Increased evapotranspiration water loss
Magwagwa-Sondu-Miriu Hydropower Project/ inter-basin water transfer	-Pollution e.g. air and water -Displacement of people -Vegetation destruction -Inadequate sanitary facilities to cater for increased population -Biodiversity loss -Habitat destruction e.g., birds and fish
Farming within the wetlands	-Pollution, soil erosion, siltation, -Increased water loss, -Low water table, -Destruction of wetland macrophytes, -Destruction of catchment's areas, -Human –wildlife conflicts, -Human- human conflicts, -Modification of natural habitat
Human settlement	-Loss of wetland area -Habitat and biodiversity loss -Degradation of water quality -Waste disposal -Change in water flow regime
Dam Construction on the Nyando River	Limiting sediment supply to the wetlands -Prevention of upstream migration of fish reducing recruitment in the wetlands -Limiting water input to the wetland during seasonal flooding -Wetland shrinkage through drying -Decline in abundance and diversity of biotic communities -Increased encroachment of wetlands- grazing and farming

Table 5.1: *Past, on-going and planned activities and interventions within the Nyando Wetland and their effects on the structure and functioning of the wetland*

5.6 Conclusion

The threats to Nyando Wetland have considerable implications on the protection of biodiversity and well-being of communities that depend on them for their livelihoods. Because of their many values and uses, the future of the wetland depends on strong political will and participatory approaches to protect them. Efforts should be focused on addressing the underlying causes of threats like market and policy failures and high population growth rates that make communities vulnerable and over-reliant on natural resources. Although the overall goal to protect wetlands should continue to be conservation of endangered and fragile sites, greater efforts should be focused on wetlands outside protected areas, which will benefit greatly from co-management strategies incorporating all stakeholders.

The Government of Kenya has recently developed a national wetlands policy for the conservation of its wetland resources which has not been ratified and enacted into law. This policy should be urgently ratified to conform to the recommendations of the Ramsar Convention to which Kenya is a signatory. This convention offers a framework to protect wetlands within protected and those outside of protected areas.

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CHAPTER 6

Experiences from Community Participation in Managing Nyando Wetland

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Summary

The greatest challenge in the conservation and management of wetland ecosystems in Kenya is the fact that most of them are found in unprotected areas and the lack of a national wetland policy. Community based approaches therefore become the most viable option. This chapter describes experiences gained in community based management of Nyando Wetland, an intervention initiated by two local NGOs (Kenya Disaster Concern and VIRED International) and the Nyando Wetland Community and funded by UNDP-Kenya. The principle of co-management of natural resources on which the intervention was based is outlined with some examples of other initiatives carried out by other institutions in Kenya. The objectives of this project are given with an emphasis on its relevance to Kenya's Vision 2030, the MDG goals and UNDP, the funding agency. The overall objective however was the rehabilitation, restoration and conservation of the degraded Nyando Wetland. The chapter explores in greater detail the approaches used in achieving the project objectives. Activities were strategically planned on a Quaterly and Annual basis starting with community mobilization, awareness creation, capacity building to catalyze full participation of the local communities. The use of alternative livelihood activities is highlighted as an incentive to the local communities, research was to enable the project team to make informed decisions and the formation of a coalition with multiple partners. The chapter ends with approaches to ensure sustainability of the initiated activities. As a pioneering initiative, experiences gained are invaluable.

6.0 Introduction

Over the years, top-down approaches in natural resource management have been criticized for being non-inclusive and insensitive to the very communities that interact directly and depend on the natural resources. Subsequently, attempts to find new solutions to problems resulting from top-down approaches to wetland resource conservation and management has gained momentum as a means towards addressing inclusivity and reduce marginalization, particularly of vulnerable segments of the society, the wetland poor. In addition, the involvement and active participation of local communities have been identified as one of the keys to integrating the diverse perspectives of the local communities. This is because, in areas where indigenous and traditional peoples live and have done so for many years, the authority for resource and ecosystem management must be devolved as much as possible to the local levels to exploit the rich indigenous knowledge.

This programme was designed to respond to Kenya's Vision 2030 which is anchored on three key pillars of development, aimed at turning the country into a middle income earner economy by 2030: social, political and economic. The centrality of sustainable environmental conservation, as envisioned in the environmental conservation, is key to all the strategies in the Vision 2030 and the MDGs' numbers 1, 3 and 7, which are focused on poverty and hunger eradication, promotion of gender equality and empowerment and ensuring environmental sustainability. The UNDAF/ Kenya C-PAP Outputs 3.1 and 3.2—which target *"equitable livelihood opportunities and food security for vulnerable groups and enhancement of environmental management for economic growth with equitable access to energy services and response to Climate Change"* are focused on addressing these MDG goals and some tenets of the Vision 2030.

This chapter presents experiences gained in a community based wetland conservation initiative in the Nyando Wetland. It attempts to demonstrate how empowerment of local communities can provide a paradigm shift from the top-down approach to wetland resource management through creation of win-win-scenarios, where wetland conservation is in tandem with socioeconomic development. It shows the approaches used, challenges, lessons learned and the importance of involving local communities as pre-requisites for sustainable management of wetland resources. The project built on earlier wetland conservation initiatives by VIRED International and funded by the Royal Netherlands Embassy within the same basin which initiated the formation of a community based organization, the Nyando Wetland Community (NWC), registered in the year 2001 and comprising of over 12 registered community-based organizations. The activities of this pioneering initiative were short lived as it was interrupted when donor support was withdrawn due to diplomatic reasons. With support from UNDP-Kenya and partnering with two NGOs (Kenya Disaster Concern and VIRED International) the Nyando Wetland Resource Utility Optimization Project was reconceived, repositioned and helped to mobilize, organize and build capacity of local communities towards sustainable practices to conserve the fragile Nyando Wetland ecosystem.

6.1 Co-management of natural resources

Many resources are too complex to be governed effectively by a single agency. Governance of many kinds of fisheries, forests, grazing lands, watersheds, wildlife, protected areas and other resources, requires the joint action of multiple parties. Co-management, or "*the sharing of power and responsibility between the government and local resource users*", is an arrangement whereby such partnerships can come about. Co-management covers various partnership arrangements distinguished from one another by the "degrees of power-sharing and integration of local and centralized management systems" (Pomeroy and Berkes, 1997). Depending on these different levels of power devolution, five major generic types of co-management arrangements including instructive, consultative, cooperative, advisory, and informative can be adopted (Table 6.1).

Type	Description
Type A (+): Centralized management	❖ The state takes all decisions of policy and does not engage in dialogue with stakeholders dependent on the resources.
Type A: Instructive	❖ There is only minimal exchange of information between government and resource users. This type of co-management regime is only different from centralized management in the sense that the mechanisms exist for dialogue with users, but the process itself tends to be government informing users on the decisions which they plan to make.
Type B: Consultative	❖ Mechanisms exist for governments to consult with users but all decisions are taken by government.
Type C: Cooperative	❖ This type of co-management is where government and users cooperate together as equal partners in decision-making. For some authors this is the definition of co-management
Type D: Advisory	❖ Users advise government of decisions to be taken and government endorses these decisions.
Type E: Informative	❖ Government has delegated authority to make decisions to user groups who are responsible for informing government of these decisions.
Type E (+): Self-governance and self-management	❖ Communities or other stakeholders take decisions about resource management and do consult or inform government or state laws.

Table 6.1: *Typology of co-management arrangements.* **Source:** *Adapted from McKay (1993) and modified by Pomeroy (1995)*

Co-management has emerged as a new solution in many countries around the world for resolving resource conflicts and building partnerships in conservation and management between local actors and government authorities. The key objective of co-management arrangements is to shape an improved management regime that can preserve or amplify the resource base, especially for the benefit of those who depend on it for household income. As co-management has been recognized internationally to be a successful way of managing common pool resources, including wetlands (Claridge and O'Callaghan, 1997), an attempt was made to explore and apply the principle in the management of Nyando Wetland resources.

6.1.1 Co-management of wetland resources in Kenya

The status of today's wetlands, including those considered to be most pristine, are the result of complex interactions among physical, biological, and human forces over time. Virtually all of the earth's wetlands have been influenced and altered by patterns of --more or less intense --human use (Gawler, 2000). There is growing awareness that, in areas where indigenous and traditional peoples live, and have done so for hundreds of years, the authority for resource and ecosystem management must be devolved as much as possible to the local level (Claridge and O'Callaghan, 1997). According

to Addun and Muzzones (1997), successful wetland co-management arrangements generally share the following characteristics:

- there is recognition by government and other stakeholders of the benefits of integrating conservation and development;
- government agency staff support and facilitate the active involvement of the local people in resource management and conservation; all key parties (direct users of the resource and responsible government agencies) are willing and able to participate fully;
- there is appropriate sharing of resources, information, power and decision-making;
- each key party clearly understands the situation, and particularly the expectations, of the other key parties;
- there is trust between the parties;
- all parties to co-management play their assigned roles;
- all stakeholders, including government agencies, possess a sufficient level of organizational skills, financial resources and capability;
- root causes of problems are understood and agreed upon by relevant parties before actions are taken; and
- there are clear benefits (both short and long-term) for communities undertaking management responsibilities, and particularly for communities required to forego some resource use benefits.

The involvement of local communities in wetland management can contribute significantly to maintaining or restoring ecological integrity and improving community well-being. Through the principle of co-management, the local communities gain direct control over the management, utilization and benefits of wetland resources and are able to use them in a sustainable manner. The involvement of local communities in wetland management empowers them to take responsibility for decisions and actions to restore and sustain wetland wise use and productivity. Sometimes, however, it is difficult to ensure that the poor are heard and that their rights to decision-making are mainstreamed into the general wetland management planning processes. In this intervention, due attention was given to this from inception right through the implementation stages.

In Kenya, it is important to note that local communities have used, managed and conserved wetland resources over the centuries (Gichuki, 1997). Participation by local communities in environmental protection and conservation of wetlands has been achieved to some extent through the development of low technology, low cost solutions for wetland restoration, and based on local environmental knowledge (Moser *et al.*, 1999). A good example of this approach is the Saiwa wetlands project in Kenya, which was intentionally designed with a small budget to enhance the prospects for sustainability. The project sought to develop a land-use system that would simultaneously benefit the resident community and the wetlands, and the project's specific objectives were determined through analysis by the local communities, who identified soil conservation as their major strategic concern.

Another example of wetland co-management is the Lake Nakuru conservation and development project that applied a catchment approach to promote the health of the lake ecosystem. The project helped to initiate over 200 tree nurseries, with an annual turnover of 200,000 seedlings. Most of these nurseries are now independently motivated, self-reliant initiatives, and do not receive any external material support. In central Kenya, riparian communities initiated activities aimed at protecting Lake Ol Bolossat and its watershed. The communities around the lake have organized self-help groups that carry out activities aimed at generating income and also protecting the lake and its watershed (Gichuki, 1997). Through co-management, a management plan has now been developed for Lake Ol Bolossat. Other wetland conservation initiatives include wetlands like Lake Naivasha, Kipsaina and Kimana Wetlands. The approaches used in these initiatives are diverse, with varying levels of success.

All these examples illustrate the increasingly urgent need to develop and implement – before it is too late –comprehensive co-management strategies for the wise use of Nyando Wetland as source of livelihood. A key lesson from all of these case studies is that, for a strategy of co-management to be sustainable, it cannot be based solely on a concept developed by government or international experts, but must ensure that it incorporates the priorities and the wisdom of local people. Claridge and O'Callaghan (1997) noted that government agencies are often slow to embrace participatory wetland management, and their support for co-management may be only lip-service. They concluded that the development of techniques for increasing government acceptance of, and commitment to, co-management was one of the major challenges facing wetland conservation. The Nyando Wetland Resource Utility Optimization Project factored in such concerns in order to maximize on the contributions of both the government institutions and the local communities and set up the following as the project objectives:

- Improve livelihood standards of the inhabitants of the project area by alleviating poverty and improving food security;
- To identify and improve the capacity of the community to mitigate, respond and cope with the recurrent natural and environmental disasters in Nyando River Basin and reduce damages and losses caused by periodic flood related disasters;
- To improve education standards of inhabitants of the lower reaches of Nyando River Basin and co-joining selected schools in the wetland conservation activities;
- To complete the Management Plan of Nyando River Wetland and apply it to conserve the rich biological diversity in the wetland ecosystem;
- To stimulate and promote eco-tourism potentials within the Nyando and other wetland ecosystems in the LVB.

The scope of the Project covered the wetlands within the lower Nyando River Basin especially within Kisumu East, Nyakach and Nyando districts in Kisumu County.

6.2 Approaches used in the Nyando Wetland Restoration Project

Wetland conservation and management is a young discipline with no well established methodologies to be followed. Furthermore, wetland ecosystems are very diverse in their composition and functioning as these depend on the type of wetland and where they are found. Given that success stories of wetlands conservation and management particularly in East Africa are scanty, the project came up with approaches which could make adaptive management possible.

6.2.1 Community Mobilization

According to Addun and Muzones (1997), Community Based Natural Resource Management (CBNRM) is anchored on five basic principles which must be put in practice. These include: i) *Empowerment*: the actual transfer of economic and political power from the few to the impoverished many, and the operationalization of community management and control; ii) *Equity:* where communities as a whole rather than a few individuals benefit; iii) *Sustainability:* which ensures development through resource-extraction practices consider the limits of the resources - their carrying and assimilative capacity, intra-generational equity or equity between the present and future generations; iv) *Systems orientation:* where the community functions in the context of other communities and stakeholders, just as resources are ecologically linked to wider ecosystems; (v) *Gender-fair:* where women are involved in the control and management of community sources, and their practical and strategic needs are addressed. The approach further ensures that communities are backed by a legal framework on rights,

benefits (direct and indirect) and economic incentives to take substantial responsibility for sustained use of resources (Bond *et.al.* 2006)

In Kenya, CBNRM groups exist in wildlife, water, forestry, fisheries, wetlands and rangeland sectors (Colchester 1994; Borrini-Feyerband 1996; Pomeroy *et al*., 2001; Matiru, 2004) with varying degrees of legitimacy and control. If not managed well, CBNRM can lead to conflicts, delays and a counterproductive setup, particularly when traditional leaders are excluded (Boudreaux, 2007). It is important to note that most NRM sectors now emphasize decentralized responsibilities as exemplified in the creation of Water Resource Users' Associations (WRUAs) in the water sector, Beach Management Units (BMU's) in the fisheries sector and a similar approach in the forest sector just to mention a few. In wetlands, the main CBNRM groups are located in some lakes like Lake Naivasha (Lake Naivasha Riparian Association) and Lake Nakuru. In most cases, wetland management initiatives in Kenya are carried out either by projects or managed by institutions such as KWS and NMK, with technical advice from international NGOs such as IUCN and WWF. The rest are being managed by national NGOs. According to Shackleton *et al.* (2002), the sharing of financial benefits is key to determining the success or failure of CBNRM projects.

The Nyando Wetland Resource Utility Optimization Project mobilized all the stakeholders to fully participate in the project activities. At the inception of the project, the community leaders were mobilized and tours conducted for them within the Nyando River Basin to enable them appreciate the environmental problems within the basin. A forum was then provided where they freely discussed the causes, historical trends and possible ways of mitigating the problems. After this exposure, the community leaders came up with specific issues to be addressed which lead to the conception of the Nyando Wetland Resource Utility Optimization Project. Nyando Wetland is surrounded by several locations including Nyalunya, Rang'ul, North Nyakach in Nyakach District, Wawidhi, Kochogo, and Kakola in Nyando District, and Kanyagwal, Bwanda, Kawino South and North, Kochieng' West and East in Kisumu East District. To initiate project activities, members of every location were mobilized with the help of the local provincial administration to attend public meetings (*barazas)* where the project activities, derived in collaboration with their leaders, were explained. Election of community management committee members were then conducted at the same meetings, mainstreaming gender and giving opportunities for people with disability to be represented. Those elected represented the different interest groups exploiting the wetland resources including mat makers/wetland products, fishermen, agriculture/horticulture, and beekeepers, among others, with the area Chief as their patron. Apart from the officials, 30 community members were also elected to participate in the PRA exercise. This exercise was very instrumental in identifying and prioritizing project activities which culminated into a community action plan which gave guidance on which interventions to carry out in each community. The elected officials were inducted into the office by training them on key issues such as leadership, financial management, conflict resolution and basics on wise use of wetland ecosystems. Each of the three districts (Nyando, Nyakach and Kisumu East) elected one person to represent them in the overall project management committee. Throughout the life time of the project, public meetings were held to monitor the progress of the project activities.

Apart from the community members, primary and secondary schools in the project area were also organized into a teachers' committee representing each district with the respective chairs and the secretaries forming the regional officials. The mandate of the teachers' committee was to oversee the implementation of project activities involving the school children.

6.2.2 Awareness Creation

Awareness is an agenda-setting and advocacy exercise that helps people to know what is and why an issue is important, the aspirations for the targets, and what is being and can be done to achieve these (Ramsar Convention Secretariat, 2010). Awareness brings the natural resource issues to the attention of individuals and key groups who have the power to influence outcomes (Stephen *at al.*, 2000). The methods of communication, education and public awareness creation are outlined by Chatterjee *et al.*, (2008). These include public awareness messages, using local communication tools (newspapers, newsletters or word of mouth), information products (brochures, fact sheets and posters), meetings and consultations (small or large gatherings with targeted stakeholders), visitor access (allowing people to visit the wetland to provide personal experience), and interpreting sites for visitors (through signals, visitor facilities and dedicated guides). Others include special events and community awareness days (World Wetlands Day), community education initiative programmes (when resources and expertise are available) and dedicated facilities.

Awareness creation is cyclical. According Bahir (2010), the five major components of a typical awareness-raising cycle involves capturing the attention of stakeholders and stimulating interest, improving public knowledge and understanding, enhancing social skills and competencies for change, increase capacity to implement change and finally to implement change and evaluate progress. The awareness creation in Nyando Wetland was made with these ideas in mind.

To stimulate maximum informed participation in the management of Nyando Wetland resources by the stakeholders, several approaches of awareness creation were used. The different approaches targeted different stakeholders. For instance, public meetings *(barazas),* exchange visits and broadcasts of well packaged information through vernacular radio stations proved to be popular and effective with the local community. Celebration of international days, especially the World Wetlands Day (Plate 6.1), and exhibitions such as agricultural shows and those organized by NEMA provided opportunities to create awareness to a wider section of stakeholders including government officials, school children, the private sector and the general public. The same was true with organized tree planting ceremonies which was an annual event throughout the life of the project. Seminars, workshops, brochures and posters proved useful among wetland resource managers, community members and learning institutions. Use of demonstration plots was however crucial in the awareness geared towards adoption of best practices like wetland rehabilitation and alternative livelihood activities.

Plate 6.1: *Students from Rae Girls Secondary School reciting a poem on wetland during the World Wetlands Day celebrations*

The role played by the schools in awareness creation was unique. The activities involving the school children were two–pronged, creating life long awareness among the pupils themselves and to the general public. All the activities including essays, drama, songs and choral verses were organized

annually as competition among secondary and primary schools respectively. The themes for the competitions were set in accordance with those set annually by Ramsar for the World Wetland Day celebrations. The best presentations were awarded trophies and prizes which went a long way in stimulating participation and raising awareness among pupils (Plate 6.2).


Plate 6.2: *Schools participating in Wetlands Essay Competition on the Prize-giving Day*

6.2.3 Capacity Building

Capacity building for natural resource management goes beyond the traditional, top-down approach of enhancing skills and knowledge through training and provision of technical advice. It focuses on enhancing genuine community engagement in all aspects of NRM, from planning to on-ground actions. Therefore, in addition to the transfer of technology and technical capability, capacity building should foster social cohesion within communities, and build both human and social capital.

Capacity building relates to a range of activities by which individuals, groups and organizations improve their capacity to achieve sustainable natural resource management (FAO 1999). Capacity in this context includes awareness, skills, knowledge, motivation, commitment and confidence (Wim *et al* 2008; Ramsar Convention Secretariat, 2010). Developing community capacity enables members of a community to draw on the skills and resources they need to take control and improve their lives (OECD/Noya A. Clarence 2009). The approach to community capacity building aims to ensure that it is an empowering experience for communities engaged in development programmes (Greenwood and Levin 1998; Forester 1999; Tania and Daniel 2003), so that their capacity is sustained after the programme ends.

The basic principles for the development of capacity building activities as outlined by Wim *et al*., (2008) includes cost-effectiveness, locally driven and owned (carried out by local organizations), use of existing capacity building infrastructure, and adoption of the principle of openness and accessibility. These principles proved useful in Nyando as the project activities were implemented by local organizations which enjoyed excellent rapport with the local communities through long term interaction and a wealth of experience on the prevailing conditions.

Community engagement in NRM decision making and implementation is a critical outcome of capacity building investments. Four broad activity areas are vital pillars for achieving community engagement, and they should not be pursued in isolation of one another. It is the combination of enhancing the *ability to act* through provision of knowledge and skills, and fostering *motivation to act* through awareness-raising and the provision of facilitation and support that should lead to effective community engagement in sustainable NRM.

Plate 6.3 *Cross-gender involvement in the fabrication of higher value artifacts from the Nyando Wetland plants*

In the Nyando Wetland Resource Utility Optimization Project areas for capacity building were identified by the community members themselves during a PRA exercise conducted at the inception of the project. The exercise gave them an opportunity to assess their current situation, come up with and prioritize their problems and thus identify areas where they were deficient for capacity building. Reviews were however done periodically in the life of the project to allow for emerging issues. Several trainings were carried out in the life of the project. These included training in wise use of wetland ecosystems, wetland rehabilitation, entrepreneurship, sustainable agriculture, making of quality wetland products (Plate 6.3), organic farming, beekeeping (Plate 6.4), fish-farming (Plate 6.5 and 6.9), value addition, marketing and agroforestry. These trainings aimed at equipping the community members with relevant knowledge and skills before they engaged in respective alternative livelihood activities. The other category of capacity building was given specifically to elected officials to improve their leadership skills. Topics covered diverse areas including leadership, financial management, conflict resolution, resource mobilization and group dynamics.

Plate 6.4 *A community managed apiary in the Nyando Wetland*

Plate 6.5 *A fish farmer in Okana Wetland feeding the fish*

Apart from the community members, the project staff were also trained on various aspects of management and wise use of wetlands, project planning and management. They also benefited from all the other capacity building activities that targeted community members as they attended all of them.

6.2.4 Need-driven research activities

Interventions made without relevant data normally do not yield good results. In this project most of the interventions were preceded by PRA, a survey or a research project. PRAs were conducted at the beginning of the project and provided ample background information on diverse issues. Rapid surveys and/or inventories were also conducted to appraise the knowledge of the project team on specific issues. Where detailed information was required, research topics were designed and graduate students, particularly from Moi University with whom the project collaborated, were engaged. This enabled the project team to generate the information both for the project and the students' thesis. Some of the researches carried out during the life of the project include socioeconomic issues, gender issues, impact of wetland resource use conflicts on food security, valuation of consumptive wetland resources and impacts of Climate Change / lake level recession on the wetland.

This approach of using need driven research in community based wetland management gave a sound basis for designing project activities to target the achievement of specific goals. The same information gathered has also contributed immensely to the material presented in this book.

6.2.5 Wetland Rehabilitation

The world's wetlands continue to be lost and degraded at an alarming rate as a result of human activities. According to the Millennium Ecosystem Assessment, wetlands ecosystems are the habitat that have been most affected by development and are being lost more rapidly than any other habitat in the world (MEA, 2005). The loss of wetlands has led to environmental and ecological problems, depreciating the socioeconomic benefits. Consequently, the essential benefits provided by wetlands to people continue to be seriously eroded. These benefits, derived from wetland ecosystem services, are unique, varied and extend across many sectors, yet their contribution and value is not always fully captured in wetland management decision-making. In the recent past, commercially sensitive and economically exploitative attitudes of society have subjected these ecosystems to stress, in some cases leading to alteration and hampering of their functions and their ultimate destruction (Ramachandra, 2001). Removing the stressors or pressures on the ecological character of wetlands is the best practice for preventing further loss and degradation; when this is not feasible, however, or when degradation has already occurred, wetland restoration must be considered as a potential response option (Alexander and McInnes, 2012).

Wetland restoration means re-establishment of pre-disturbance aquatic functions and the related physical, chemical, and biological characteristics (Grenfell *et al.,* 2006) with the objective of emulating a natural and a self regulating/perpetuating system that is integrated ecologically with the landscape and the functions the wetlands perform (Grenfell *et al.,* 2006). There is growing documented evidence that wetland restoration and improved management of wetlands may warrant high priority in relation to Climate Change adaptation strategies. Restoration, however, is not a substitute for protecting and ensuring the wise use of wetlands. For instance, the potential to restore a wetland is not a justification or suitable trade-off for the continued degradation of wetlands. Furthermore, while restoration can play an important role in enhancing wetland benefits, experience shows that a "restored" wetland rarely provides the full range and magnitude of services delivered by a wetland that has not been degraded.

One of the major aims of the Nyando Wetland Resource Utility Optimization Project was to mitigate the continued degradation of Nyando Wetland which was under undue pressure from different anthropogenic activities. Conservation and rehabilitation of these fragile, yet important, ecosystems was thus the core business of the project, with other activities being the means to achieve this goal. For instance, creation of awareness, capacity building and alternative livelihood activities were designed to catalyze wetland conservation.

Reconnaissance surveys conducted at the inception of the project gave a clear picture of the status of wetland within the Nyando River Basin. This helped in the categorization of the actual sites that needed urgent protection from further degradation and those that had to be rehabilitated. To achieve this goal, each community group in the different locations had to choose and be in charge of a specific area of the wetlands targeted for rehabilitation. The areas selected and mechanisms used for rehabilitation by the communities varied, depending on the location of the wetland and sources of pressure. Most of the rehabilitation was done through passive means where the source of pressure was removed through mutual agreement among the community members and the wetland ecosystem allowed to recover. A total of over 65 hectares of wetland area was rehabilitated within the three districts riparian to the Nyando Wetland. Active restoration was applied only in Okana wetland where the wetland had already been completely lost due to extreme degradation. In the project, Okana was chosen to provide an example of how a degraded inland wetland can be restored by the local community members.

6.2.5.1 Case Study: Restoration of Okana Wetland

From time immemorial, the livelihoods of the Okana community relied heavily on papyrus (*Cyperus papyrus*) from the wetland. The area was well known for mat making which was the major occupation and source of income for the households. In its pristine state, Okana Wetland had huge stands of papyrus which provided diverse habitats and supported a rich biodiversity. However, between 1975 and 1980, intense anthropogenic activities including overharvesting of the papyrus and increased interest by the community to plant food crops set up the momentum for wetland degradation. This was further catalyzed by drought that was experienced during the same period, which led to the drying up of influent streams and reduced productivity of the wetland. This culminated in massive migration of the wildlife to other areas like Ombeyi, Kabar and Miwani, resulting in overall loss of biodiversity. Between 1982 and 1990, the farming practices increased with the introduction of cash crops, especially rice and sugarcane under individual own farm management (*Achung' Kenda*). The situation scaled up rapidly, accompanied by burning of papyrus, overgrazing and land sub-divisions, resulting in complete depletion of wetland vegetation, especially papyrus, the backbone of their economy (Plate 6.6). Thenceforth, the women could walk up to 15km in search of papyrus for mat making.

Between the years 1992 and 1995, Okana Wetland dried up completely as a result of severe drought, triggering a series of conflicts over land between Okana and the neighbouring Sidho community. The conflict lasted almost one year, with conflict resolutions attempts by the government yielding very minimal results. Due to drought and reduced productivity, food insecurity set in as there was a drastic reduction in the production of indigenous food crops and mass death of livestock. The once thick papyrus vegetation turned to dry land with path roads traversing the wetland that join Sidho, Ahero, NIB, Kasiru, Wanjare and other neighbourhoods. (Plate 6.6)

In the year 1997, VIRED International, a local NGO, intervened through their Nyando Wetland Programme by creating awareness and building the capacity of the Okana Community on possibilities

of restoring the wetland. A 2.5 acres demonstration plot was set up and when the community saw signs of papyrus returning to Okana, they embraced the activity. Papyrus rhizomes were acquired from fringing wetlands along Lake Victoria for replanting in Okana. The efforts benefited greatly from the 1997-1998 *El nino* rains. The project was however short lived and the Nyando Wetland Resource Utility Optimization Project, funded by UNDP-Kenya through Kenya Disaster Concern (a local NGO), came in handy in supporting the continued wetland restoration activities to its present status. Presently, several hectares of Okana wetland is thriving with luxuriant wetland vegetation and a tremendous increase in the diversity of wetland flora and fauna. The wetland is currently jealously guarded by the community members who have now zoned the wetland to provide for different activities like farming, grazing, demonstration site, and the several hectares of restored wetland area. The papyrus in the restored site is now being sustainably exploited in a rotational manner to allow for regeneration of harvested plants before they are harvested again (Plate 6.7). The Okana Wetland is a living example of how communities can restore a completely destroyed wetland.

6.2.6 Alternative Livelihood Activities

Plate 6.6: *One of the degraded expanses of the Nyando Wetland before rehabilitation initiatives commenced*

Plate 6.7: *The Okana Wetland as it is today after the community-led rehabilitation initiative*

The livelihood of rural communities riparian to wetland ecosystems are closely linked to the exploitation of wetland resources (FAO 1999). Conservation of such ecosystems without providing alternatives as an incentive may achieve very little as the attention of the community must be diverted at the expense of the resources under pressure. In this project, alternative livelihood activities was used as an incentive to catalyze conservation of Nyando Wetland by the predominantly poor and food-insecure riparian communities. Incentives are specific inducements designed and implemented to influence or motivate people to act in a certain way (Emma 2004). In the context of nature conservation, they are concerned with making it more worthwhile in the livelihood terms for communities to maintain, rather than to degrade, natural resources in the course of their activity. Incentive measures therefore play a crucial role in nature conservation at all levels of society – local through to global.

Incentives can both be direct or indirect and take different forms. These include *Property rights:* measures which allocate rights to own, use or manage natural resources; *Livelihood measures:* measures which strengthen and diversify local livelihoods; *Market measures:* measures which rationalize prices and improve markets; *Fiscal measures:* budgetary measures which apply tax and subsidy systems; and *Financial measures:* measures which mobilize and channel funds and finance. Incentive measures for community nature conservation are never absolute. They are designed and applied under particular circumstances in order to reach particular goals. The circumstances which determine nature degradation and conservation vary between different groups and over time (Anker *et al.,* 2004). The nature and goals of incentive measures must themselves be responsive to such changes. Incentive measures will only have limited effectiveness and are unlikely to be sustainable over the long-term if they do not take account of diversity and change in local livelihoods and the status and integrity of natural systems.

Several alternative livelihood activities were used in this intervention. The pressures leading to the degradation of Nyando Wetland were identified to primarily arise from overexploitation of wetland goods and services by the community in search of their livelihood. It was therefore pertinent that the issue of sustained livelihoods be addressed if any meaningful outcomes were to be achieved by the project. The choice of the specific alternative livelihood activities was based on the outcome of the PRA exercise which came up with the community's preferred activities. This was also influenced by professional on-site assessments for the suitability of the suggested sites. The activities chosen included aquaculture (fish farming), apiculture (bee keeping, Plate 6.8), dairy goat keeping, poultry farming, horticultural crop production, agroforestry, production of value added wetland products such as mats, murals, lampshades, table mats and furniture (Plate 6.9).

Plate 6.8: '*KEBS-Quality-Certified' Nyando Wetland honey on display at one of the sales outlets*

The communities were supported through capacity building on the specific ventures they were to engage in, followed by providing financial support for the initial establishment. After this, the project's field extension officers monitored the success of the activities. If any limitation was noticed, remedial measures either in the form of further on-site training or additional financial support would be given promptly.

Despite their popularity with the community, the success realized with the alternative livelihood activities was varied. Horticulture, for example, was very popular as it addressed the community's

Plate 6.9: *Composite pictures of various Income Generating Activities (IGAs) initiated during the Project*

immediate food security needs, but the activity suffered several setbacks including pest and diseases which interfered with food production levels. The other major drawback came from extreme variation in climatic conditions since the area is prone to drought and perennial flooding events. The alternative livelihood which proved most successful was beekeeping. This is because the activity is environmentally friendly and required minimal time investment from the community. Beekeping was rapidly upscaled, leading to the production and branding of a Kenya Bureau of Standards (KEBS) Certified pure organic "Wetland Honey" that soon hit the local markets(Plate 6.8). Production of value added wetland products was also doing very well, with artisans making high quality mats using very little papyrus but fetching very high prices, thus improving income of the community members. (Plate 6.11)

6.2.7 Partnerships in Community Wetland Conservation in Nyando

Partnerships are very important in community based wetland management if sustained success has to be achieved. This intervention benefited greatly from partnerships which lead to collaborative activities among the local communities, with government departments, the civil society and with institutions of higher learning particularly universities and the private sector. Collaborative activities carried out in the life of the project included capacity building, tree planting, World Wetland Day celebrations, flood water control and management, public health issues and research. The major government institutions which worked closely with the project included NEMA, Ministries of Agriculture and Fisheries, Water and provincial administration. Others were Kenya Wildlife Service (KWS), Lake Basin Development Authority (LBDA), Water Resource Management Authority (WRMA), Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Forest Service (KFS), Ahero Town Council and Nyando County Council. The civil society also became handy. For instance, SCC Vi Agro-forestry offered assistance in training the local community on agro-forestry and provided certified seeds to the community tree nurseries. Other invaluable contributions were received from other CSOs like Wildlife Clubs of Kenya (WCK), Lake Victoria Sunset Birders, Red Cross and World Vision among others. The project also benefited from corporate bodies like Chemelil Sugar Company and environmental initiatives like the Lake Victoria Environmental Management Project (LVEMP II).

Unique partnership with institutions of higher learning emerged during the life of the project. More than 20 university students undertaking environmental studies at Moi, Egerton, Maseno and Kenyatta Universities were attached to the project to gain experience in community based wetland management. The project also accommodated students from as far as Uganda's Makerere and Bugema Universities (Plate 6.10). The project also served as a field training ground and hosted students on several occasions from Kenya Wildlife Service Training Institute (KWSTI). Apart from attachment and field study site, the project partnered with Moi University students who carried out their BSc degree senior research activities and MSc degree research in specific areas to provide information to the project while also contributing to the award of their respective degrees.

Plate 6.10: *Students from colleges an universities visiting the project to learn community based wetland management.*

6.2.8 Towards Sustainability

The major problem with most donor funded community projects is the lack of inbuilt Exit Strategy which would ensure that novel project activities are sustained to provided continuous benefits. The strategies the intervention came up with to overcome this obstacle include capacity building, formation of a marketing federation and coming up with a Wetland Management Plan.

6.2.8.1 Capacity Building

Capacity building was designed to equip the community members with skills that would enable them mobilize resources even after they are left on their own. In the course of the project, trainings were conducted on entrepreneurship, marketing, project proposal writing, development of business plans and handling alternative livelihood projects like agriculture as a business. These were aimed at improving their skills in resource mobilization.

6.2.8.2 Formation of Marketing Federation

The alternative livelihood activities provided the communities with a means of raising income. In the course of the project, the community groups were encouraged to open their own bank accounts and to save the surplus for future investments. However, this could not be achieved if there was no strategy of marketing their produce to maximize profits. The project made deliberate efforts to build the capacity of the communities in marketing and business plan development and facilitated the formation of a marketing federation to enable them focus on the future. Experiences gained in the implementation of alternative livelihood activities made it easier for the community to engage in activities which proved to be economically viable. The project went ahead and set up marketing outlet stalls (Plate 6.11), at strategic centres which will go along way in helping the community with marketing of their products.

Plate 6.11: *One of the roadside outlet stalls where wetland artifacts, furniture and honey are displayed and sold to the public*

6.2.8.3 Nyando Wetland Management Plan

The Nyando Wetland Management Plan is a document formulated with the participation of all the stakeholders (Plate 6.12). The document is a blue print of the road map the community wishes to take as concerns the management of their wetland for posterity. The plan outlines all the environmental problems, relevant activities to mitigate them, key players and strategic objectives to be achieved for each. This document promises to play a major role in guiding the community towards sustainable management of the wetland ecosystem. It will also act as an invaluable fundraising tool.

Plate 6.12: *Some of the stakeholders who participated in one of the Nyando Wetland Management Plan Workshops*

6.3 Emerging issues

Several issues emerged from the implementation of this project which provide good learning points for wetland managers and scholars. Most of these are covered in Chapter 8 as challenges and lessons learnt. As concerns replicability, it is important to point out that this is possible but due attention should be given to the uniqueness of the wetland ecosystem in question.

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CHAPTER 7

Managing Nyando Wetland in the face of Climate Change

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Summary

Wetlands exist in a transitional zone between aquatic and terrestrial environments, and thus can be altered by slight changes in hydrology. Climate Change predictions for the tropics gives mixed results with some areas in East Africa expected to receive below normal rainfall. The semi-arid areas of the Lake Victoria Basin, the floodplains, would be warmer with frequent and prolonged drought events. These changes, however subtle, are likely to affect the functioning of many freshwater wetlands. Potential impacts will range from changes in community structure to changes in ecological function, and from extirpation to enhancement. This will have implications on the well-being of riparian communities who rely on wetlands for the supply of essential goods and services. The important role of wetlands in the global carbon cycle will also be affected; tropical wetlands are able to sequester 80% more carbon than temperate wetlands. Currently, the effects of Climate Change are being felt by residents in the riparian areas. However, the changes have not been investigated to determine the extent to which they might affect the supply of goods and services to people living in the adjacent areas. Mitigation strategies for minimizing the adverse impacts of Climate Change on the wetland ecosystem include reduction of current anthropogenic stresses, active management to preserve wetland hydrology, and a wide range of other management and restoration options. For the dependent communities, existing anomalous mitigation measures need to be enhanced, and planned mitigation mechanisms put in place. Adaptation and coping strategies which are being employed by the people also need to be strengthened. However, appropriate measures cannot be put in place without tangible evidence of the extent and trend of climate related impacts on wetland ecosystem function which affect the flow of goods and services. This chapter gives the perspective of the riparian communities of the Nyando Wetland on the impacts of climatic changes and possible mitigating measures which should be carried out to ensure sustainable management of the wetland resources.

7.0 Introduction

In the lowlands of the Lake Victoria Basin, many river floodplains are endowed with expansive swathes of swamps and bogs, some permanent and some seasonal (see Chapter 1), and for many years, these areas have been important sources of an array of goods and services to the resident communities. They also include the riverine wetlands on the floodplains and mouths of many rivers that empty into the lake and the fringing papyrus wetlands at the lake shore. The Nyando Wetland, deriving its name from its occurrence at the mouth of the Nyando River, forms part of the expansive and complex system of freshwater papyrus swamps renowned for their biodiversity and ecosystem goods and services (Balirwa, 1995; Kipkemboi, 2006; van Dam *et al*., 2006; Morrison *et al*., 2012).

Climate Change, associated with increased carbon dioxide and other greenhouse gases could significantly alter many of the world's freshwater wetland ecosystems. In the Nyando Wetland,

the effects of Climate Change and variability can best be looked at in the context of the changes in atmospheric carbon levels, hydrology, temperature, evapotranspiration, geochemistry, water quality and biomass accumulation, all with a bearing on its structure and function. Indeed, any change in the yearly patterns of climate will spell doom for the diverse goods and services upon which many people rely for their livelihoods. The important role played by papyrus wetlands in reducing the amount and rate of increase in atmospheric carbon dioxide will also be at risk.

For wetlands in the Lake Victoria Basin, Climate Change and climate variability introduce a new external factor that had not been included in the planning processes of water resource managers. However, the Government of Kenya now has a policy document, the National Climate Change Response Strategy (NCCRS, 2010) which gives a basis for addressing the adverse effects of Climate Change and sensitizing the public on the necessary mitigation and adaptation strategies. However, just like in the rest of other developing countries, adaptive capacities in Kenya are inadequate because of lack of financial and technical resources that hamper the establishment of effective and appropriate planned mitigation and adaptation measures (IPCC, 2001). According to IPCC (2001), adaptive capacity is the ability of a system to adjust to Climate Change so as to moderate potential damages, take advantage of opportunities, or cope with the consequences. Adaptive capacity determines resilience of a system (Allison and Hobbs, 2004). To date, there has been limited discussion on the potential impacts of Climate Change and variability on wetland ecosystems in the Lake Victoria Basin and the relevant mitigation and adaptation strategies that need to be put in place.

This study evaluates the historical trends of Climate Changes in the Nyando Wetland and their impacts on ecosystem function and the goods and services to resident communities. Information presented in this chapter relied heavily on a survey conducted by Nyando Wetland Resource Utility Optimization Project among some 300 randomly selected residents of the immediate catchment of the wetland. Relevant information was also collated from published literature, related research activities carried out in the area and from workshops and direct observations. By incorporating indigeneous knowledge, a number of mitigation measures have been presented together with the coping and mitigation strategies which could be employed to help minimize the observed impacts.

7.1 Climate Change: historical trends and future scenarios

As a global phenomenon, Climate Change is a major threat to the well-being of the ecosystem. The major driver of Climate Change has been identified to be the increase in global warming as a result of excess greenhouse gases in the atmosphere (IPCC, 2007). Continued greenhouse gas emissions at or above current rates will cause further warming and induce many changes in the global climate system during the 21st century. Because wetlands depend on the presence of water, current and future changes in water availability will have the greatest influence on freshwater wetlands. The most dominant climate drivers for water availability are precipitation, temperature and evaporative demand (determined by net radiation at the ground, atmospheric humidity, wind speed and temperature). Climatic variables, particularly temperature and precipitation, are strong determinants of wetland ecosystem structure and function (Mulholland *et al*., 1997). Tropical temperatures are increasing; temperatures in the 1980s were 0.5°C warmer than a century earlier and 0.3°C warmer than during the period 1951-1980 (IPCC, 2001). Concurrently, Lake Victoria's epilimnion is warmer compared to the 1960s when temperature was 0.5°C less (Hecky *et al*., 1994). Although current climate scenarios project only small increases in tropical temperatures, small changes in temperature and water balance can dramatically alter wetland hydrology and productivity.

Evaporative demand, or 'potential evaporation', is projected to increase almost everywhere (IPCC, 2001). This is because the water-holding capacity of the atmosphere increases with higher temperatures, but relative humidity is not projected to change markedly (Bates *et al*., 2008). Water vapour deficit in the atmosphere will increase as well as the rate of evaporation (Trenberth *et al*., 2003). Changes in

evapotranspiration over land are controlled by changes in precipitation and radiative forcing, and the changes would, in turn, impact the water balance of runoff, soil moisture and water in reservoirs, the groundwater table and the salinisation of shallow aquifers.

Groundwater levels in the Nyando River floodplains have shown a decreasing trend over the last three decades. This is mainly as a result of decreased ground water recharge caused by declining rainfall (drought events have become more pronounced and frequent in the recent past (Table 7.I) and land use change as a result of intensive deforestation in the upper catchment of the Nyando River Basin. In the Nyando River Basin, wetlands have witnessed 79% decline between the years 1991 and 2006 (Swallow *et al*., 2009). This follows an earlier loss where 6000ha of wetland were converted to irrigate rice production fields in the 1960s and 1970s (Swallow *et al*., 2007). Much of the wetlands have been converted into farmlands (maize, sugarcane and vegetables), grazing fields and human settlement areas. The result has been that many streams flowing into the wetland have become intermittent and others have completely dried up. The major rivers like the Nyando and Awach Kano have become erratic and recorded the lowest discharge levels in recent times. Additionally, the water levels of Lake Victoria have been fluctuating in the recent past, reaching the lowest level of 1951 by the end of 2005 (NAPE, 2006; LVBC, 2006). Because 85% of the water in the lake comes from direct precipitation on the lake, overall decline in lake level also indicate that precipitation has been declining over the recent years. This contradicts a report by Bates *et al.* (2008) which noted that an annual precipitation exceeding 20% have occured over East Africa. This projection is not consistent at the local scale because of the differences in relief and other factors which create discordant rainfall patterns within short distances (Anyah and Semazzi, 2007). Within the Nyando River catchment, changes in the amount of rainfall from one place to another are remarkable (JICA, 1992). It is projected that Lake Victoria Basin's wet areas will receive increased and intense rainfall. This will increase soil moisture, runoff and river discharge and the water table, all with the danger of flooding.

Climate Change will have its most pronounced effects on Nyando Wetland through altered precipitation and frequent or intense disturbance events (droughts, storms, floods). The combined changes in temperature, precipitation, soil moisture and evapotranspiration will influence the rate of river runoff and discharge, and groundwater recharge. Studies in the tropics project an increase in the seasonality of river flows, increased peak during the rainy season and decreased baseflows during the dry season, a situation mediated by past widespread deforestation in many of the river basins (Melesse *et al.,* 2008). Because of the effect of Climate Change, the frequency and intensity of floods and droughts have increased in the region over the recent past (Table 7.1).

Many floods reported in the Nyando floodplains area are a result of intense and/or long-lasting precipitation. In the tropics, floods depend on precipitation intensity, volume, timing, antecedent conditions of rivers and their drainage basins e.g., soil character and status (saturated or unsaturated), wetness, urbanization, existence of dykes, dams and reservoirs. Human encroachment into floodplains and lack of flood response plans increase the damage potential. In Nyando River Basin, the observed increase in precipitation intensity during the early 1950s marked the onset of destructive flooding. Globally, the number of great inland flood catastrophes during the 10 years between 1996 and 2005 was twice as large, per decade, as between 1950 and 1980, while related economic losses have increased by a factor of five (Kron and Berz, 2007). The global rate compares well with the local experience in the Nyando River floodplains (Table 7.1). Dominant drivers of the upward trend of flood damage are socioeconomic factors such as economic growth, increases in population and wealth being concentrated in the vulnerable areas and upstream land-use change (Swallow *et al*., 2009).

Date	Area affected	Disaster/ main cause	Summary of Effects
March 1952	Lake shore and Nyando River floodplains	Floods- heavy rain	Houses abandoned and people displaced to higher ground
Early 1961	Lake shore and Nyando River floodplains	Floods- heavy "Uhuru" rains	Many people died and others displaced
1975, 1977 and 1980	Widespread	***La Niña*** drought	Affected tens of thousands of people each year
1982	Nyanza Province	Floods- heavy rains	4,000 people displaced
1983/84	Widespread	***La Niña*** drought	Most severe, 200,000 people affected in Kenya
1985	Nyanza and Western Provinces	Floods- heavy rains	10,000 people displaced
1997-98	Widespread, including Nyando River floodplains	Floods- El Niño rains	1.5 million people affected
1999/2000	Widespread	***La Niña*** drought	4.4 million people affected
April-June 2002	Nyanza and Western Provinces	Floods- heavy rains	150,000 people displaced
26th Aug to 12th Sept, 2003	Western Province – Budalangi and Nyanza (Nyando)	Floods -heavy rains	1 person died, Over 2,500 people left homeless
May 2004	Widespread	Floods- heavy rains and drought	2 people died and 12,470 displaced by floods; 2.3 million people affected by drought
2005	Nyanza Province	Drought	Thousands of people affected
Dec. 2006	Budalangi- Busia and Nyando Plains	Floods- heavy rains	Over 12,000 households displaced
2007	Budalangi	Floods- heavy rains	Over 10,000 people displaced, schools closed down
2008	Widespread	Floods and drought	
2009	Widespread	El ***Niño*** floods; ***La Niña*** drought expected in 2010	Thousands of people displaced, many more affected by drought

Table 7.1: *Major flooding and drought events in Lake Victoria Basin during the period 1952-2009**

** Areas mostly affected, main causes and their effects on people have been indicated. Some events were not limited to Nyando floodplains because other areas, like Budalangi area in the Nzoia River basin, were also affected.*
Sources: Republic of Kenya (2004) National Poverty on Disaster Management (Revised Draft), Nairobi, Kenya; Daily Nation 5th September, 2007; KRCS Disaster Appeals 2003 and 2006; Achoka and Maiyo, 2008; Onywere et al., 2007).

Drought is another climatic phenomenon that has had dramatic impact on people's livelihoods in Lake Victoria Basin. Recent trends indicate that the events have been severe, frequent and prolonged (prolonged after every 10 yrs). Climate Change, its influence on the structure and function of wetland ecosystems is likely to be increasingly felt. Droughts have become more common in the tropics since the 1970s, with human activity being the likely bigger contributing factor (Bates *et al*., 2008). Decreased land precipitation and increased temperatures, which enhance evapotranspiration and reduce soil moisture, are important factors that have contributed to more regions experiencing droughts (Dai *et al*., 2004). In the Lake Victoria, record drought in 2009 reduced water flow in major rivers, including Nyando, to record low levels. Over the past 20 years, a number of streams, such as Ombeyi, Atoyien'go, Nyalbiego and Obuso, previously permanent, have become seasonal.

7.2 Impact of Climate Change on wetland functioning

Current and future changes in water availability arising from Climate Change will have the greatest influence on freshwater wetland functioning. At the local level, the extent of impact will also depend on the interaction between natural conditions and human factors such as changes in land use, land cover and the demand for and use of water.

7.2.1 Hydrological effects

Wetlands will be affected in different ways by shifts in the hydrological cycle in the Lake Victoria Basin, and especially in the semi-arid floodplains of Nyando Wetland. Climate Change will most likely alter the hydrologic cycle in a way that will cause substantial impacts on water resources availability and changes in water quality. On average, current climate model suggest an increase of about 1-2% per degree Celsius from warming forced by carbon-dioxide (Allen and Ingram, 2002). In the Lake Victoria Basin, all climate model simulations show complex patterns of precipitation change, with some regions receiving less and others more precipitation (IPCC, 2007). Trenberth *et al.* (2003) hypothesized that average precipitation will tend to be less frequent but more intense when it occurs, implying more of extreme floods and droughts.

The source of water for the Nyando Wetland include direct precipitation, runoff from upland areas, inflow from rivers, recharge from groundwater aquifers and backflow from the lake during flooding and sub-surface backflow (Karicho, 2010; Khisa P., *pers coms*). A study in the Kano Plains utilizing the stable isotopes of deuterium ($\delta\ ^{2}H$) and oxygen-18 ($\delta\ ^{18}O$) indicate that the major source of water, including that in the Nyando Wetland, is from direct precipitation (Karicho, 2010). The wetland is incised within a floodplain riparian zone which is the transition between the surrounding upland areas on one end and the Lake Victoria at the other end. What is not known is the amount of groundwater exchange between the wetlands and surrounding ecosystems, which include the adjoining upland areas, the streams, rivers and the Lake Victoria. However, groundwater-surfacewater (GW-SW) exchanges between the wetlands and linked ecosystems are seasonally dependent, marked by extreme drying of the wetland soils during the dry season and excessive water-logging and flooding during the wet season.

Box 7.1: Effects of Climate Change on freshwater wetlands

Climatic variables, particularly temperature and precipitation, are strong determinants of wetland ecosystem structure and function (Muiholland *et al.*, 1997) through their influences on ground water- surface water (GW-SW) interactions. Hydrology in freshwater wetlands is influenced by human activities such as modifications to the management of the uplands and riparian zones (i.e. land use change by clearing of native vegetation for dryland agriculture, irrigation, forestry and urban development), and changes in the flow regimes of the inflow streams and rivers due to regulation, channelization and upstream water abstractions. These stresses and man-made alterations make freshwater wetlands more susceptible to climate change. Impacts of climate change will vary depending upon the types, magnitudes, and rate of changes in temperature, precipitation, runoff, atmospheric CO_2 concentration, and other factors (Burket and Kusler 2000). Either an increase or decrease in rainfall with an increase in the concentration of CO_2 levels will affect freshwater wetlands in the following ways:

- Increased precipitation will lead to rise in water table and increased recharge of groundwater into the wetlands from upland areas. This will lead to an increase in wetland area. Projections of more intense rain events over shorter rainy seasons will exacerbate flooding and erosion in catchments and flooding in the wetlands themselves. On the other hand, wetlands in areas with increased rainfall will increase in size (Burket and Kusler, 2000).
- Relatively small increases in precipitation variability will significantly affect wetland plants and animals at different stages of their life cycle (Keddy, 2000).
- The seasonal migration patterns and routes of many wetland species will change. Fragmentation of existing wetlands by human activities will worsen the situation.
- Prolonged dry periods will promote terrestrialisation (Chauhan and Gopal, 2001) of wetlands with dangers of permanent conversion if the trend becomes pronounced.

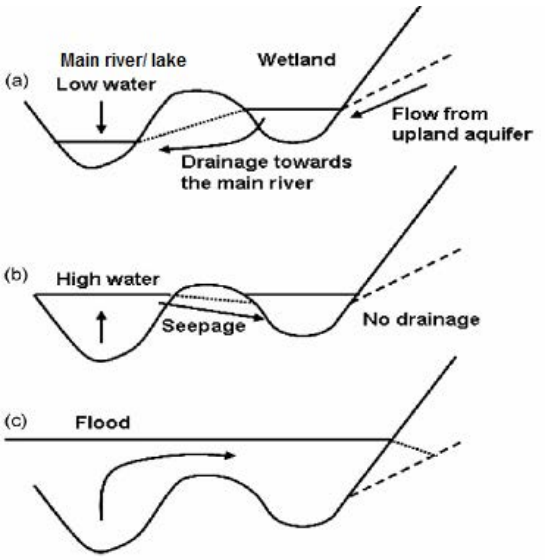

Figure 7.1. *Schematic illustration of the short-term dynamics of GW–SW connectivity in relation to lake/ lake stages: (a) (low-water stage), the wetlands may be supplied by an upland aquifer or prior flood; (b) (high-water stage), the wetlands are supplied by river infiltration into the alluvial aquifer and possibly by river backflow through a surface channel connection; (c) (flood), the wetlands are supplied by overbank flow (derived from Amoros and Bornette, 2002).*

With the lack of clear information on GW-SW interactions in Nyando Wetland and the exchanges with the surrounding ecosystems, studies done elsewhere in semi-arid areas can help elucidate possible scenarios for the Nyando Wetland. Amoros and Bornette (2002) indicated that GW–SW interactions can vary in the short term as a result of differences in river and wetland water levels (Figure 7.1). In the long term, groundwater exchange directly affects the ecology of surface water by sustaining stream base flow and moderating water level fluctuations of groundwater-fed water bodies such as lakes and wetlands (Hayashi and Rosenberry, 2002).

The extent to which the wetland will lose water through underground outflow has not been investigated. As indicated above, this scenario applies in case there is an overall decrease in the amount of precipitation in Lake Victoria Basin, with an overall reduction in river flow into the wetland and a further decline in lake levels; meaning backflow from the lake into the wetland will not occur. For example, when the surface of Lake Chad declined dramatically in the 1960s due to decreased rainfall and discharge from the Chari River, the ecotonal wetlands in the semi-arid climate were dramatically affected (Talling and Lamoalle, 1998).

Local geology is another factor that will strongly influence the movement of groundwater into and out of the Nyando Wetland. The soils in the area are heavy-textured due to past alluvial depositional processes. Because the hydraulic conductivity of the clays and silts are lower than that of the underlying aquifer, they will impede groundwater movement between the aquifer and the wetland. The soils are very high in sodium (the groundwater in the area is salty) and the alkali carbonates ($Na^{+}+K^{+}$ and $HCO_3^{-} + CO_3^{2-}$) water type dominate (Karicho, 2010). This means that the impedance will be further exacerbated because these soils can disperse and swell when wetted with low-salinity surface water, leading to significant reductions in hydraulic conductivity (Jolly *et al*., 1994).

The Nyando Wetland occurs in a semi-arid area where surface water regimes are vulnerable to rainfall variability and/or river regulation and abstraction activities (Swallow *et al*., 2008). The receding lake also poses a potential risk to the wetland because there is groundwater and surface-water exchange from the lake into the wetland; a situation likely to disappear if Climate Change reduces the lake level further. This is the worst case scenario because, with the lake level decline, the wetland will lose water and eventually dry up. However, with an increase in water level in the lake, the wetland will be regenerated. An illustrative scenario is the water levels in Lake Victoria which showed a strong non-stationary behaviour from 1900–1960. Thereafter, there was a great level increase of 2.5 metres from 1133.9m to 1136.28m from January 1960 to June 1964. After that period, the levels started to fluctuate in another level until 2005 when it decreased to near water level observed before (Figure 7.2).

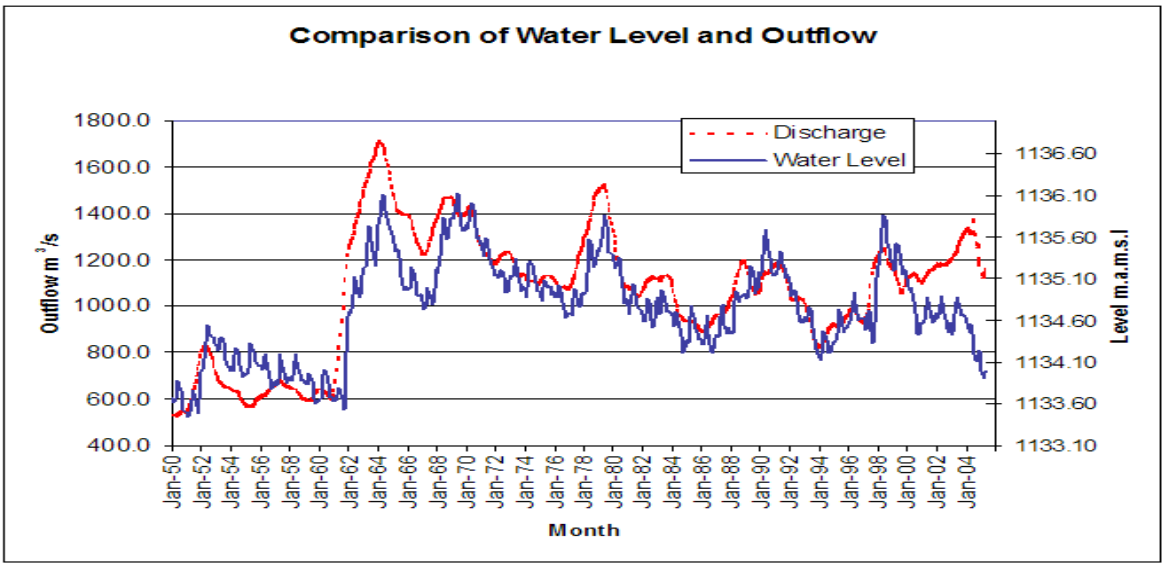

Figure 7.2: *Comparison of water level and outflow of Lake Victoria (from 1950-2005) Source: LVEMP Water Quality Synthesis Report, 2005*

7.3 Community perspectives on Climate Change in Nyando Wetland

The results of the survey, conducted among the 300 respondents randomly drawn from riparian communities, revealed major shifts in a number of climatic parameters investigated (Figure 7.3.). Respondents were asked to make judgment on whether there were differences in the parameters between the current conditions and the ones that were experienced 20 years ago. The results revealed that increased rainfall, humidity and flooding were the norm two decades ago, a situation that had changed significantly. The residents experienced increased frequency of droughts, temperature and sunlight intensity. Other parameters which have moderately increased include wind strength, a situation that could be attributed to changes in atmospheric temperature within the riparian zone and decreased vegetation cover. While the residents were of the view that flooding had declined, occasional flooding in the area, thought to be more severe, was being exacerbated by land use change and settlement in flood prone areas because of increased population growth.

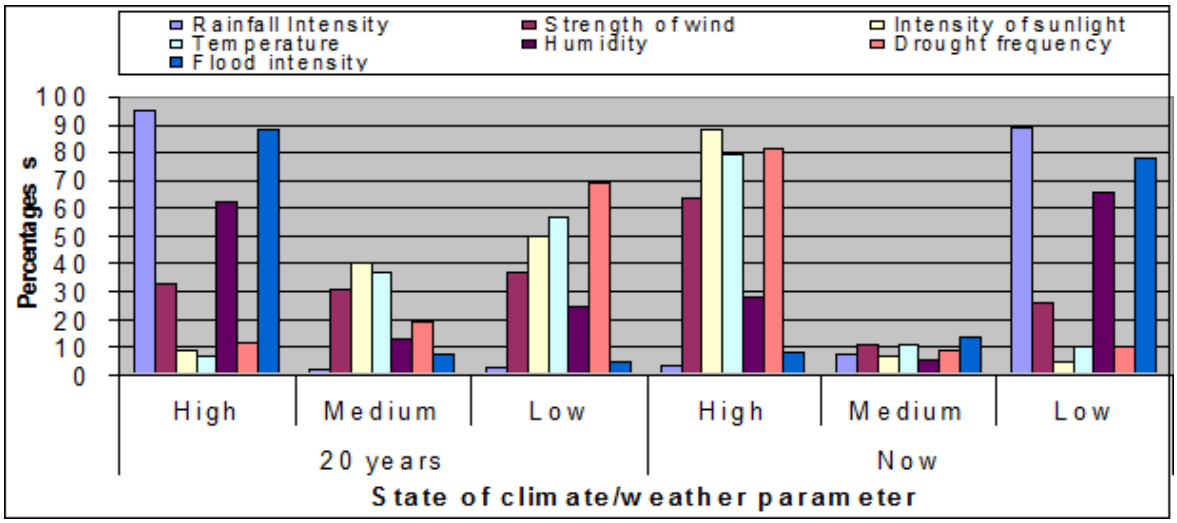

Figure 7.3: *Changes in some weather /climate parameters experienced by residents of Nyando Wetland over the past 20 years*

Climatic changes have been observed in Nyando Wetland and surrounding areas. According to Bwango *et al*. (2000) the East African region has experienced seven droughts on average over a period of 10 years (1991 to 2000) compared with only eight droughts recorded over an 80-year period (1911 to 1990). Others contend that the phenomenon of frequent El Niños in the region is associated with Climate Change (Orindi and Eriksen, 2005). Extreme drought events occur approximately every 3–4 years during the short rains, every 7–8 years during the hot dry season (December to February), and every 5–8 years during the long rainy season (Awange *et al*., 2008b). These events point to the fact that the greatest impact of Climate Change and variability will be on the aquatic resources in the region. This is likely to have a strong influence on the structure and function of existing wetlands within the Lake Victoria Basin.

7.3.1 Indirect impacts of Climate Change on wetlands

Direct effects of Climate Change on wetlands are likely to be accentuated by human induced changes that will increase stress to wetland ecosystems. Prominent human activities include modifications to the management of the uplands and/or riparian zone (i.e. land use change such as clearing of native vegetation for dryland agriculture, irrigation, forestry and urbanization) and changes in the flow regimes of the influent rivers due to regulation, channelization and upstream water abstractions. Others include overharvesting of macrophytes, burning of wetland vegetation, particularly during the dry seasons, draining for agriculture (encroachment), planting of *Eucalyptus* spp. and overgrazing (see Chapter 5 for more details on threats to Nyando Wetland). Deforestation, for instance, will decrease mean flow of the basin by reducing evapotranspiration (Sahin and Hall, 1996). The rivers will be erratic with dangers of drying up during prolonged drought events. This shift would mean less available water in the wetlands along these rivers, unless there are interventions to re-afforest upper catchments. This will change the hydrology of smaller wetlands and most will be threatened with drying, especially if the extent of land conversion in their catchment areas is increased.

Water demand is projected to increase steadily during the coming decades. In the semi-arid Nyando floodplains, however, Climate Change is expected to lead to a decrease in water availability. To address this challenge, efforts should be made to abstract groundwater for use through sinking of more boreholes. Other response measures to address Climate Change, such as dam construction, could have implications for wetlands. The construction of dams will put additional stress on wetland ecosystems by increasing habitat fragmentation. Fragmentation will prohibit migration of potamodromous fish species upstream and other animals in response to changes in temperature or water levels.

7.3.2 Impacts of Climate Change on goods and services

The impacts of Climate Change on land and water has been the driver to human population migration in seach of better livelihoods. Wetlands are highly dependent on water levels, and so changes in climatic conditions that affect water availability will highly influence the nature and function of the Nyando Wetland and the biodiversity therein. This will in turn affect the flow of ecosystem goods and services to people living in the riparian areas. The poverty levels that are already high in the basin shall be exacerbated, given the effects on agriculture and food security and other natural resources. Currently, a number of impacts related to Climate Change are already being felt in the area (Table 7.2).

7.3.2.1 Changes to water quality

Wetlands are major sources of water for domestic use in the the Nyando Basin. Climate Change will have a significant effect on water quality and quantity as a result of the likely impacts on freshwater wetlands. Higher water temperatures, increased precipitation intensity, and longer periods of low flows are projected to exacerbate many forms of water pollution, including sediments, nutrients, dissolved organic carbon, pathogens, pesticides, salt and thermal pollution. This will promote algal blooms (Hall *et al*., 2002), and increase the bacterial and fungal content. This will, in turn, impact ecosystems, human health and the reliability and operating costs of water treatment systems. In 2009, water borne diseases, mainly cholera, were a major concern in the region, exacerbated by prolonged drought and poor hygienic standards. This problem can only get worse in view of the rising human population and diminishing water supplies. The favourable temperatures will also provide appropriate breeding grounds for the malaria causing mosquitoes.

Climate related phenomena	Wetland ecosystem function affected	Attributes of the change	Ecosystem goods and services affected	Effects on residents
Drought-increased, frequency prolonged and severe	❖ Hydrological and Hydraulic Functions ❖ Water quality & quantity functions	❖ Drying of streams and rivers or reduction in baseflow ❖ Receding of Lake Victoria and terrestrialisation of wetlands ❖ Human encroachment ❖ Declined water table in floodplains (Water rest level was 40M 30 yrs ago but 70-100M currently)	❖ Water supplies reduced in quality and quantity ❖ Clogging of water intake points	❖ Increased transport costs in the lake ❖ Water scarcity ❖ Proliferation of water-borne diseases like typhoid, dysentery and cholera ❖ Increased medical costs ❖ Increased water treatment costs ❖ Increased abstraction costs for groundwater ❖ Human settlement on the receded part of the lake
	❖ Habitat functions	❖ Destruction of wildlife habitat by frequent fire outbreaks ❖ Increase in water temperature in the lake- increase by 0.5 ^{o}C since 1960	❖ Increased human/ wildlife conflicts e.g., hippo and crocodile attacks	❖ Water-use conflicts; human/ human and human/ wildlife ❖ Low birth rates among animals ❖ Hibernation and migration of animals ❖ Increased stress because of high temperature
	❖ Biodiversity functions	❖ Biodiversity loss or reduction in abundance	❖ Disappearance or reduced abundance of biota, especially fish species eg., *Ningu, Mumi, Fulu, Dado* ❖ Disappearance of medicinal plants e.g., *Nyalwet kwach*	❖ Fish catch per unit effort has declined due to reduced breeding sites ❖ Increased food insecurity ❖ Diminishing family livelihoods ❖ Increased incidence of curable diseases
Flooding-increased intensity of precipitation sometimes characterized by storms	❖ Hydrological and Hydraulic Functions ❖ Water quality and quantity functions ❖ Water quality	❖ Raising of water table ❖ Blockage and bursting of sewer lines ❖ Filling of water wells and contamination ❖ Submergence of grazing fields and farms	❖ Reduction in water quality because of contamination ❖ Water purification reduced ❖ Soil erosion and silting of streams and rivers	❖ Reduced underground water abstraction costs ❖ Outbreak of waterborne diseases ❖ Displacement of people ❖ Loss of life and destruction of property e.g., crops and houses ❖ Destruction of infrastructure e.g., roods, schools, electric and telephone lines ❖ Closure of schools ❖ Increased food insecurity
	❖ Habitat functions ❖ Biodiversity functions	❖ Habitat functions ❖ Biodiversity functions	❖ Smothering of habitat for benthic fauna ❖ Breeding and feeding grounds enhanced for fish ❖ Increased productivity of macrophytes	❖ Increased fish catches, hence food security ❖ Increased amount of macrophytes for harvesting ❖ Increased diversity of biota

Table 7.2: *Climate variables and their effects on ecosystem function, attributes of the change, ecosystem goods and services affected and the impacts on residents*

The recharge of aquifers through seasonal inundations of floodplain wetland areas represent an important process for the maintenance of water resources upon which many of the communities depend. However, declining wetland coverage as a result of human activities and Climate Change will minimize or eliminate this important wetland function. According to the 2003 UN World Water Development Report, between 1991 and 2000, over 665,000 people died in 2,557 Climate Change related disasters – 90% of which were water related and 97% of the victims were from the developing countries mainly in sub-Saharan Africa (United Nations World Water Development Report, 2003). The recorded annual economic losses associated with these disasters grew from US$ 30 billion in 1990 to US$ 70 billion in 1999. Nyando Wetland experiences perennial disasters as a result of extreme flooding and drought events with huge losses on community livelihoods recorded.

Drought induced Climate Change in the semi-arid Nyando floodplains for instance, is likely to increase salinisation of shallow groundwater due to increased evapotranspiration. Decrease in streamflow might increase, the salinity of the rivers might increase, thus affecting the quality of water available for domestic use and irrigation.

7.3.2.2 Changes in biodiversity

Wetland ecosystems, and the biodiversity associated with them, may be particularly at risk due to a combination of socioeconomic pressures, land-use and climate-change factors. Elevated atmospheric CO_2 associated with Climate Change will affect the physiology of many wetland plants (Marsh, 1999). There are, however, few assessments of how Climate Change or responses to it could affect local wetland biodiversity. For example, based on community knowledge, a shift is being witnessed in the abundance and diversity of some plant and animal species in the Nyando Wetland. Invasion by terrestrial species will increase as already observed in many wetlands in the region. Terrestrial plant species currently invading wetlands in the area include *Mimosa pudica* (Plate 7.1). Similarly, indigenous tree species previously abundant, but currently rare, include *Bondo, Ngou* (fig tree), *Omburi, Ober, Dwele, Euphorbia, Obino, Dundu and Siala*. These changes can be more pronounced if the conditions become severe because of Climate Change.

Plate 7.1. *Mimosa pudica: one of the major terrestrial plants rapidly invading degraded wetland ecosystems in Nyando*

Increasing temperature will result in a warming of water temperatures in the rivers and wetland. Rare and endangered plant and animal species with sensitivity to small temperature changes will be affected. For instance, because most fish species in the Nyando River Basin are potamodromous and rely on environmental cues, changes in water temperature being the most significant, to move upstream of major rivers to spawn (Ochumba and Manyala, 1992), changes in water temperature will affect the breeding patterns of many fish species. This will result in a major decline in catches of wetland fish species such as *Clarias* spp. and *Protopterus aethiopicus*. The situation will be worsened by fragmentation of existing wetland, following massive encroachment for agriculture and settlement.

7.3.2.3 Impact on community livelihoods

The dramatic fall in the lake level has created intense pressure on Nyando Wetland from the increasing human population and livelihood demands that threaten its very existence and value, especially when the wetland is dry and more accessible to humans and livestock (Obiero *et al,* 2012). Due to the recent survey conducted to document community responses and perceptions to the hydrological changes resulting from lake water recession indicated that the wetland is put to various uses by the community (Figure 7.4). Agricultural activities is the most predominant (72.5%) followed by communal grazing of livestock (10%), human settlement, fishing and water supply for the community. Other land uses represent physical infrastructure (electricity power lines, roads, towns), but these were negligible, a situation likely to change as human population increases. Most drying areas (terrestrialised) of the wetland and the lake are being settled and this will reduce the wetland integrity and area which is crucial in sustaining community livelihoods. The inevitable movements increase the conflicts experienced in resource utilization.

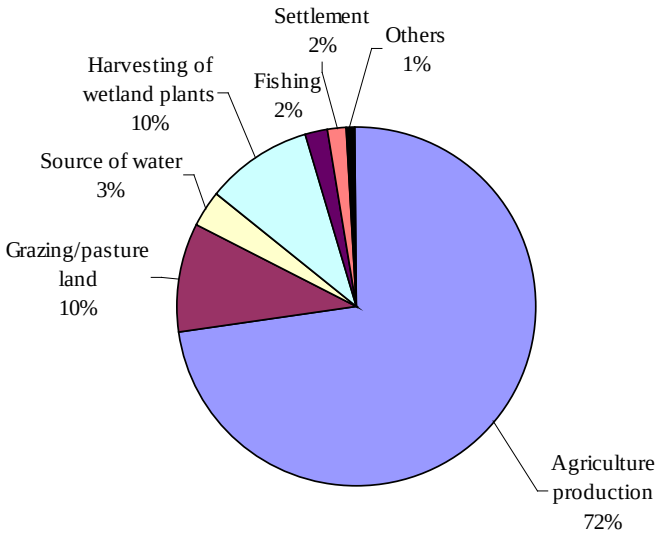

Figure 7.4. *Rating for different activities in Nyando Wetland in terms of acreage utilized*

(a) Household food production

The lake water level decline due to climate variability had a major impact on household food production in the study area (Obiero *et al*, 2012). There was a significant change in the quantity of the natural wetland food resources derived from the wetland as a result of recession. A comparison by ranking changes in the overall food production in the households before and after recession indicates a marked increase in food production due to a progressive shift of farming system enterprises from terrestrial to wetland-based production systems (Figure 7.5). The study also revealed a strong relationship between lake water recession and increased food production. Cereals (predominantly maize, *Zea mays* and sorghum, *Sorghum* spp.) constitute the main diet of many households in Nyando District.

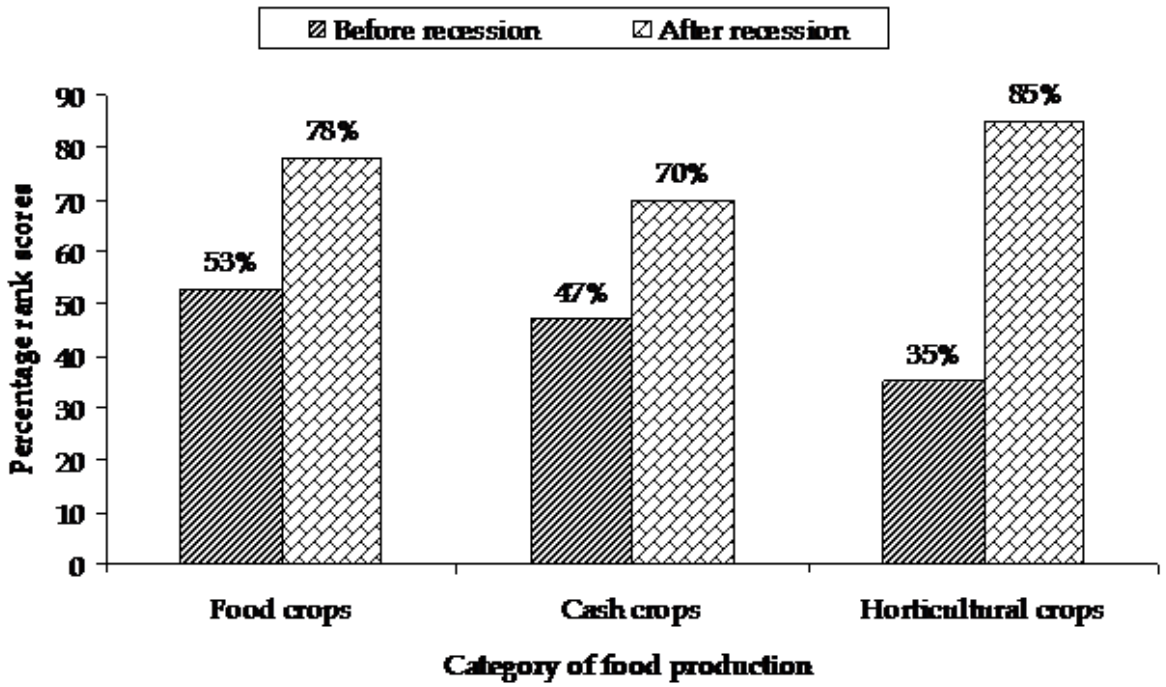

Figure 7.5: *Changes in household food production in Nyando Wetland due to lake water level decline.*

(b) Community Sources of Income from the Wetland

The Nyando Wetland forms an integral part of the rural economies and livelihood of the local communities. It was established that a significant change occurred in income generated from various activities before and after lake water level recession (Figure 7.6). Comparison of the sources of income shows that wetland farming (95%) became the major practice that fetched high income after lake water recession compared to a paltry 10% before. The main uses of papyrus, which is the major wetland macrophyte species, included mat making and house thatching. The trade in wetland products on the other hand reduced to (40%) from 48.3% due to lake level recession. Similar trend was recorded for lake fisheries which declined to 18.7% despite being a major income earner (86.7%) before the recession. Other sources of income which reduced significantly after recession include formal employment (10%), lake transport (5%) and wetland fishery (3.3%)

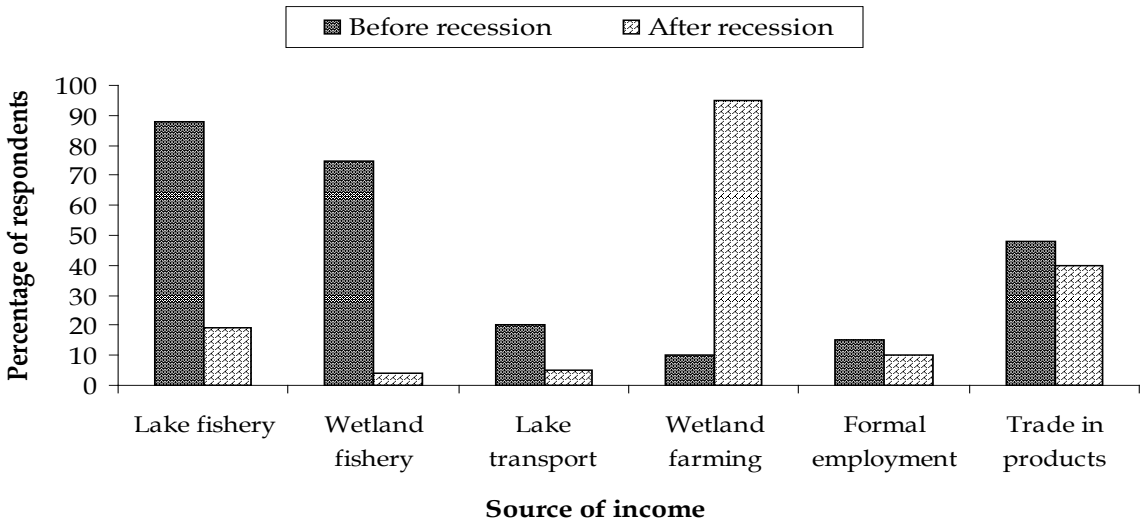

Figure 7.6: *Changes in community sources of income from Nyando Wetland resources before and after lake level recession following droughts*

(c) Fisheries production

The impact of Lake Victoria water recession on lake and wetland fisheries was also determined. Fish is the most common source of protein and a wide range of indigenous fishes are consumed by the local inhabitants around the Nyando Wetland. Causes of changes in fish catches are presented in Table 7.3. The same causes have been identified in previous studies in the lake and its influent rivers. All the respondents (100%) reported that they had experienced changes in fish catches, with majority (91.7%) saying that fish catches have decreased tremendously (Obiero *et al,* 2012). Human activities that affect water quality have been identified as the major cause of decline in both riverine and lake fisheries production.

Causes of change in fish catches	**Frequency (n=120)**	Percentage (100%)
Loss of wetland habitat and refugia	52	43
Exposure of feeding and breeding areas by clearing macrophytes	48	40
Illegal and destructive fishing methods	12	10
Drying up of landing sites	5	5
Migration of fish to deeper waters	3	2

Table 7.3: *Causes of decline in fish catches in the Nyando Wetland and the frequency of community members who attribute the decline to the mentioned cause (n = 120)*

7.4 Community Adaptation Measures and Coping Strategies

Adaptation in the context of Climate Change can be defined as a deliberate management strategy to minimize the adverse effects of Climate Change, to enhance the resilience of vulnerable systems, and to reduce the risk of damage to human and ecological systems from changes in climate. To ensure sustainability, wetland management needs to embrace appropriate adaptation measures in the face of both climatic and socioeconomic pressures in the Nyando Wetland. Changes in wetland use will be driven by the combined effects of land availability for settlement and farming, changes in the demand of macrophytes and other goods such as fish and other demands including groundwater abstraction and use of rivers and streams for irrigation, industrial and domestic uses.

The changing weather conditions in Nyando Wetland and its environs have necessitated the need for adaptation strategies among the people so as to avert the adverse effects on community livelihoods and well-being. *Autonomous adaptation* actions are defined as responses that will be implemented by individual farmers, rural communities and/or farmers' organizations, depending on perceived or real Climate Change in the coming decades, and without intervention and/or co-ordination by regional and national governments and international agreements (Bates *et al*., 2008). A survey conducted among community members within the lower Nyando Wetland revealed a number of changing weather patterns related to Climate Change and the autonomous adaptation measures available to farmers and communities (Table 7.4). Among the strategies are the use of water for irrigation and cultivating the cooler wetland soils during the drought. Farmers have also realized the importance of crop diversification as a mode of coping with adverse weather conditions as apposed to mono-cropping. The intercropped varieties include drought resistant and fast maturing crops like sorghum, cassava and finger millet and hybrid maize

Wetland rehabilitation and re-growth has also been done, especially at Okana Wetland. This is a viable alternative to flood control and dredging efforts designed to cope with larger and more frequent floods, possibly associated with Climate Change. According to Bates *et al*., (2008), other anomalous adaptation strategies that can benefit the people of Nyando Wetland and the floodplains include:

- Modification of irrigation techniques, including amount, timing or technology;
- Adoption of water-efficient technologies to 'harvest' water, conserve soil moisture (e.g. crop residue retention), and reduce siltation and saltwater intrusion;
- Improved water management to prevent water-logging, erosion and leaching in case of increased flooding due to increased rainfall;
- Implementation of seasonal climate forecasting;
- Land-use changes that take advantage of modified agro-climatic conditions;
- Biotechnology and conventional breeding that may help develop new cultivars with enhanced traits better suited to adapt to Climate Change conditions. These include drought and temperature stress resistance; resistance to pests and disease, salinity and water-logging.

However, it is important to note that some adaptation measures may place extra demands on the wetland and other environmental resources as warming increases. To this end, maladaptation, e.g. pressure to cultivate marginal land, or to adopt unsustainable cultivation practices as yields drop, may increase land degradation and endanger the biodiversity of both wild and domestic species, possibly jeopardizing future ability to respond to increasing climate risk later in the century. *Planned adaptation*, therefore, including changes in policies, institutions and dedicated infrastructure, will be needed to facilitate and maximize long-term benefits of adaptation responses to Climate Change (Bates *et al*., 2008). This way, the elements of an adaptation strategy should have not only involved physical alterations in the management system, but also technological and institutional changes that can deal with changing conditions.

Witnessed change	Effects arising from Climate Change	Adaptation/ Coping strategy
Planting	• Change in planting season/ patterns • Short rainfall duration • Unpredictable rainfall • Irregular planting	• Planting of early maturing and drought resistant crop varieties like cassava, sweet potatoes • Plant horticultural crops e.g., kales, tomatoes and Osuga • Irrigation • Planting any time of the year depending on availability of rainfall • Mixed cropping (sorghum and maize)
Harvesting periods and crop yield	• Delayed harvesting • Quantity of harvest reduced • Attack by pests and diseases • Crop failure	• Practice fishing to supplement food shortage • Reduced food consumption (from 3 to 2 meals per day) • Making of wetland handicrafts to generate income • Buying of food • Withered crops used as animal feed • Harvest premature crops (e.g., maize for boiling and not cooking Ugali) • Harvesting wild vegetables from wetland • Farming in the moist wetland soils (vegetables and rice) • Resort to small scale business • Depending on relief food • Begging from relatives • Use of agrochemicals to improve yields • Sell of vegetables to buy cereals and other foodstuffs
Temperature changes	• Increase in mosquitoes • Increase in stress and fatigue • High temperature that lead to crop infection by pest and high livestock diseases Extremely low temperatures that cause Flu	• Use mosquito nets • Longer resting periods under shades • Irrigating crops • Practice aforestation/ re-afforestation • Spray crops with pesticides and treat infected animals • Keep local breeds of poultry , sheep and other livestock like Zebu cattle • Build shades in homes • Farming in the wetlands • Visit community health workers • Draining stagnant water used by mosquitoes to breed • Raising the roof of houses, using mats for the ceiling and using grass for thatching houses
Low vegetation Cover	• Lack of fodder • Soil erosion • Reduced rainfall • Dusty conditions aggravating respiratory /eye infections	• Buying animal feeds • Walk long distance in search of animal feed • Under-feed animals, but stunted growth • Feed animals on rice stalk • Reducing the number of livestock Grazing in wetland, riparian areas of rivers, lake and swamps
Increased Rainfall intensity	• Flooding	• Irrigation of farms using flood water • Establishment of drainage channels • Planting flooding resistant crops like sugarcane and arrow roots • Raising the foundation of houses
Infection by water-borne diseases	• Frequent infection/illness	• Boil/treat water • Visit community health centres • Use herbal medicine
Water availability	• Water shortage	• Treat/boil water • Digging dams/boreholes/wells • Water selling and buying

Table 7.4: *Impacts of Climate Change on livelihoods, and adaptation and copying strategies by local communities in the Nyando Wetland*

7.4 Mitigation strategies

Mitigation in the context of Climate Change can be defined as a deliberate management strategy to reduce greenhouse gas emissions from sources and enhance the extent and functioning of sinks and reservoirs of greenhouse gases (IPCC, 2007). Wetlands store large amounts of carbon and when these wetlands are lost or degraded, CO_2 and other greenhouse gases are released into the atmosphere in large quantities. Therefore, conserving wetlands is a viable way of maintaining existing carbon stores and avoiding CO_2 and other emissions.

In the context of Nyando River Basin and considering the current national and regional levels of disaster preparedness, it is clear that these changes pose a threat to the 35 million inhabitants of the Lake Victoria Basin (LVB) and beyond. In the last three decades, Climate Change has emerged as the key challenge in the LVB, given the geographical and climatic conditions that include high dependence on natural resources and limited capacity to adapt to rapidly changing climate and frequent natural disasters (African Development Bank, 2003).

Wetlands currently contain approximately 10% of the total global carbon store (IPCC, 1996). Wetlands are under continual threat of degradation due to infrastructure developments and conversion to agricultural land and other uses, making the conservation of wetlands a potentially important strategy to prevent increases in greenhouse gas emissions. Wetlands conservation and their sustainable use as natural habitats include management strategies that prevent destruction, degradation, fragmentation and pollution of these ecosystems. These strategies may include a multitude of activities related to innovative natural resources exploitation, legislation, enforcement, incentive measures, impact assessment, capacity building and awareness creation.

An additional mitigation strategy is the restoration of degraded wetlands and creation of man-made wetland ecosystems. Restoration and creation can compensate, to some extent, for the loss of natural wetland functions, such as flood storage and water quality buffering (Kusler and Kentulla, 1990) and provide opportunities to store carbon.

7.6 Conclusion

Freshwater wetlands are critically important ecosystems that provide globally significant social, economic and environmental benefits. Climate Change is likely to have severe impacts and compromise their ability to provide these benefits. Changes in hydrology and in the temperature of water bodies will lead to reduction in the goods and services provided by these wetlands. Further, efforts to respond to Climate Change may have negative and compounding effects on freshwater ecosystems.

The goals of wetland conservation and wise use are unlikely to be achieved without taking Climate Change into account. The need to address Climate Change and increasing climate variability in the great lakes of East Africa is urgent. Information about the consequences of Climate Change on specific wetland types is needed to allow water resource and wetlands managers to integrate changes in climate into their planning and management efforts. It is generally understood, though, that removing the existing pressures on wetlands and improving their resilience is the most effective method of coping with the adverse effects of Climate Change.

7.7 Recommendations

Communities in the great lakes region are heavily dependent on natural resources, which are threatened by Climate Change. Therefore, the first adaptation measure to sustainably manage the Nyando Wetland is to implement and adhere to the existing laws and regulations on environment management (EMCA, 1999), and most importantly the NCCRS (2010). It is also essential to undertake a full vulnerability assessment for Climate Change and variability including documenting existing coping mechanisms employed by local communities. This assessment will enable key stakeholders to prioritize interventions in areas based on the threats posed. Other strategies include:

- Encouraging dialogue with affected communities so as to incorporate the use of indigenous knowledge in the adaptation and mitigation measures;
- Enhancing weather forecasting so as to facilitate provisions of weather records to the larger public in a timely manner;
- Institutionalizing effective communication systems at local and national levels;
- Profiling and funding Climate Change coordination works in the regional, at the basin and local levels;
- Establishing partnerships between local, national and regional governments/ institutions and within the civil society and private sector, so that information generated on adaptation and mitigation measures is shared;
- Continuous building of institutional and human resource capacity at local, national, regional levels for scenario setting and climate modeling;
- Funding to improve adaptive capacity of the communities riparian to wetland ecosystems.

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CHAPTER 8

Challenges and Lessons Learnt on Community Based Wetland Management

Raburu P.O., Kwena F. and Nyandiga, C.O.

Summary

Wetland conservation is a young science and its management largely depends on adaptive management approaches. Challenges and lessons learnt in a community based management of Nyando Wetland therefore form one of the most important outcomes of the Nyando Wetland Resource Utility Optimization Project. This chapter gives a comprehensive breakdown of the challenges faced as market failures, lack of institutional framework, policy failures, lack of baseline information and awareness among stakeholders, and unclear land tenure and ownership within wetland ecosystems. Other challenges include inadequate funding of wetland conservation initiatives, inadequate community participation, variability of climatic conditions, lack of political goodwill and lack of wetland management plans to guide towards wise use of wetlands. Several lessons were learnt in this initiative which could guide future interventions in the basin. These include taking care to ensure participatory approaches and mainstreaming of gender in order to reduce resource use conflicts, and careful selection of alternative livelihood activities. Others include designing project activities with complete knowledge of the attitude of the community towards the resource in question and the level of literacy of the stakeholders. Leadership skills of the community and their leaders and copying with Climate Change must also be manipulated to ensure attainment of conservation goals. It is also important to share information, identify all stakeholders and form partnerships for collective success.

8.0 Introduction

Wetland loss and degradation has been a persistent problem in many parts around the world because of population growth, which imposes great pressure on water resources and undeveloped land areas for settlements, higher agricultural and industrial production and infrastructure expansion (IUCN, 1999). More fundamentally, wetlands are lost or degraded because their products, functions and attributes are not adequately appreciated or valued by human institutions and policies. The unsustainable utilization of wetland resources can be considered to result from a combination of information failures, market and policy failures or intervention failures and other socioeconomic considerations.

Wetland conservation and management is a new/emerging science as opposed to other disciplines such as forestry or wildlife management which have been around for a long time. Management approaches used are therefore adaptive and experimental in nature as there are minimal well established methodologies which can be used as a reference point. Management should therefore be

able to identify interventions which are both productive and environmentally sustainable. Lessons learnt from the Nyando Wetland Resource Utility Optimization Project are therefore crucial in guiding the management of other wetland ecosystems within the region in a sustainable way.

Nyando is the second largest deltaic river mouth wetlands on the shores of Lake Victoria along with Yala, Kuja, Dunga, Osodo and Bunyala. These wetlands are critical to the livelihoods of riparian communities and ecological wellbeing of Lake Victoria. This is because they act as bio-filters of pollutants coming from upstream of the major rivers which drain areas with high agro-industrial activities into the lake through these ecosystems.

8.1 Challenges to Community Based Wetland Management

8.1.1 Market failures

The level of awareness among communities living within and around Nyando Wetland on the ecological and economic importance of the wetland is limited. People have not appreciated the value of wetland resources except for the limited consumptive use of some of the wetland resources. Little, if any, of the ecological values are considered important by the local inhabitants while in fact their their livelihoods depend entirely on sustenance of these values. This lack of awareness among community members often generates negative tendencies that put the well-being of the wetland at risk; for instance dumping of wastes, draining and land clearing for grazing and agriculture, burning and overexploitation of wetland resources. As a form of market failure, there is no mechanism to attribute appropriate values to the 'public goods' provided by wetlands, ranging from water supply to flood protection, water recharge and purification functions and non-use values such as biodiversity conservation' (IUCN, 1999). There is, therefore, a need to market wetland resources and place a price of their utilization to discourage overexploitation and abuse, including the polluter pays principle and payment for ecosystem services.

8.1.2 Lack of appropriate Institutional Framework

Currently, the government of Kenya does not have a ratified and legally binding institutional framework for management of wetland ecosystems. Different aspects of wetland conservation and management are currently handled by different government agencies and departments such as Kenya Wildlife Service, Ministry of Fisheries, Water Resources Management Authority; Ministry of Agriculture, National Environment Management Authority (NEMA), city and town councils, local authorities and communities without a clear legal framework. The Environment Management and Coordination Act (EMCA, 1999) provides for the conservation and management of wetlands while NEMA only coordinates as the principal custodian of the environment. With their various mandates and priorities, the different government agencies and departments often clash in their attempts to use, protect and restore degraded wetland areas. Devolution of power to the counties presents fresh challenges to wetland management in Kenya. There is therefore an urgent need to harmonize the different roles played by different departments and agencies and place them under one national body charged with the protection of wetlands and related resources. These fragile ecosystems will also benefit greatly if the newly established counties comes up with appropriate co-management approaches as soon as possible.

8.1.3 Policy failures

Lack of and poor enforcement of policies on wetland management is one of the major challenges facing community based conservation of wetland ecosystems. Whereas there are appropriate regulations, poor institutional structures have made it very difficult to enforce the relevant policies. Another form of policy failure is insufficient information presented in a format that is easy to understand and readily accessible to all wetlands stakeholders including the policy makers, managers, planners and resource users. When available, the information is scattered among several institutions and is not easy to access, understand or interpret by most of the stakeholders. Worse still, different government ministries/departments in charge of managing wetland related resources have conflicting provisions on the same, causing confusion among the stakeholders thus aggravating the degradation.

8.1.4 Lack of awareness / Baseline Information

Baseline information is very important if we are to come up with a comprehensive sustainable management protocol to save wetland ecosystems. Currently, there is inadequate baseline information on existing wetland resources, including the bio-physical characteristics as well as the socioeconomic and cultural values of the resources together with the threats that affect them. No comprehensive inventories have been conducted for many wetlands, in the Lake Victoria Basin and other wetlands in Kenya. Similarly there is inadequate technical and skilled human resources to undertake specialized conservation and management programmes i.e. research, monitoring, integrated coastal zone planning, EIA/EA and extension work to monitor and manage the existing wetlands and their resources.

There is also a disconnect between the law meant to govern relations among people and the science that is intended to protect ecological processes and functioning of the wetlands. Another major gap also exists between the wetland resource managers and indigenous knowledge from the riparian communities. In most cases, laws that are meant to govern how people live together are co-opted to protect the environment with their inherent lack of the scientific aspects that can foster the well-being of a wetland's ecological processes and functions.

Long term conservation of wetland resources will benefit greatly from promoting positive attitudes among the entire populace. The use of riparian school children proved to be very effective in increasing the awareness of the pupils themselves and local community in Nyando Wetland. The challenge however is that wetland conservation is not incorporated in the school curriculum. This is a major challenge as school curricula are developed at the national level with different areas being endowed with different natural resources. However, something needs to be done to take care of the specific aspects of each area which may be possible with the advent of the county governments.

From the foregoing, equipping the local communities with the right knowledge and skills to participate in wetlands conservation and management would go a long way in minimizing this challenge. Whereas the current constitution of Kenya gives this provision for stakeholder participation, no appropriate methodologies have been developed. There is therefore a need to come up with participatory approaches which will catalyze active involvement of resource managers, professionals and all citizens.

8.1.5 Land tenure and ownership

Land tenure and ownership in wetland areas is not clear, thus compromising the success of community based wetland management initiatives. The communities living in these areas need a firm guidance to enable them chart appropriate management measures. According to a socioeconomic survey conducted during the Nyando Wetland Resource Utility Optimization Project, 65.3% of the respondents indicated that wetland is owned by local communities while 34.7% showed that the wetland is owned by the government. However, the nature of this ownership is not clear as some parcels of land allocated to individuals within the wetland areas by the Ministry of Lands fall under areas which should legally be protected. Some claims on parcels of land in the wetlands are sometimes also based on ancestral inheritance, and have been a source of continuous human-human conflicts. Communities living within the Nyando and other wetlands in the country have a problem with regard to land tenure. These uncertainties exercebate destruction of wetland ecosystems. This is particularly so whenever the lake water level recedes, thus exposing it to degradation forces.

8.1.6 Inadequate funding for wetland conservation and management

Most institutions and organizations participating in conservation of wetlands often do not have adequate skilled manpower, equipment and funds to carry out their work. This includes personnel for monitoring, management, research and community awareness. The government of Kenya has in the past decades allocated minimal funds in the conservation and management of wetland ecosystems. To a great extent, therefore, most of the wetland conservation in the Lake Victoria Basin has been spearheaded by local and international NGOs and through regional projects. This has presented a challenge in light of the massive destruction of these ecosystems, particularly those in unprotected areas.

8.1.7 Inadequate community participation

As partners in the management and protection of national resources, communities have for long not been actively involved, a situation that is now changing, courtesy of Kenya's new 2010 Constitution that recognizes the rights of indigenous communities. Moreover, lack of community involvement has often been a source of resentment, with many communities abandoning their traditionally sustainable wetland use practices in favour of destructive ones as a form of protesting their exclusion. Environmental agencies have also not succeeded in their efforts to educate all the local communities on attitude change in favour of sustainable practices within wetlands and related water catchment areas. Eviction of people and communities from conservation areas has been a thorny issue in the country due to inadequate awareness creation before such actions are taken. Finding the right balance between conservation and sustainable utilization of natural resources in the face of increased demands for natural resources remains a challenge in the conservation of wetlands and other natural resources.

8.1.8 Lack of Wetland Management Plans

Lack of management plans has exacerbated wetland destruction and degradation in many areas around the country. Livelihoods and human developments depend on a number of factors including access to information about the rights and entitlements, the way the communities cope with risks and uncertainties and how they use their resources. There is therefore a need to strengthen processes that incorporate development of participatory management plans as a blue print in the management of wetlands by integrating environmental concerns into development planning while at the same time enhancing sustainability (NEMA, 2004). As a first step, the Management Plan for the Nyando Wetland will need to build on the existing community initiatives.

8.1.9 Political goodwill

Politicians normally enjoy the support of the local communities and as such whatever position they take as concerns natural resource management is very important. Unfortunately, their position are in most cases guided by maximizing the number of votes in the next elections rather than best conservation practices even if they have the right information. In some instances the election of community project management committees can be influenced by alignments to the local politicians. If not well managed, this may introduce mediocrity and compromise the choice of competent persons with proven leadership qualities which might lead to failure of community based wetland conservation initiatives.

Politicians in the region have also introduced another negative aspect of dishing "handouts" to their supporters. This has spread over to other activities including conservation efforts where some members of the community believe that they must be "bribed" to participate fully in any activity. This needs to be addressed very early in a community based wetland management project by inculcating the right attitude if meaningful succees is to be achieved.

8.1.10 Variability of climatic conditions

The Nyando Wetland is situated in an area which experience extremes in climatic conditions with perennial flooding during the rainy and drought during the dry seasons. This had various impacts on the management of Nyando Wetland by the community. The most obvious ones include massive degradation during drought when all the livestock of the riparian communities are driven to the wetland for grazing, reclaimation of wetland for agricultural purposes, overharvesting wetland plants for construction of houses and making of fishing gears, destruction of fish spawning and breeding grounds through destructive fishing techniques and burning of wetlands for various purposes among others. Apart from degrading the wetland, these activities increase the number of resource use conflicts among the stakeholders (Obiero *et. al.,* 2012).

Floods in Nyando are a blessing in disguise to the conservation of the wetland. During the rainy seasons, everybody is normally forcefully thrown out of the wetland, making it the best time for these ecosystems to recover from anthropogenic stress during the dry seasons. However, flooding events paralyze the community livelihood activities as all their investments normally go down the drain. During the KDC-VIRED-UNDP Nyando Wetland Resource Utility Optimization Project, some of the alternative livelihood activities like horticulture suffered a great deal from flooding events, making the activity unsustainable. It would therefore be important to design appropriate adaptation and mitigation measures to minimize the impact of unpredictable climatic changes.

8.2 Lessons Learnt

The discussion below summarizes some of the key lessons learnt during the few years of community based management of Nyando Wetland.

8.2.1 Literacy level of the stakeholders

Wetland conservation is a new and emerging science with several unfamiliar terminologies and concepts which must be well understood to ensure wise use of wetland ecosystems. Conserving these ecosystems therefore requires above average understanding of their ecological interactions with both water and the terrestrial environments. The new terminologies notwithstanding, the riparian communities who have lived in these areas from time immemorial also have a wealth of indigenous knowledge which needs to be harnessed. During the Nyando Wetland Resource Utility Optimization Project it was learnt that the literacy level of the local communities had minimal effect on the overall achievement of project activities.

The success of any intervention lies in the participatory approaches used in the mobilization and implementation of the activities. In the current intervention, before any engagements was made with the community members, a Participatory Rural Appraisal (PRA) was carried out which provided a suitable entry point. The development of awareness creation and capacity building packages was informed by the findings from the PRA exercise. Thirdly, the participation of all stakeholders was catalyzed by the use of appropriate language and methodologies. When all the above are taken care of then it is easy to achieve success in the interventions irrespective of the literacy levels of the riparian community. However, for long term benefits to the country, it would be most appropriate to include wetland conservation in the school curricula, right from primary school to the university level. During the life of the intervention, greater and faster achievements were made by the schools component of the project as compared to the local community. It would therefore be important to elicit the full participation of the riparian schools in a community based wetland management initiative.

8.2.2 Attitude of the riparian community

Historically, the Nyando basin has suffered perennial floods which normally affect the livelihood investments of the riparian community. During such times, the community has always benefited from relief food and other goods donated as humanitarian aid from the government and other nongovernmental organizations. This has made some members of the community to believe that any aid should be given as handouts in the form of cash. The project area also happens to be a hotspot that attracts many interventions by different organizations, with different approaches in mobilizing the community members, approaches that may include cash handouts. The situation has recently been worsened by politicians who buy the electorate to achieve their political ambitions, something known locally as the "*gonya*" syndrome. These, together with the fishing industry and the large labour force occasionally needed in the rice irrigation scheme, has turned the local community to be accustomed to very quick financial gains. This attitude affected community participation in the project as most of them enrolled as members expecting quick financial rewards only to withdraw on realizing that the intervention was advocating for their active participation.

8.2.3 Introduction of Alternative Livelihood options

Where community members are poor, it is imperative that an alternative livelihood be incorporated to help achieve conservation goals. The concept which was introduced by the project went a long way in sustaining a reasonable number of community members. It has also addressed the issue of sustainability of the activities beyond the project life span. Other lessons learnt were that alternative livelihood activities, though a great idea in helping to divert attention off the stressed wetland resources, can also be abused if not implemented with emphasis on the conservation agenda.

For alternative livelihood options to be successful and sustainable, it is imperative to link communities to markets. One way the intervention achieved this was by setting up marketing centres or outlets for the wetland products in strategic areas such as Rabuor, Kibuye and Ahero. Structures were also put in place to plough the money back to the community. With such direct access to markets, "middle men" are cut off and the communities make more money from their produce.

The intervention also facilitated the setting up of a community Marketing Federation. The process involved the training of the communities in entrepreneurship, leadership, resource mobilization' proposal writing and development of business plans. They were also taught sustainable ways of exploiting wetland resources, making quality products, packaging and branding that resulted in higher value products. Other opportunities offered for marketing the wetland products were done through displays during the World Wetlands Days, World Water Days and the annual agricultural shows. To authenticate some of the products, the Nyando Wetland honey was certified by the Kenya Bureau of Standards, substantially increasing its demand. The project worked with the honey producing communities to increase the production to cope with the demand.

Organic production of horticultural crops was successful in terrestrial areas around the wetlands where most schools are found. The potential is higher in areas riparian to the wetland due to the fertile soils. However, pests and diseases destroy the crops, making the production minimal without the use of pesticides. Poultry production by the community members was initially based on the broilers which are labour intensive. They fetched higher prices but since they used commercial feeds, production costs were high. The community members had to shift to free range local chicken which eat less and are more resistant to diseases. These free range local breeds were preferred due to their better taste as well as the quality of eggs they produce. The free range chicken can be kept long after maturity for egg production while broilers have no more value once they are big enough for meat yet they continued to demand feeding and care.

8.2.4 Level of awareness of stakeholders

Level of awareness among stakeholders is very crucial in achieving set objectives in a community based wetland conservation initiative. The project used different approaches in creating awareness. It was clear at the beginning of the project that all the stakeholders from local communities to those at policy level were not aware of different aspects of wetland conservation and management. Different approaches proved to be successful for some stakeholders than others. Government officials for instance, benefited most from seminars and national celebrations. In schools, awareness creation through competitive activities such as drama, choral verses, songs and essay writing were very successful. The teachers who were the backbone of the schools programme benefited most from workshops with a focused message. Teachers proved to be the best group to work with as they were able to grasp issues very quickly and translate them to action which would be seen immediately in the participation of their pupils on stage. As concerns the local community, radio programmes, '*barazas*'

and wetlands day celebrations proved to be the most popular approaches. From the foregoing, it is important when planning to create awareness among a cross section of stakeholders to identify which approach will give the best output.

8.2.5 Coping with Climate Change

The single most problematic issue that affected both the wetland conservation and the success of alternative livelihoods in the project was variability in climatic conditions in the Nyando. The resilience of the livelihoods of the poor and the resource base upon which they depend must be improved in response to current and future climate variability. As such, means must be sought to ensure the transition from coping with shocks towards more adaptive resilient systems that can confront future climate extremes.

Most of the alternative livelihood activities such as horticulture introduced in the project failed to pick up due to the variability in weather conditions. The ones that passed the test include apiculture, papyrus based wetland products, planting of bamboo, mulbery trees and fish farming. To mitigate the variability of extreme weather conditions, the World Vision funded some of these communities to start green house farming for horticultural products.

Flooding necessitated putting beehives at a level that would not be reached by water during floods; by putting them on higher ground --on trees or erected platforms. This was done by assessing the farthest points beyond which none of the major rivers could route themselves. It was however discovered that on some high ground, the bees migrated during the dry season in search of water. It is important to make water retention ponds near the beehives that would retain the water when the floods recede.

8.2.6 Leadership/Governance of Wetland resources

Leadership and overall governance in natural resource management is very important for any conservation initiative to achieve the desired goal. The project devolved the leadership of group activities to the local communities with the local leaders such as the Chiefs acting as patrons. Apart from group activities, the overall decision making organ to oversee all the conservation of the entire wetland ecosystem was lacking. It was learnt that despite some community members having parcel numbers of land within the wetland, an oversight authority was lacking. This role was neither played by the government nor the community, thus compromising the management of sites set aside for rehabilitation.

Political leaders in the area were not seriously involved in the management of natural resources in the region. However, the provincial administration played a very important role in coordination and conflict resolution in some critical project activities. It is therefore advisable to actively involve the local administration in all project activities. To improve the governance issues, the project came up with a participatory wetland management plan which also needed to be anchored onto some institutional framework that would foresee its implementation. NEMA coordinates all environment initiatives. However, there is need for the formation of an indipendent government agency with the mandate to coordinate, supervise and oversee wetland conservation activities.

To reduce the opportunity for any official to take advantage of the group members by selling the produce and keeping the money to himself or herself, it was agreed that the sale of any of the community products would be done by more than one person and that the leadership of the community wetland management groups would rotate periodically.

8.2.7 Gender issues

Equitable involvement of all gender is critical in conservation of wetland resources for it was learnt that different gender makes use of different wetland resources at different times and purposes. However, women were the majority in conservation and marketing activities, with men and the youth always being underrepresented. This overburdened the women whose daily itinerary was already crowded. Future community based wetland management should seek ways of improving the involvement of men and the youth to actively participate in conservation activities.

8.2.8 Participatory approaches

Whereas participatory approaches are the best with popular activities for members of the community, it was learnt that other intervening factors should also be taken into account. For instance, horticultural production came up as the most popular alternative livelihood activity which was addressing food insecurity among all the community groups. However, due to the erratic weather conditions in this area (which included drought and flooding as well as pests and diseases) the activity proved to be unsustainable. Participatory approaches are however very important as they lead to an all inclusive broad based involvement with all the stakeholders knowing and being part of what is being implemented, thus creating a strong sense of ownership.

8.2.9 Conflicts in wetland resource use

It was learnt that there are many types of conflicts that arise from the utilization of wetland resources by different stakeholders in the Nyando Wetland. These conflicts were worsened by erratic weather conditions, particularly during droughts when the level of degradation and number of conflicts escalated. These conflicts also affected the food security situation of the area, thus triggering further degradation. Coping mechanisms should be designed to mitigate negative impacts of resource use conflicts.

8.2.10 Policy issues

To date, Kenya does not have a national wetland policy. This is a major drawback to wetland conservation and management, particularly for those wetlands outside protected areas. Even when a provision exists, such as the ones on regulations governing wetlands, riverbanks, lakeshores and seashores, the mechanisms for enforcement at the community level is very poor. Sectoral conflicts still exist that undermine implementation of such key issues like delineation and protection of the buffer/ riparian zones in both lacustrine and riverine wetlands. This situation is worsened by the allocation of land ownership rights to individuals by the ministry of lands in fragile wetland ecosystems without consultation with other key ministries such as Water, Fisheries and Environment. For instance, when Lake Victoria receded, it was extremely difficult to stop further destruction of the wetland due to contradictions on the boundary of the buffer zone from different sectors of the government. Something must be done urgently to mainstream relevant policies at all levels through co-management approach if the remaining stressed wetland resources are to be saved. From the foregoing, the project mobilized the community to come up with their own bylaws to protect their wetland.

8.2.11 Fatigue by the community

A number of interest groups had been conducting research activities in Nyando Wetland over time, with most of them seeking the same information from the local communities. With time, the communities became fatigued, some becoming uncooperative with researchers. However, the project benefited from the good rapport with the community over time. Nonetheless, it is important to note that fatigue may result in researchers collecting unreliable data, thus making inaccurate decisions in a community based wetland management initiative.

8.2.12 Partnerships and collaborative activities

The project benefited greatly from working with different institutions, considering that the project offered opportunities for researchers, students and managers to come and learn about community based wetland management. In the life of the project, several students from institutions of higher learning, both nationally and internationally, were attached to the project as part of their professional training.

8.2.13 Communication and information sharing

There is also a need to come up with a formal communication strategy in a community based wetland management initiative. Some of the representatives of the community groups who attended meetings/trainings, for example, were unable to pass the information when they went back home. Documentation and sharing of data collected is important so that other interested parties do not go back to the communities for the same information.

In the life of the project, several need-driven research activities were carried out which proved useful in informing the interventions that were implemented. This approach can be replicated in other community based wetlands management initiatives as a best practice. Where it is not possible to do both, there should be a link between the implementers of the wetland community based management with institutions of research or higher learning to provide the much needed information. Regular dialogue between scientists and policy makers to inform and guide policy regarding wetland management is also crucial. From the foregoing, it is important to establish a resource centre having all the data regarding the particular wetland and link it with the national wetlands database.

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CHAPTER 9

Nyando Wetland in the Future

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Summary

The future of Nyando Wetland seem to be at cross-roads between community livelihood support and biodiversity conservation. This important wetland ecosystem, currently threatened by pollution from both diffuse and point sources, Climate Change and variability, poverty manifesting itself as low income, knowledge and food insecurity portend serious and deleterious effects on the ecosystem integrity as well as the socioeconomic well-being of Nyando Wetland-dependent communities. The degradation of this wetland has been exacerbated by lack of a substantive wetland policy and a gazzeted inventory/map of Kenya's wetlands, resulting in social chaos characterized by encroachments into the wetland, overexploitation of wetland goods and uncontrolled human behaviour towards the wetland. This chapter uncovers two scenarios for the Nyando Wetland, taking cognizance of the current pressures, threats and opportunities including the development and implementation of an integrated wetland management plan. The scenarios are constructed in line with the constitution of Kenya 2010 and the national blue print --Kenya Vision 2030-- both of which are strongly anchored on the tenets and principles of sustainable development. The chapter therefore summarizes the entire book and provides the future pathway towards sustainable management and utilization of Nyando Wetland resources through participatory multi-pronged approaches, gender and culturally-sensitive interventions and policy frameworks.

9.0 Emerging scenarios and the future of Nyando Wetland

The challenges facing the management of Nyando Wetland include pollution, Climate Change and variability, gender inequity, poverty, reclamation for agriculture, resource use conflicts, lack of policy and legal frameworks leading to unsustainable management and utilization of resources. These challenges have long-term implications and the location of the wetland in unprotected areas demands carefully thought out long-term community-based interventions. It is imperative that strategic management actions are informed by established trends and the potential of the ecosystem in question. This chapter explores amalgamating scenario and forecasting/outlooks to help explain the discontinuity and uncertainties of future developments (Alcamo 2008, Raskin 2005) in the basin and come up with the way forward for managing this fragile ecosystem.

Scenarios are consistent and coherent descriptions of alternative hypothetical futures that reflect different perspectives on past, present and future developments, which can serve as a basis for action and a means of handling uncertainty (van Asselt *et al*. 2007). Environmental scenario analysis used here has become a commonly used approach for supporting forward-looking assessments in integrated environmental assessments. They offer a framework for bringing together insights from a range of perspectives and disciplines to assess the complex interactions between socioeconomic and environmental developments (Alcamo and Henrichs, 2008, Borjeson *et al*, 2006). In doing so, scenario exercises provide a structure within which to reflect on and think through the possible implications of

alternative decision pathways, bringing expert knowledge and stakeholder perspectives to bear. This is expected to provide various options to tackling the challenges facing Nyando Wetland that have been highlighted throughout this book. The analysis has been done in the light of the provisions of Vision 2030 which stipulates that Kenya should embark on a broad environmental programme aimed at conserving wetlands and watersheds, terracing fragile agricultural lands, managing invasive alien species, and reforesting both public and private land (GoK, 2007).

The Nyando Wetland outlook scenario is therefore conducted here to:

- follow through the emerging issues, challenges and opportunities presented by the wetland resources that are of socioeconomic importance;
- identify and track changes in key environmental drivers in order to isolate major thresholds and tipping points for negotiating tradeoffs that would inform policy and environmental management at different scales;
- track progress, under different pathways of the interventions in Nyando Wetland in relation to the key development outcomes including MDGs, LVBC, the Vision 2030;
- perform sensitivity analysis of alternative policy options in order to generate a range of policy actions that would fast-track progress towards key environmental goals;
- create awareness among key stakeholders especially policy makers and local communities on salient wetland management options as well as the cost and benefits of alternative wetland management schemes.

9.1 Nyando Wetland scenarios

The two distinct scenarios provided and discussed for the Nyando Wetland in the light of the Constitution of Kenya 2010 as well as the national development blue print, Vision 2030 are:

i. Business as usual (open market forces, social chaos, ownership/tenure issues, resource use conflicts, overexploitation);
ii. Business unusual (transformational impact, policy reform, good governance, public participation, implementation of Nyando Wetland Management Plan)

9.1.1 Scenario 1: Business as Usual

Under this scenario, it is assumed that the Nyando Wetland communities and the government will continue operating and maintaining a status quo, in which individual community members are on their own and continue to exploit and derive profit from the Nyando Wetland. In this scenario, market forces and competition dictate the pace of wetland utilization. In addition, government structures do not support controlled exploitation of wetland resources, plunder and social chaos result, with far-reaching implications on socioeconomic inequity and resource-driven conflicts. Similarly, the government and other actors put in place reactive policies and regulations in an attempt to reverse the negative effects of wetland degradation of uncontrolled market-driven wetland resource exploitation. These policies are primarily top-down in nature and thus fail to entrench participatory conservation. They do not lead to the establishment of sustainable and equitable environmental and wetland management institutions. The efforts are too little too late.

The other basic assumption in this scenario is a total breakdown in social systems coupled with unprecedented economic crises. Here, a select group of individuals, communities and institutions take control of the lion's share of the wetland assets at the expense of the majority for their own selfish economic gains. There occurs wanton plunder and damage to wetland resources, a drastic

increase in wetland degradation and escalation of poverty and environmental conflicts. In this most pessimistic scenario, the future is characterized by inefficient institutions, and a failure to address wetland degradation, slow economic growth, social exclusion and inequalities, unemployment and poverty. The political dilemma is characterized by poor policy formulation and weaknesses in the oversight institutions. In this scenario, wetland communities are systematically dragged into an abyss of underdevelopment and hopelessness and the assumptions are similar to those guiding the AEO Fortress World Scenario.

9.1.2 Scenario 2: Business Unusual

A paradigm shift is assumed in this scenario which would see the communities meet the MDG targets, realize the Vision 2030 aspirations and sustainably manage its environmental assets. The assumptions are akin to those underlying the AEO Great Transitions Scenario (UNEP 2006). As a result of carefully thought out policies and institutional arrangements, the environment and wetland agenda is fully mainstreamed in national development planning. Well-functioning public institutions support wetland management, agriculture and market development.

Market barriers are reduced, infrastructure improved and the prevailing policy environment facilitates environmentally sensitive innovation in both urban and rural economies. The impact of Climate Change is adequately addressed through low carbon growth, vibrant adaptation strategies and technologies, communities embrace wise-use principle of wetlands. This is the most optimistic scenario and the country experiences political, social and economic reforms in line with the Vision 2030 and Constitution of Kenya 2010 aspirations. The policy and institutional environment is characterized by functioning institutions, policies and a strong regulatory environment that is able to address issues to support economic growth and environmental sustainability.

9. 2 Building scenarios with regards to the Constitution of Kenya 2010 and Vision 2030

Government of Kenya has over the past few years recognized that short-term strategies have to be put in the context of long-term development planning. Environmental changes are largely long-term and must be overlaid on the broader socioeconomic development landscape. Vision 2030, whose primary goal is to transform Kenya into a globally competitive and prosperous nation, was launched in 2007 and has become the reference point for all government policy activities including those on the environment. Central to this effort has been a reconsideration of the manner in which the state engages in development policy and which models of development to emulate. The wetland scenarios in this chapter are used to provide stakeholders with key lessons from plausible development pathways. Apart from the aspirations of Vision 2030, these scenarios are also pegged on the 2012-2030 temporal scale and are used as targets to measure the impact of Nyando Wetland sustainable management action over this period.

9.2.1 Mainstreaming of gender, disability and HIV and AIDs

The confluence of gender, HIV and AIDS and wetlands has not been explored for the Nyando Wetland. However, loss of wetlands and the benefits can be devastating for women's livelihood security, and the survival of their families. Wetland ownership, access to and control of wetland resources, type of products harvested, and the environmental income derived from such products

follow specific and distinct gender patterns at the community-level. Women of Nyando still carry an inordinate burden of work as providers of family food, fuel and water which bring them into contact with the wetland in this area on a daily basis. In addition, as the caregivers, they provide essential support to families and ill-relatives, occasioned by the HIV and AIDS pandemic.

The HIV/AIDS shows regional heterogeneity in the country, with Nyanza Province-- posting an overall prevalence of 14% --being the worst affected with. In Nyando, HIV and AIDS prevalence stands at 15%, double the national prevalence (6.3%) (KDHS, 2008), reducing the productive capacities of many household members. This accelerates dependency and over-reliance on the available wetland resources. Such intricate linkages between people and wetlands must be taken into account particularly when developing programmes and policies towards managing the Nyando Wetland for both nature conservation and the wellbeing of the people.

On the other hand, environmental crises such as floods frequently experienced in Nyando River Basin result in the displacement of people aggravating Gender Based Violence (GBV). This is because inadequate resources and access to basic services create despondency, predisposing the displaced, particularly women and girls to higher than-average levels of violence. The fact that victims are often in uncharted territories means that they do not know where to turn to for help and often have to endure months or years of gender based violence before they can get help, a situation worsened by inadequate gender-sensitive infrastructure such as evacuation centres. All these have negative implications on the sustainable management of the Nyando Wetland. The Constitution of Kenya 2010 as well as Vision 2030 guarantee a healthy people and re-enforces the right to healthcare. The supreme law further discourages discrimination based on sex. Thus Gender and GIPA (Greater Involvement of People with AIDS) principles underscore the sustainable management and utilization of the Nyando Wetland resources. In addition, strategic interventions must also ensure disability mainstreaming at all-levels.

9.2.2 Addressing poverty and sustainable livelihoods

The nexus between poverty and sustainable wetland management are new areas of research work. Poverty exacerbates wetland degradation in a number of ways. The poor rural communities are forced to overexploit the open access, unregulated and unprotected Nyando Wetland resources because to them, "*nature is a daily lifeline*" (WRI *et al*., 2005). In addition, due to lack of security of tenure, local communities encroach into and tend to occupy and reclaim the wetland portions for agriculture (Schuyt, 2005). This is why it is not surprising that poverty indices have tended to confirm the contention that some of the Lake Victoria lakeshore districts have some of the highest incidences of poverty in the country. Nyando District poverty levels stand at 60%, far much higher than the national one as reported by the World Bank Poverty Incidence Report (2012). According to UNDP's report (2010), 46.6 percent of Kenya's population lives below the national poverty line. Because poor people do not enjoy secure land rights, they are forced to cultivate ecologically fragile landscapes such as wetlands, lakeshores and floodplains with catastrophic consequences for themselves, biodiversity, ecosystems and the general environment.

In addition, continued use of rudimentary technology due to poverty contributes to wetland degradation. For example, overharvesting of papyrus (*Cyperus papyrus*) for making traditional mats, wrong fishing gear that targets young and gravid fish populations moving upstream to spawn, promotes depletion of fish stocks in Nyando Wetland ecosystem. The situation has been aggravated by erosion of traditional and indigenous knowledge, partly caused by westernization. Traditionally, cultural norms and practices regarding respect of taboos and totems, reverence of sacred sites for cleansing, ritual regulation of resource harvests and buffer zone maintenance were used to ensure sustainable use of valuable plant and animal species for the common good of the entire communities (CBK, 2008).

Wetland degradation on the other hand exacerbates poverty. For instance, pollution of River Nyando from upstream agro-based industries such as Muhoroni Sugar Company and Agro-Chemicals and Food Company, pose a huge challenge in terms of increasing vulnerability and diminishing health and well-being of the poor rural Nyando Wetland communities. Several cases of animal/livestock deaths belonging to communities living in the lower portions of the Nyando River have been reported, and this has partly been attributed to pollution from chemicals discharged into the River Nyando. Communities are therefore vulnerable as they lose their livelihood sources, occasioned by restricted and limited gamut of coping mechanisms. As a result, Payment for Ecosystems Services (PES) and Ecological Compensation are imperative in order to realize environmental justice. Under PES, the polluters may be forced to pay for the pollution caused (invoking the polluter pays principle ascribed by EMCA (1999)) while ecological compensation demand that the wetland resource users (particularly, downstream) undertake serious wetland restoration programmes such as planting papyrus on the degraded wetland areas including riparian zones and zoning the entire wetland ecosystem.

All these interventions must be embedded in and integrated with sustainable livelihoods upon undertaking a livelihood analysis using Sustainable Livelihood Approach (SLA). This approach is based on the premise that households or individuals select a set of strategies based on the availability of a mix of assets, either human, natural, capital, social, physical or political to improve the quality of their lives. There is opportunity for Nyando Wetland partners to link up with organizations that provide training in management of savings and credit groups such as Decentralized Financial Services (DFS).

Box 9.1: Payment for Ecosystem Services (PES) for wetlands conservation

Continued degradation of natural resources is largely due to unsustainable and adverse human activities characterized by over-exploitation, increased human populations, high poverty levels and escalating civil strife in many regions of the developing world. Communities living in and bordering protected areas and similar areas with high biotic diversity and endemism often do not receive incentives to compensate for their stewardship in conservation. As a consequence, communities who are cost bearers of ecosystem goods and services, live poised to ignore sustainable use of natural resources in favour of unsustainable extractive practices. Conservation and management measures have also fallen short of ensuring equitable distribution of costs and benefits between the various beneficiaries and cost bearers of ecosystem goods and services. Thus, a need to develop and implement incentive mechanisms for the conservation of resources within productive landscapes is lately an issue of international appeal (e.g., UNDP, 2005; Stern, 2006; Hall, 2008; Wunder *et al*., 2008). Payments for Environmental Services (PES) are systems designed to provide monetary compensation for the services ecosystems (including wetlands) supply to society, including carbon sequestration, biodiversity, scenic beauty and watershed protection, among others. In order for PES to be implemented, environmental services must be identified and evaluated and payment mechanisms established to encourage continued provision of services. While PES is a well established mechanism for environmental protection elsewhere (Wunder *et al*., 2008), the practice is taking root with a number of projects currently running on many landscapes in Eastern Africa (Masiga, 2011). The practice has been mooted as one of the most viable approaches of incorporating communities in natural resource management in Eastern and Central Africa (Berttram, 2011). Learning from its successes in areas it has been implemented, PES has a huge potential for protecting wetlands while at the same time addressing the high levels of poverty among communities inhabiting wetlands and adjoining areas (e.g., Wanjohi *et al*., 2011).

9.2.3 Human Rights Approach (HRA), indigenous knowledge and institutions and public participation

The Constitution of Kenya 2010 has firmly enshrined the Bill of Rights in Chapter Six. This is the supreme law of the land, founded on principles of good governance through multiparty democracy, participatory governance, transparency and accountability, separation and devolution of powers, respect for human rights and fundamental freedoms and the rule of law (GOK, 2010b). Similarly, the supreme law has entrenched the principle of public participation and right to access information (consultation) on issues that directly and indirectly affect people. The right to a clean and healthy environment for all is articulated in Article 42 of the Constitution. Human rights values, sustainable wetland management integrated with good governance of democratic institutions create avenues for communities to participate in policy making either through formal institutions or informal consultations. Human rights approaches also establish mechanisms for inclusion of multiple social groups such as youth, women, and people with disability, elderly and other marginalized and vulnerable segments of the community in decision-making processes, especially locally. Further, upholding human rights principles encourage local communities to formulate and express their positions on issues of importance to them including sustainable management and exploitation of wetland resources. Thus the creation of adequate democratic space, good governance, transparency and accountability is imperative towards the managing the Nyando Wetland and its resources. This will require continual capacity building and awareness-raising of local communities to understand the government's roles and responsibility and establish mechanisms of holding the government and other state actors accountable for management of the wetland and delivering state services to the public.

In the realm of the rule of law, human rights-sensitive sustainable wetland management initiatives may require stringent penal systems at community-level while encouraging respect for the rule of law particularly on the current and existing wetland related legislations and policies. This will require rigorous mind-set shifts from impunity-richness towards open and transparent judicial systems that ensure both human and environmental justice. Finally, anti-corruption measures will also be required as part of the good governance framework and to bolster community participation, transparency and accountability. Community-level initiatives that may be required include establishing local-level wetland-based institutions such as village anti-corruption commissions (VACCs), creating mechanisms of information sharing, and monitoring governments' use of public funds such as Constituency Development Fund (CDF), environment management/restoration funds and implementation of policies and Nyando Wetland management by-laws.

9.2.3.1 Improved information gathering, management and dissemination

Information is an essential element in the sound management of land and water resources which include wetlands. According to Bruch (2003), access to information is the cornerstone of public involvement in any management decisions because it evokes emotions on the basis of knowledge of the nature, location and gravity of environmental harm and threats as they get exposed to communities. Such knowledge enhances the ability of resource users to make prudent decisions and be responsive to environmental circumstances in support of sustainable and efficient wetland management and conservation actions. Availability and access to relevant information can therefore improve the quality decisions and spur Nyando Wetland riparian communities into sustainable wetland management actions. Sustainability in this regard is attainable through learning process, which develops awareness,

knowledge, understanding of the environment and critical thinking skills among the resources users (Hamed, 2009). In an increasingly connected world where actions in one area within a river basin such as the Nyando system can affect people and the environment in other areas downstream or upstream of the basin, it is imperative that such an important element of resource management is made not only available but also sharable among stakeholders.

Information gathering, management and dissemination in the region and the wetlands, in particular, is fragmented, thus inhibiting the very purpose for which information is required. This also works against environmental conservation and management. More often than not, one encounters poor networking and therefore little or no sharing of data or information among stakeholders. Even if that were possible, a further hindrance would be the nature and packaging of information which is poor with minimal integration. This makes it relatively inaccessible by those who need it to generate suitable resource use decisions for the sustainable management of the Nyando Wetland.

The scenario is further aggravated by inadequate resources and legal structures both at the formal and informal levels as well as weak frameworks to support information sharing mechanisms. Such frameworks need to be simple and community friendly to excite their effectiveness and utility. Like in many regions in Kenya, there is no harmonized and centralized data source through, for example, a Community Information Management System (CIMS) or an established website, which would catalyze a standardization process with a simplified procedure for continual data collection and updating for use in conservation decisions. Capacity building activities on information gathering, processing and management which include monitoring and evaluation are biased and largely elitist and have over the years neglected the needs and roles of local communities who ideally should be the practical consumers of the information.

With this kind of scenario in the Nyando Wetland ecosystem, there are grave implications on implementation of the Nyando Wetland Management Plan since there seems to be a disconnect between practice, conservation measures and policy processes due to inadequacy of information. In such scenario, degradation process continues unabated because there is no effective coordination of conservation measures.

Several models of information gathering, management and dissemination have been used to address scenarios of this kind especially in the Nyando project with varying success rates for instance, a model involving research, monitoring and evaluation, workshops, and such like tools. However, it is imperative that future models should take into account the fact that the receiver of the information holds the key to its success and when a model is suitable, an effect must be achieved as desired (Lasswell, 1948) with an attitude that leads to behaviour change. Such behaviour change can be sustained through repeated messages. The models will also need to embrace overlapping experiences to simplify and make it easier to gather and communicate information successfully (Schramm, 1954). This means that model designs must embrace involvement of communities fomenting the use of primary groups (Rileys, 1965) in information generation, management and dissemination. At a more technical level, information gathering should embrace modern tools and processes of information such as remote sensing and GIS for scenario development. However such tools and information management processes must be domesticated and translated into simplified information packages that communities can appreciate and consume.

9.2.4 Youth and sustainable wetland management

The youth constitute an integral part of the Nyando Wetland community and are entitled to enjoy all the rights and fundamental freedoms including access to and control of the wetland resources, taking into account their unique needs. According to the Constitution of Kenya (GoK, 2010b), youth is defined as a collectivity of individuals in the republic who have attained the age of 18 years but have not attained the age of 35 years and include both girls and boys, men and women. The population of Nyando is skewed towards the youth. With this in mind, this segment of the society cannot be ignored at all in the development and implementation of Nyando Wetland management plan, policies and programmes (PPPs). Their systematic inclusion in driving the Nyando Wetland management agenda is imperative; otherwise their exclusion may imperil the achievement of Vision 2030 goals and the multi-pronged objectives of Nyando Wetland management plan. This can be done through establishing affirmative action on wetland related programmes and participatory wetland governance structures at the community-level.

9.2.5 Adaptation to effects of Climate Change: building capacities and resilience

According to SEI (2009), Kenya already has a complex climate, with wide variations and very strong seasonality across the country and Nyando is no-exception. Regardless of the scenario, this is expected to continue towards 2030. The current projections of future Climate Change based on downscaled global models for Kenya indicate future increases in mean annual temperature (average monthly temperatures) of 1-3.5^{0}C over the range of models beyond 2030 (by the 2050s). The changes in precipitation are anticipated to be most uncertain. Many climate models show that rainfall regimes will change based on the season and region. Extreme events (mainly floods and droughts) are already being experienced in the Nyando River Basin and are expected to intensify over the scenario period with heavy rainfall in the wet seasons and thus greater flood risks while droughts are likely to intensify in the already affected floodplain.

The current scenario pathways towards 2030 are expected to only diverge, based on the strategies the country and Nyando Wetland communities and stakeholders are putting in place for understanding the economic cost of Climate Change, designing sustainable adaptation strategies and mainstreaming low carbon growth in all sectors such as agriculture, water, infrastructure, tourism and health. Ensuring adequate adaptive capacities of wetland ecosytems and communities that are already vulnerable to Climate Change is urgently required by all actors in order to improve adaptive capacities and coping mechanisms to climate related risks and disasters.

The Nyando Wetland is susceptible to periodic flooding and extreme drought regimes, occasioning loss of livelihoods, biodiversity and deterioration of community's health and well-being. Climate Change-people-wetland nexuses must therefore be analyzed together to provide adequate information that can inform integrated and strategic policy interventions. Such kind of analyses must wear the gender-spectacle as effects of both wetland degradation and impacts of Climate Change and variability are different on different genders. This therefore calls for integrated programmes encompassing population, health and environment (PHE) intertwined with a structured Information, Education and Communication (IEC) strategy for information dissemination and disaster preparedness.

9.2.6 Supportive Policy, Legal and Institutional Frameworks

Kenya is a signatory to a number of international and regional Multilateral Environmental Agreements (MEAs) and conventions. The Ramsar Convention (1971) is the intergovernmental treaty that specifically addresses sustainable management of wetlands. The convention lays a lot of emphasis on wetlands wise-use and promotes sustainable practices and management of wetlands. Kenya ratified this Convention in 1990 and since then enlisted five (5) wetlands as Ramsar sites-wetlands of international importance, mainly the Rift Valley lakes which include Lake Nakuru, Lake Naivasha, Lake Baringo, Lake Bogoria and L Elementaita.

Of strong relevance to the Ramsar Convention is the Convention on Biological Diversity (CBD --to which Kenya is signatory) there exists the Environmental Management and Co-ordination regulations (conservation of biological diversity and resources, access to genetic resources and benefit sharing). This convention acts very much as an overarching structure, to which other conventions with their own more precise focus, can and must relate and contribute. The world community's growing commitment to sustainable development has inspired this convention. It represents a dramatic step forward in the conservation of the biological diversity much of which is derived and supported by wetland ecosystems, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources. In addition, the African-Eurasian Water Bird Agreement (AEWA) developed in 1993 from deliberations of the Bonn Convention which held its first consultative meeting of range states of AEWA in Nairobi in June 1994, is another agreement that offers a good opportunity for the management and conservation of the Nyando Wetland.

At the national level, the Constitutional dispensation of Kenya (2010) is regarded as 'green' law, recognizing and giving prominence to environment as a critical and integral part in achieving sustainable development. Article 2 sub-article 6 states that '*any treaty or convention ratified by Kenya shall form part of the law of Kenya under the constitution*'. Article 42 of the Bill of Rights provides all Kenyans with the environmental right to a clean and healthy environment, again giving prominence to the environment, not as a State-given resource, but, rather, God-given. The supreme law therefore underscores the need for sustainable utilization, exploitation, management and conservation of the environment and natural resources as well as ensuring ecologically sustainable development and the protection of ecologically sensitive areas (ESAs) such as wetlands.

In addition, the motherboard environmental framework law, the Environmental Management and Coordination Act (EMCA, 1999) and the subsidiary legislations such as the Wetlands Regulations (2009) among others underpin sustainable management of wetland ecosystems. Section 42 of EMCA (1999) spells out clear provisions towards management of wetlands, including development of wetland management plans for the protection of rivers and lakes. Section 55 provides for the protection and conservation of coastal and marine related wetlands. Other Acts of Parliament with relevance on wetlands management include the Agriculture Act, Water Act (2002), Forest and Wildlife Acts. Although these sectoral Acts emulate the need for sustainable management of wetlands, their enforcement has not been achieved and often provide conflicting management regimes and setback lines. The implementation of the Constitution anticipates harmonization of the diverse sectors, ministries and government agencies towards integrated and harmonised approaches in environmental and natural resources management in the country.

Kenya Vision 2030

The Vision 2030 which is a 20-year development blueprint recognizes wetlands and water catchments as key components in spurring economic growth, thereby reducing poverty. Under the social pillar, the vision appreciates that Kenya's journey towards prosperity involves the building of a just and cohesive society, enjoying equitable social development in a clean and secure environment. The Vision has provided clear flagship projects for water (wetland) based tourism. In terms of policies, it is a pity that most laws are made before policy development. In fact, most policies in Kenya are at the draft (sessional paper) level awaiting finalization and enactment. Of relevance to wetlands are two policies, currently at the draft stage, which include the draft Environment Policy (2012) and the Draft Wetlands Management and Conservation Policy (2012). The former provides overall policy direction and guidance on sustainable environmental management including wetlands and freshwaters. Development of the Draft Wetland Policy is in cognizance of the importance of wetlands nationally and Kenya's obligation under the Ramsar Convention. The object of the draft policy on wetlands is to ensure wise use and sustainable management of wetlands in order to enhance sustenance of their ecological and socioeconomic functions for the present and future generations of Kenya.

Institutionally, wetlands in Kenya are managed by diverse institutions such as NEMA, WRMA, KWS, KFS, among others. Oftenly, this poses a serious challenge of roles, overlapping mandates and responsibilities. KWS is the Ramsar administrative focal point, charged with the management of Kenya's Ramsar sites (20%). Despite this, it does not have authority over wetlands in unprotected areas, which constitute the biggest portion of the country's wetlands (80%). On the other hand, WRMA looks at wetlands from a water resource angle. The conservation of wetlands in unprotected areas will therefore still benefit heavily from community based efforts, which to date do not have formal documented structures.

9.3 Participatory Management of Nyando Wetland: key recommendations

9.3.1 Trans-disciplinary research, information sharing, awareness and capacity building

The Millennium Ecosystem Assessment (MEA, 2005) documents the dependence of human well-being on healthy ecosystems, the global loss of ecosystem services, and the options for reversing this trend. Although people may readily articulate the benefits they derive from wetlands, they are usually unaware of many others, and they often miss the key points that most of those benefits depend on healthy wetland ecosystems and that these ecosystems are already degraded or threatened. Ecosystem services need to be explicitly linked to socio-ecological scenarios to demonstrate how ecosystems benefit humans (Tallis and Kareiva, 2006). The World Summit on Sustainable Development (2002) highlighted the need for integrated management of wetlands from the catchment through the river/estuary into the lake/sea. Trans-disciplinary researches integrating both social and wetland research are imperative. The information/data derived should be churned into community-friendly information packages, establish information resource centre at the community-level, as well as development of policy briefs while fostering education and awareness to local stakeholders on experiences and perspectives of sustainable wetland management within the River Nyando Basin.

9.3.2 Embrace adaptive and co-management principles

Like many others, the Nyando Wetland is a dynamic ecosystem. It is therefore important to take note of this and promote flexible programmes and adaptive policy frameworks that recognize and are sensitive to changing scenarios of both the wetland and the dependent communities, including the integration of Climate Change adaptation interventions. Co-management recognizes that the Nyando Wetland community has direct control over the management, utilization and benefits of the wetland resources in order to value and use them in a sustainable manner.

9.3.3 Link Nyando Wetland science outcomes to the management and policy formulation

A key gap in sustainable management of wetlands is that policy and wetland management is not adequately informed by reliable scientific knowledge and data. The success of the management of the Nyando Wetland is partly attributed to the deliberate involvement and active participation of women, despite their busy itinerary as depicted by the gender profiles. However, there is no research conducted on why the youth, despite their numbers and being the majority, and men, are taking a back seat in the conservation and sustainable utilisation of the wetland. In addition, it is useful to create avenues for constructive dialogue, discussion and sharing of ideas between the communities implementing the wetland management plan, scientists/researchers and policy makers.

9.3.4 Respect for the rule of law, good governance and traditional knowledge

Establishing supportive, open and transparent systems of wetland governance/frameworks is necessary. This would involve appropriate changes to laws that address land tenure, wetland resource access, property rights, and the recognition of co-management regimes in local policies, legislation, and development plans, and how these affect local initiatives. These should effectively incorporate traditional knowledge and technologies in the protection and conservation of the wetlands

9.4 The Nyando Wetland Integrated Management Plan

A wetland management plan is a blue print which stipulates clear actions and activities to be undertaken by the wetland actors. The development of the plan is anchored on the existing law (EMCA, 1999) as well as requirement by the Ramsar Convention. The plan was developed in a participatory manner through involvement of all the stakeholders within the Nyando River Basin. The plan provides broad strategic objectives towards sound management of this fragile ecosystem. Under each strategic objective are several activities whose achievement will culminate in attainment of wise use and sustainable management of the wetland. The five strategic objectives which will guide the future management of the Nyando Wetland as enshrined in the Integrated Wetland Management Plan include:

i) To minimize resource use conflicts in Nyando Wetland through capacity building and diversification of IGA for improved socioeconomic benefits;
ii) To implement adaptation and mitigation measures to combat negative impacts of extreme variability in climatic conditions for sustainable livelihoods;
iii) To minimize environmental degradation through sustainable agro-forestry and other land use practices within the Nyando River Basin;
iv) To minimize the impact of water pollution through improved wastewater treatment and agricultural practices upstream;
v) To minimize loss of wetland biodiversity for increased food security.

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