WETLAND UTILIZATION AND COMMUNITY PERCEPTION ON PAYMENT FOR ECOSYSTEM SERVICES IN CONSERVATION OF NYANDO WETLAND OF THE LAKE VICTORIA BASIN, KENYA

BY

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University or for any other award.

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DEDICATION

I dedicate this thesis to my lovely wife Grace, son Brayden, daughter Addeline and my parents for their love, inspiration and encouragement, and their enormous support.

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ACRONYMS AND ABBREVIATIONS

BMU	Beach Management Unit
CBD	Convention for Biological Diversity
CBOs	Community Based Organizations
CPRs	Common Pool Resources
CREPP	Community Rehabilitation and Environmental Protection Program
DSR	Driving force (Pressure)-State-Response
EIA	Environmental Impact Assessment
EMC	Environmental Management and Coordination
GoK	Government of Kenya
HWC	Human-Wildlife Conflict
KNBS	Kenya National Bureau of Statistics
KWS	Kenya Wildlife Service
KWSC	Kenya Wetland Standing Committee
LVBC	Lake Victoria Basin Commission
LVFO	Lake Victoria Fisheries Organization
MEA	Millennium Ecosystem Assessment
NEMA	National Environment and Management Authority
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Cooperation and Development
PES	Payment for Ecosystem Services
PRA	Participatory Rural Appraisal
SDGs	Sustainable Development Goals
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total Economic Value
UNEP	United Nations Environmental Programme
UNDP	United Nations Development Programme
VIRED	Victoria Institute for Research and Development
WTA	Willingness to Accept
WTP	Willingness to Pay

ABSTRACT

People's livelihoods especially those living near wetlands in developing countries are often directly dependent on wetlands and watersheds through provision of food, water and biomass. The high rural population density within Lake Victoria is rapidly enhancing urbanization, land conversion to settlement, agriculture and industry. These activities have resulted to depletion of wetland resources and threaten the Lake wetland ecology and livelihoods of the local communities. The aim of this study was to examine the utilization and evaluate payment for ecosystem services within the Nyando wetland for enhanced environmental sustainability and community livelihoods. The objectives of the study were to investigate institutional arrangements governing conservation of Nyando wetland resources, examine the utilization of Nyando wetland ecosystem services, and examine the local community's perception on payment for ecosystem services in Nyando wetland. The study uses two theories namely the social-ecological systems and the driving force state response framework. A case study survey design approach was employed for data collection. A stratified random sampling based on two administrative sub-counties namely Nyando and Nyakach was employed to collect data at household level using a structured questionnaire. A total of 394 households were sampled. In-depth interviews were undertaken with key informants from governmental and non-governmental organizations and members of the local community. The quantitative data was subjected to descriptive statistics, Chi-square test and correlation analysis which were performed in SPSS version 20. The data was presented in figures and tables. Content analysis was performed on qualitative data whereas land use/cover change analysis was performed for land use change detection. The results show that the local community mainly depend on the wetland for farming, harvesting of firewood and papyrus, and fishing for both domestic and commercial use. Human disturbance from vegetation clearing and burning for agriculture and settlement, climate change and variability, and inefficient resource governance has resulted to reduction in the size of the wetland by -2,933.1 Ha (-24.4%) between 1985-2020 which has consequently affected the availability of its ecosystem services. Both informal and formal institutions exist in the conservation of Nyando wetland with the former having evolved over time and were gaining little appreciation as a result of commercialization of farming activities, ethnic mix, modernization and influences from the western culture. Several conservation initiatives including tree planting activities, flood control, education and capacity building were taking place in the area being championed by either County governmental or Non-governmental organizations. Lack of resources (33.3%), high poverty and limited knowledge amongst the local community (28.6%) and policy conflicts and duplications resulting to poor organizational coordination (23.8%) are the main challenges to effective enforcement of conservation rules. Lack of awareness was cited as the reason for non-familiarity with the payment for ecosystem services concept. This study recommends Nyando wetland boundary delineation, co-management of the wetland resources, adoption of sustainable alternative livelihood activities and payment for ecosystem services, and harmonization of the different legislations contained in many pieces of government frameworks in-order to achieve coherence in sustainable management and conservation of wetlands.

CHAPTER 1: INTRODUCTION

1.1 Background to the study

Wetlands are of great importance for biodiversity and people and are amongst the important natural resources of the world (Gardner *et al.,* 2015; Okonkwo *et al.*, 2015; Ramsar Convention on wetlands, 2018). The recognition of the contribution of local natural resources especially vegetation to the livelihoods of the rural people is increasing in Africa (Rönnbäck *et al.,* 2007; Shackleton *et al.,* 2008; Lannas and Turpie, 2009; Little and Lara, 2010; Adekola and Mitchell, 2011; Terer *et al.,* 2012; Khan *et al.,* 2013). Well-functioning wetlands produce multiple ecosystem services (Morrison and Harper, 2009) and therefore their losses are becoming of particular interest for communities who depend on them for their livelihoods (Maclean *et al*., 2011).

The Millennium Ecosystem Assessment (MEA) describes four major classes of ecosystem services namely; provisioning (goods) such as water and food, cultural services such as spiritual, recreational and religious, regulating services including regulation of floods, droughts, diseases and land degradation and supporting services such as nutrient cycling and soil formation (MEA, 2005). Ecosystem functions are the ecosystem's components and processes ability to offer services and goods for satisfaction of human needs either directly or indirectly (de Groot *et al.,* 2002; TEEB, 2010). Wetland ecosystems provide services and goods which are important for sustenance of livelihoods (Costanza *et al.,* 1997). Based on MEA definition of ecosystem services, Díaz *et al.,* (2006) acknowledges ecosystem services importance for human well-being for making life possible and worth living i.e. basic material

for life, health, good social relations, security and freedom of choice and action (MEA, 2005). To translate a function into a service that ecosystem beneficiaries may be willing to pay, ecosystem services research requires the identification of beneficiaries, their location and the way they use the service (Egoh *et al.,* 2007).

Wetlands provide habitats to many organisms and are part of the most productive ecosystems (Daigneault *et al.,* 2012). Despite their importance, they have been described as least understood and most abused assets (Maltby, 1990). For instance, MEA (2005) and Abraham (2015) argue that wetland ecosystems are more rapidly lost than other world's habitats as a result of their ecosystems being affected mostly by development. The continued conversion of wetlands to other uses has been enhanced due to misconceptions on wetlands as wastelands and the little awareness on the vital services they provide (Ramsar Convention Secretariat, 2015). Environmental and ecological problems have arisen as a result of wetlands loss consequently leading to depreciation of socioeconomic benefits (MEA, 2005).

High agricultural productivity characterizes the Nyando wetland (Terer *et al.,* 2005). High soil humidity as a result of nutrients and sediments transported by runoff and rivers fertilizing the soils and the freshwater availability mostly during the dry season are amongst the main factors making the wetland attractive for agriculture (Terer *et al.,* 2005; Van Dam *et al.,* 2013). Large portions of land which are exposed along the interface of the lake/land due to recession of the Lake Victoria waters have contributed to land use changes in the Nyando river basin (Obiero *et al.,* 2012a). Over the past decades, these land use changes have negatively impacted on the wetland ecosystems resulting to degradation of habitat and loss of wetland services and values (Swallow *et al.,* 2008). Global International Water Assessment (GIWA),

2006) reports that the livelihoods of almost 80% of the Nyando human population rely on subsistence agriculture. This implies that as agriculture continues to intensify, significant environmental impacts will continue to be felt from Nyando catchment.

Payment for ecosystem services (PES) is an emerging and promising conservation approach that offers payments to natural resource user's upon delivery of ecosystem services (Wunder, 2005; Pagiola and Platis, 2007; TEEB, 2010; Schomers and Matzdorf, 2013). PES approach has the capacity of enhancing conservation of biodiversity, management of wetlands, eradication of poverty and contributing to sustainable development (Wanjohi *et al*., 2011). For instance, ecosystem services compensation for land users would make markets to consider such services in decision making processes and therefore enhance opportunities for controlling degradation of land (Pagiola *et al.,* 2005).

PES arrangements can provide opportunities to link conservation efforts at local level to regional and global markets consuming these services and who have the capacity to offer financial resources (Pagiola *et al.,* 2005). PES schemes development motivation is driven by the need for alternative sustainable financing of protected areas, ecosystem services demand, ecosystem services corporate interest investments and supportive changes in natural resources governances (Scherr *et al.,* 2006). PES schemes have been shown to have lots of potential in developing countries particularly in rural areas where poor communities and the bulk of biodiversity reside (Scherr *et al.,* 2006). Rural communities' riparian to wetland ecosystems have their livelihoods linked closely to wetland resource exploitation (Food and Agriculture Organization (FAO), 1999), and therefore the

need to provide incentives such as ecosystem services payments so as to divert the community's attention from the resources which are under exploitation.

Advocacy for PES schemes within the Nyando basin has been taking place through alternative livelihood activities to wetland exploitation. Non-Governmental Organizations (NGOs) such as SCC Vi-Agro forestry and Victoria Institute for Research and Development (VIRED) have been offering agro-forestry training assistance and providing certified tree seedling to the local communities (Raburu *et al.,* 2012). The Nyando wetland has had some level of co-management of its resources with incentives from NGOs operational within the Nyando basin. A classic example is the restoration of Okana wetland which had been degraded and dried up completely (Raburu *et al.,* 2012). Presently, a large portion of Okana wetland is surviving with an increased biodiversity (Raburu *et al.,* 2012).

Consultation of communities on proposed conservation and restoration projects is required so as to know people's needs, values and perceptions in connection to a given ecosystem to be conserved (Johnson and Pflugh, 2008; Menzel and Teng, 2009). Analysis of people's perception to conserve is important as differences in response through policies, attitude and actions are expected from groups within a society (Brown, 1997). In investigating complex ecosystem services like the case of Nyando wetland, the use of non-monetary valuation approaches such as consultative methods using questionnaires and interviews is recommended so as to elicit people's preference and perceptions of which the monetary valuation approaches alone can be challenging and inappropriate (Eftec, 2006; Ormsby and Kaplin, 2005; Christie and Gibbons, 2011). The identification of different ecosystem services and their perception by local stakeholders has not been addressed explicitly by many studies

(O'Farrell *et al*., 2007; de Chazal *et al.,* 2008; Pieroni and Giusti, 2009; Quétier *et al*., 2010; Lamarque *et al*., 2011; van Riper *et al*., 2012; Hutchinson *et al*., 2013). This informs the need for this study to link wetland resource utilization, conservation institutional arrangements and community perception on PES for conservation of Nyando wetland. This will be important for the Nyando wetland conservation authorities to design and implement institutional arrangements in order to achieve various conservation objectives that advance improvement of the local people's socio-economic conditions and biodiversity conservation (Barrow *et al.,* 2000; Campbell *et al.,* 2000; Coupe *et al.,* 2002).

1.2 Statement of the problem

Loss of wetlands has been enhanced by institutional conflicts and laxity (Chidzonga, 1994; Frenken and Mharapara, 2002; McCartney *et al.,* 2005). Most developing countries have weak institutional arrangements and therefore are not able to avert the loss of wetland ecosystems (Mahonge, 2010; Dixon *et al.,* 2013; Jamu *et al.,* 2013; Were *et al.,* 2013). The Kenyan wetland degradation problem is exacerbated due to the fact that these wetlands are managed by various government ministries and departments which causes challenges of conflicting roles, mandate overlaps as well as responsibilities leading to confusion among the stakeholders (Raburu *et al.,* 2012). Sustainable use of wetlands and strengthening of robust governance structures are necessary so as to ensure continued contribution of wetlands to poverty reduction (Raburu *et al.,* 2012). This calls for research to address this gap so as to improve institutional structures governing wetland conservation in Kenya.

Lake Victoria basin which forms the Nyando wetland has a very high rural population density of up to 1,200 persons per Km^2 (World Agro-forestry Centre, 2012) in parts of Kenya. Kisumu city is the main city on the Kenyan waters of the Lake Victoria basin. It has a population of 1,155,574 persons and a population density of 554 persons per Km^2 (Kenya National Bureau of Statistics (KNBS), 2019). This population density is quite high compared to the Kenya's density of 66 persons per Km^2 (Commission of Revenue Allocation (CRA), 2011) and has been growing over time with the increasing population. Rapid urbanization, land conversion to agriculture, settlement and industries are taking place as a result of this increasing population growth (Odada *et al.,* 2004; Kairu, 2001). These development activities deplete and degrade wetland resources to an extent that sometimes they can't replenish naturally (Kairu, 2001; Masifwa *et al.,* 2001). These problems therefore threaten the local community's livelihoods, lifestyles and the potential of the lake and Nyando wetland ecosystem's recreational opportunities (Lake Victoria Basin Commission (LVBC), 2011). Low economic standards contribute to local communities' livelihoods overdependence on wetland ecosystem resources (Abila, 2002). This overdependence creates some level of interactions between the rural communities and the Nyando wetland ecosystem through resource utilization and conservation interventions, which forms part of the focus of this study.

The wellbeing of wetlands is greatly threatened by human activities which results to their degradation or total loss (Bjerstedt, 2011). The ability of the Nyando wetland ecosystem to offer ecosystem services is at a threat because of increasing over-use, environmental degradation and reclamation (Osumba *et al.,* 2010; Morrison *et al.,*

2012). The kinds of motivating incentives to local communities to enable them cooperate with conservation agencies in biodiversity and other ecosystem services conservation arrangements, while maintaining their enthusiasm throughout the management of wetland resources has remained unclear (Kiss, 2004; Wells, 1994; Wells *et al*., 1992). Thus, this research addresses the local community's perception on PES to establish the potential for developing PES schemes in Nyando wetland to aid in environmental conservation. The study is therefore geared towards linking wetland resource utilization (i.e. social economic activities), institutional arrangements for resource conservation (i.e. conservation organizations, rules and policies and their enforcement) and community perception to PES so as to assess how this has affected the Nyando wetland resources and conservation efforts.

1.3 Research Objectives

1.3.1 General objective of the study

The aim of this study is to examine the utilization and evaluate payment for ecosystem services within the Nyando wetland for environmental sustainability and to enhance the livelihoods of the local community.

1.3.2 Specific research objectives

The specific objectives of this research are:

1. To investigate institutional arrangements governing conservation of Nyando wetland resources
2. To examine the utilization of Nyando wetland ecosystem services

3. To examine the local community's perception on payment for ecosystem services in Nyando wetland.

1.4 Research questions

1. How are the institutional arrangements governing Nyando wetland resource use?
2. Which are the resources extracted from the Nyando wetland and how has their extraction impacted on the wetland ecosystem?
3. How is payment for ecosystem service schemes carried out within the Nyando wetland and what are the perceptions from the local community on payment for wetland ecosystem services? Which are the key ecosystem services provided by the Nyando wetland that can benefit from PES?

1.5 Study hypotheses

Ho: The existing institutional arrangements governing Nyando wetland have significantly enhanced its resource conservation

Ho: Unsustainable wetland resource utilization has significant negative impacts on Nyando wetland ecosystem services

Ho: The respondent's level of education, age and duration of residence within the Nyando wetland have significantly influenced their perception on ecosystem services and their payment.

1.6 Significance of the study

The rich biodiversity and extensive food webs supported by wetlands makes them be referred to as biological supermarkets as well as landscape kidneys due to the roles they play in chemical and hydrological cycles (Mitsch and Gosselink, 1993; Barbier *et al.,* 1997; Amani *et al.,* 2017; Talukdar, 2017). Wetlands in the tropics supply local communities with crucial goods and services and are therefore considered as significant ecosystems contributing considerably to rural livelihoods and the national economy (Ogutu *et al.,* 2003). Despite Nyando wetland contribution to economic development and human well-being, their functions have been degraded by over-exploitation which has led to biodiversity loss and increased poverty. There is therefore need to improve sustainable exploitation and conservation of these wetland ecosystems (MEA, 2005).

PES has an immense potential to protect wetlands and address the high poverty levels of the local communities living in wetlands (Milder *et al.,* 2010; Wanjohi *et al*., 2011). PES approach has been applied often in both developed and developing countries as a policy instrument to conserve ecosystem services (Wunder *et al.,* 2008; Schomers and Matzdorf, 2013).

According to World Bank (2004), while promotion of PES in agricultural and forest-based landscapes to support environmental stewardship across the developing world is taking place, the development of PES mechanism is lagging behind in Kenya like elsewhere in Africa. The inventory of PES status in Eastern Africa, 13 projects are documented in Kenya by the Katoomba group and which are being carried out on pilot basis with donors providing the needed support (Mutunga and Mwangi, 2006;

Ferrarro, 2009). These PES schemes in Kenya deals with carbon (i.e. the Bamburi Lafarge Fuel Conversion and Kwale Forest Projects), water projects (i.e. Lake Naivasha Watershed Management Project, Western Kenya Integrated Ecosystem Project, Mount Kenya and Tana Basin Payments for Water services and Sasumua Water Treatment plant) and biodiversity (i.e. The Kitengela Wildlife Lease Programme, Arabuko Sokoke Forest Management and Conservation Project and the Amboseli project) (Mwangi, 2008). Majority of these PES projects are at early stages and this suggests a substantial potential for PES schemes in Kenya. The assessment of institutional arrangements present and the communities' perception to PES within the Nyando wetland forms the basis for designing a working PES scheme to enhance the wetland conservation.

Policy makers need to understand the relationship between wetlands, people, and existing human institutions in order to achieve successful wetland use and management (Shine and de Klemm, 1999; Maconachie *et al.,* 2008; Dixon *et al.,* 2013). This study on institutional arrangements in wetland management is therefore important so as to maintain and restore the integrity of wetlands as it may ensure appropriate measures to improve the existing institutional structures are put in place as required by the Ramsar guidelines on wise use of wetlands (Ramsar Convention Secretariat, 2015).

Kenya having adopted the Sustainable Development Goals (SDGs), active conservation and management of wetlands can certainly help the country to achieve some of them including ending poverty (SDG 1), ending hunger and achieving food security (SDG 2) and protecting, restoring and promoting sustainable use of terrestrial ecosystems, halting land degradation and biodiversity loss (SDG 15)

(World Health Organization (WHO), 2015). This will go hand in hand in achieving the Kenyan vision 2030 goals, the Kenya's long-term economic development aspirations (Government of Kenya (GoK), 2007a).

1.7 Theoretical and conceptual framework for the study

This study uses two theories namely the social-ecological systems (Ostrom, 2009) and the driving force state response framework (United Nations (UN), 1996). Wetland resources which humans depend on for their livelihoods are embedded in complex social ecological systems (Ostrom, 2009). The complexity of wetland ecosystem services conservation in ecological dimensions (resource systems and resource units) and social dimensions (i.e. different users and governance systems) made it important to apply these two theories in order to understand their interactions with humanity. Humans are an incorporated part of ecosystems and therefore the focus of sustainability science is to link social-ecological systems; an approach which adds social aspects to ecosystem management in order to understand their relationships and interactions (Berkes and Folke, 1998; Costanza *et al.*, 1993; Gunderson *et al.*, 1995; Kinzig, 2001; Ostrom, 2009).

The study draws from the Driving force (Pressure)-State-Response (DSR) theoretical variant model developed by the Organization for Economic Cooperation and Development (OECD), 1993). The United Nations Commission for Sustainable Development (UNCSD), 1995) applied the DSR framework to research local biodiversity state and conservation schemes, and the local communities and biodiversity conservation institutions relationships (Kuldna *et al.*, 2009). The US Environmental Protection Agency (EPA) applied the framework to discuss the

cultural, social and economic aspects of environmental and human health (Yee *et al.,* 2012). The DSR framework is applied in this study to examine the pressures exerted on Nyando wetland as a result of human activities and how these affect the state of wetland resources and the resultant mitigation responses. The simplicity of the framework is seen as part of its weakness, however, its popularity, adaptability and replicability are its strengths which make it to be used to guide decision making for implementing strategies in planning policies in response to wetland resource loss to ensure their sustainability (Spano *et al.,* 2017).

Different interests, perspectives and influences of several groups give rise to different responses that affect the magnitude of influence on policies pertaining conservation and development (Brown, 1998). The DSR framework is applicable to analyze environmental and socio-economic issues with regard to responses in policy i.e. studying the effect of institutions on wetland resource utilization (Mangi *et al.,* 2007, Yee *et al.,* 2012). For instance, in a case of resource utilization in Nepal, those with greatest input into formulation of policy are those with greater scale of influence while those with minimal magnitude of influence (local users) have less input into these policies which directly impact on their livelihoods (Brown, 1998). The impact of global forces and processes on the natural resource base especially in the developing countries have key impacts on livelihoods of households relying on utilization of these same resources (Bob and Moodley, 2003). Nilsson *et al.,* (2009) argue that the sustainable management of wetland ecosystems can be influenced by resource competition among individual users, their differing perceptions and the responses by institutions.

The DSR theoretical framework conceptualizes that human activities (i.e. population growth, socio-economic) exert pressures (i.e. wetland conversion for agriculture and settlement) on the wetland bringing modifications that vary the state or condition of the wetland. The human reactions to these alterations include any organized behavior (Wells, 1994; Grabrielson & Bosch, 2003) which purpose to reduce, prevent or mitigate these undesirable changes (i.e. alternative livelihood strategies to wetland resource utilization through payment for ecosystem services or conservation rules in place). The focus of wetland ecosystem services conservation strategies is relieving the resources perceived pressure through advocating the use of resources in a more sustainable manner (Wells, 1994). The DSR framework illustrates that ecosystem services from the wetland ecosystem flow into the pressure component. The pressures result from human society expansion and are therefore human induced (socio-economic activities and human population) (Swanson, 1998; Wells *et al.*, 1992; Tscherning *et al.*, 2012). Examples of such wetland ecosystem pressures are land conversions, mining, farming and grazing as well as drivers which lead to the threats such as the local people's socio-economic situations and government policies (Salafsky and Wallenberg, 2000; Tscherning *et al.*, 2012).

Information (human perceptions and local experiences) about the state of ecosystem services and pressures will determine the kind of responses to be taken in order to address the perceived problem. A heightened awareness of environmental problems is produced as a result of human experiences with environmental degradation and resources depletion, this will in turn promote decisions pertaining the adoption of response strategies so as to deal with the resource loss (Aboud, 1992; Fisher *et al.*, 2009).

The local ecosystem services perceived state and condition reflect pressure and how effective the responses are, therefore, such perceptions will influence the societal and other conservation institutions response to the state of ecosystem services. Response differences through policies, attitude and actions by groups in a given society are expected (Borrini-Feyerabend and Brown, 1997; Joumard and Gudmundsson, 2010) and hence the need to analyze people's perception to conserve and the institutional arrangements for enhanced response to the declining state of the Nyando wetland resources. Salafsky *et al*., (1999) notes the need to design conservation projects properly through mixing of different interventions and strategies in order to battle the threats. Responses by individuals and institutions to ecosystem services decline include establishing sustainable alternative livelihood activities such as PES. Societal and local community response and perceptions to Nyando wetland ecosystem services will in turn influence the state of and the pressures acting on the ecosystem services.

The socio-ecological system adds the social aspect in the management of ecosystems as humans are an integral part of an ecosystem (Ostrom, 2009). Ecosystem services from wetland ecosystem flow into the pressure component most of which are human induced (Swanson, 1998). The increase in the pressure will lead to a decline in wetland ecosystem services hence the local community and conservation organizations determines the responses to be put in place so as to address the problem (Joumard and Gudmundsson, 2010).

The DSR theoretical framework is applied here to relate the perceived state of Nyando wetland ecosystem services and its pressures, how the state of its ecosystem services are perceived, and mitigation actions by Nyando society and conservation

organizations to improve the state and mitigate impacts (OECD, 2003; Joumard and Gudmundsson, 2010; Tscherning *et al.*, 2012). Therefore, the two frameworks are combined to understand the relationship between human and the Nyando wetland ecosystem, the interaction thereof and the driving forces to the wetland ecosystem services decline and the human responses to reduce, prevent or mitigate the pressures to the ecosystem (Figure 1.1). Combining these two frameworks, there might be some weaknesses but for the purpose of this study the modified framework is sufficient in achieving the study objectives. The study also analyses institutional design principles for common pool resource management for conservation of Nyando wetland resources (Ostrom, 1990; Anderies *et al.,* 2004). These frameworks have helped to identify relevant variables for development of the conceptual framework for this study (Figure1.1).

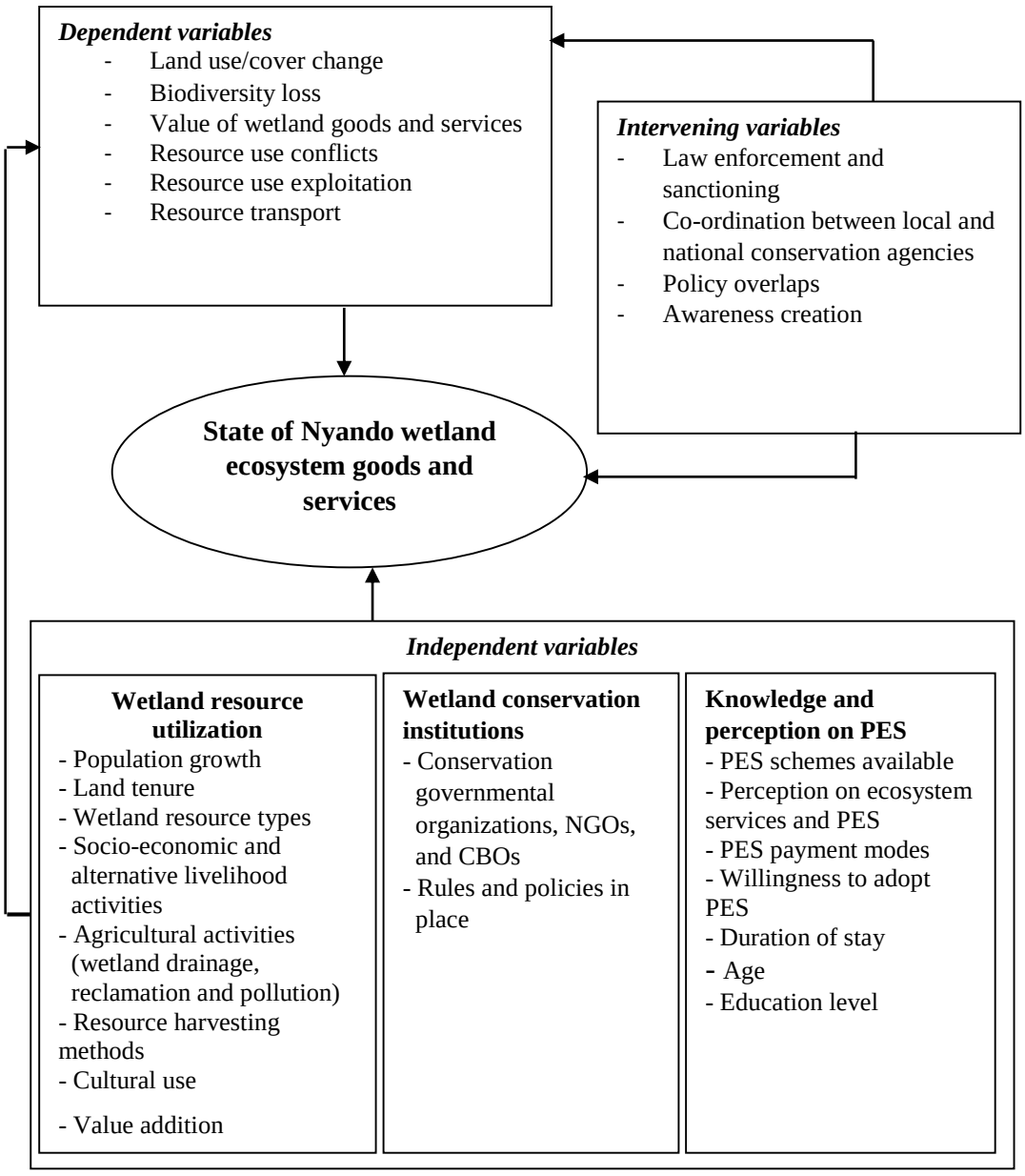

Figure 1.1: Wetland ecosystem conceptual framework for the study (Source: Author, 2019)

1.8 Definition of terms

Wetland refers to "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh,

brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters" (RAMSAR, 1971).

The Kenya National Wetland Standing Committee (NWSC), 1994) defines wetlands as "areas of land that are permanently or occasionally waterlogged with fresh, saline, brackish or marine waters, including both natural and man-made areas that support characteristic biota"

Ecosystem is "a dynamic complex of plant, animal, and microorganism communities and the non-living environment interacting as a functional unit" (MEA, 2005).

Ecosystem services are "the benefits people obtain from ecosystems" (MEA, 2005).

Ecosystem approach is "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way" enabling "conservation, sustainable use, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" (Convention for Biological Diversity (CBD), 2010).

Institutions are "humanly devised constraints that structure human interaction. They are made up of formal constraints (e.g. rules, laws, regulations), informal constraints (e.g., norms of behaviour, conventions, self-imposed codes of conduct), and their enforcement characteristics" (North, 1994).

Payment for Ecosystem Services (PES) is "(i) a voluntary transaction where (ii) a well-defined ecosystem service (ES) or a land-use likely to secure that service (iii) is being 'bought' by a (minimum one) service buyer (iv) from a (minimum one)

service provider (v) if and only if the service provider secures service provision (conditionality)" (Wunder *et al.*, 2008).

Environmental perception assessment is a means of understating the perspectives of the local people (i.e. knowledge and values) as relates to how they utilize and manage ecosystem services (Brancalion *et al.*, 2014; Meijaard *et al.*, 2013).

1.9 Limitations and assumptions of the study

The study was limited to a certain duration of time and therefore the results could be affected by the operations of the local community during that time. The limitation of finances implies that the study was based on the opinions of only few villages. It was assumed that the respondents were conversant with the payment for ecosystem services. Since the survey was conducted at household level, it was assumed that the opinion of the household head was a representative of the household wetland users. The key informants were assumed to be knowledgeable on matters of wetland resource utilization and conservation.

CHAPTER 2: LITERATURE REVIEW

2.1 Institutions arrangements governing conservation of wetland resources

In chapter one, institutions have been defined by North (1994) as humanly devised constraints that structure human interaction. These institutions are made up of formal constraints (rules, laws, and constitutions), informal constraints (norms of behavior, conventions and self-imposed codes of conduct) and their enforcement characteristics; thus they shape incentives in human exchange, whether political, social or economic (North, 1990, 1994). Environmentally oriented scholars define institutions as conduct codes assigning roles, defining practices, and guiding interactions; the set of rules in use (Berkes, 1995).

Organizations are groups of individuals bound by a common purpose to achieve certain objectives (North, 1994). These organizations include political, economic, social and educational bodies. Organizations and people bring institutions to life (North, 1990; Leftwich and Sen, 2010). Institutional framework influence what kind of organizations come into existence and how they evolve over time while organizations in turn influence how institutions change (North, 1994). Gibson *et al.,* (2005) and Ostrom (1999) argue that institutions and organizations are important in regulating and guiding the way people interact as well as the way they use and relate with natural resources.

2.1.1 Formal constraints in natural resource management

Formal constraints are written rules, laws, constitutions, policies, rights, and regulations that are enforced by official authorities (Leftwich and Sen, 2010; North,

1994; North, 1990). Institutional constraints include what individuals are prohibited from doing and under what conditions is sometimes the undertaking of certain activities permitted. Communication of formal institutions is through channels that are accepted widely as official written form and backed up by actors or entities which are legally recognized rather than socially defined categories (Helmke and Levitsky, 2004). Formal rules may be enacted to either replace, modify or revise the existing informal constraints hence complementing and increasing the effectiveness of these informal institutions (North, 1994) to enhance wetland resource conservation. The extent of political and economic diversity and interests is very crucial as this determines the structure of rules in use for natural resource conservation.

Common Pool Resources (CPRs) are commonly owned resources by a group of users (Ostrom, 1990) which may include among other things water, grazing areas, fisheries, farm lands, forests and wetlands. A major characteristic of CPRs is the difficulty of excluding others from using the resource and therefore the use by an individual or a group means less and less is left for other users (Ostrom, 1990). The term common pool is more focused on the resource characteristic rather than the human arrangements of its management. Governments, private individuals or local community ownership are the various property rights under which natural resources are regulated. Common pool resources with no property rights to regulate them are under open access and such resources and institutions of the commons are central to many environmental problems (Ostrom, 1990).

Hardin (1968) described the term “Tragedy of the Commons” and asserted that the inherent logic of the commons mercilessly generates tragedy. Hillman (2002)

describes the word *tragedy* as a remarked decrease of the limited resources while *commons* as that inclusive possession which could mean the lack of property rights and private ownership of the resource. The tragedy dilemma occurs when individuals sharing a limited resource and who are driven by their own selfish interests cause resource depletion as they do not consider its future sustainability (Dietz *et al*., 2003). This is in consistent to Hardins theory that allowing freedom in commons can result to bringing ruin to all (Hardin, 1968, 1998). Onyango (2000) and Jentoft *et al*., (2010) also agree that unlimited freedom of access to common pool resources can result to ruin which can be a source of human misery especially those who do not have other survival means other than depending on the said resource.

The Hardin's (1968) article, which has a bearing on a central concept in human ecology and environmental study stimulated lots of interest in research on the commons (McCay and Acheson, 1987). Throughout the 1970s and 1980s, articulation of the challenges to the conceptual underpinnings of the Hardin's model, its theoretical adequacy, its empirical validity as well as its generalizability was done. Researchers in the diverse common property institutions noted the serious confusion by Hardin on the concept of common property with open access conditions where rules limiting entry and use do not exist. This empirical work led to the development of the Common-Pool Resource Theory. Ostrom (1990) and Baland and Platteau (1996) have managed to show that members of smaller groups are capable of designing institutional arrangements to help in resource management in a sustainable manner within some combinations of frequently occurring conditions. Johannes (1998) argue that the broad and prevalence of local level

commons institutions indicates that they have been crucial for many societies survival and still remain relevant for contemporary resource management. As part of the limitations to the lessons from these cases, Agrawal (2002) argues that, causal variables multiplicity and the lack of attention to how the observed effects of these variables depend on the state of the context, has made significant gaps in explaining the working of common property institutions. Since common property institutions continue to frame the governance of natural resources in many parts of the world, addressing these gaps is very crucial (Agrawal, 2002).

Local level common property institutions have been adopted by governments in many developing countries as a new policy drive to govern natural resources. This policy has been as a result of the realization that natural resources are not immune to external influences and cannot be isolated from the rest of the world despite many of them being community based (Berkes, 2006). Ostrom (1990) identified eight design principles (Table 2.1) which can be used to design institutions for management of common pool resources. These design principles, if well-articulated are capable of enhancing the robustness of CPRs institutions and making them last for a long period of time (Ostrom, 1990). These design principles will be helpful in examining how the Nyando wetland institutions are designed to ascertain if they are operating appropriately in the conservation of the wetland resources.

Establishment of rules preventing use of resources (so as to avoid over exploitation and complete destruction) in the interest of long term sustainability has been argued as a solution to the management of common pool resources such as Nyando wetland (Acheson, 2006). Permitted resource users in a common pool resource need to establish rules so as to curb resource exploitation. Rules limiting the harvesting of a

resource i.e. rules that govern the place, time and technology used (Acheson and Wilson, 1996) as well as how much of the resource may be harvested must be devised to control wetland resource utilization.

Table 2.1: Design principles and enabling factors of designing institutions for common pool resource management

Enabling factors	**Description**
Clear defined boundaries	The resource system and involved households and individual units have to be clearly defined and demarcated
Costs and benefits are in equivalence	The allocated resource units should be based on specifying rules that are context dependent and consider the opportunity costs etc.
Rules based on collective-choice and easy to monitor	Modification of resource harvesting and conservation rules is by a group of members consisting of the affected individuals
Accountable officials and monitors	Monitoring of biophysical conditions and user behaviour is by either the resource users (participatory monitoring) or to some degree, are liable to the resource users
Sanctioning system	There should be a gradual sanction system which is context-dependent in case of non-compliance or breach by either facilitators/officials or users of a resource
Conflict resolution	Low cost mechanisms or local arenas should be in place
Rights to organize are recognized by external governmental authorities (Institutions devised at multiple levels)	The government should guarantee clear long term tenure or user rights to the resource as well as the right to form user institutions
In larger systems: nested enterprises	In larger systems, there is need to organize rules and mechanisms in nested enterprises in several layers

Source: Adapted from Ostrom, 1990 and Anderies *et al.*, 2004.

Natural resource management approach which combines science, economics and policy to study and manage natural resources and ecosystems is an important tool to avert resource degradation and environmental issues (Allison and Hobbs, 2010). In practice, the natural resource management approach requires different institutions at local, regional and international levels and scales to work together. Governments pass laws and regulations which help in natural resource protection. However, these

governments have failed in resource management. Government conservation efforts failure has been associated with the open access nature of wetland resources, the selfishness of government officials and politicians who serve their own interest rather than those of the public good (Cook and Levi, 1990; Moberg, 1994; Shleifer and Vishny, 1998). Government bureaucracies have led to poor cooperation between agencies as well as caused them to work against each other and this has led to institutional failure (Sproule-Jones, 2002). Institutional failure is the cause of resource degradation and therefore having the right governance structures and rules will ensure natural resources are used wisely and conservation goals are met (Acheson, 2006).

Allison and Hobbs (2010) outline the importance of social organization and social processes and their interaction as being connected to sustainable natural resource management. Participation and building social capacity of all stakeholders involved will determine the success of sustainable natural resource management (Ostrom, 1990; Allison and Hobbs, 2010). An important mechanism of natural resource management is an integrated ecosystem approach which enables the analysis of interaction and link between people and environment in which they are integrated in. This ecosystem approach is a scheme for water, land and living resources management in an integrated manner to enhance their conservation and sustainable use in an equitable way at the same time allowing their conservation; sustainable use and fair and equitable sharing of benefits resulting from genetic resources utilization (CBD, 2010).

Several researchers have emphasized the significance of local institutions for improved management of the world's ecosystems and natural resources (Berkes &

Folke, 1998; Costanza *et al.,* 1998; Nabhan, 2000; Ostrom, 1990; Turner *et al.,* 2000). Local institutions have been argued to be better capable of adapting to feedback dynamics since people inhabiting near the resource base and wetland ecosystems may have a faster detection of ecological change. However, Baland & Platteau (1996), Colding & Folke (2000) and Young (1995) argue that these local institutions on their own cannot perform the roles of regional or national institutions. This calls for the linking of local institutions working for wetland conservation with institutions existing at other hierarchical levels and across scales such as at the regional and national levels (Alcorn & Toledo, 1998; Folke *et al.,* 2003; Hanna, 1998). Such cross-scale institutional linkages are referred to as nested institutions with the simplest kind being the one that connects local-level management with governmental-level management in partnerships such as co-management (Berkes, 2000).

Claridge and O'Callaghan (1997) have emphasized co-management success in managing common pool resources including those of wetlands. Berkes *et al.,* (1991) argue that co-management is one institutional form that encourages a multi-level perspective. He further argues that co-management also involves rights and responsibilities sharing among several actors (state, resource users and civil society) for a particular resource. In Kenya and over the centuries, local communities have been using, managing and conserving wetland resources (Gichuki, 1997). The sustainability of co-management requires that it not only be based purely on a concept developed by experts from governmental or international level, but should incorporate the priorities and wisdom of the local people (Claridge and O'Callaghan, 1997).

Berkes *et al.,* (1991) defines co-management or collaborative management as the sharing of power and responsibility between the government and local resource users. Singleton (1998) defines co-management as the term given to governance systems that combine state control with local, decentralized decision making and accountability. The World Bank (1999) defines co-management as the sharing of responsibilities, rights, and duties between the primary stakeholders and in particular local communities and the nation states. Several critics have criticized the co-management definition for not capturing the complexity, variations and dynamic nature of contemporary systems of governance (Carlsson and Berkes, 2005).

The co-management definition is lacking in accounting for the complexities of; the state, the communities, co-management as a governance system, the resource itself and the system (Carlsson and Berkes, 2005). These complexities arise due to the fact that co-management is a political process involving different actors with different access to sources of power and resources. These complexities of the system signifies that all collaborative arrangement types highly depend on the level to which parties acknowledge each other's legitimacy. Therefore, success of co-management will depend on whether external conditions are favorable for developing such systems. Ostrom (1990) points some of these exogenous factors to include; sense of security of resource tenure, financial resources, their right to organize and facilitation support. Local people need education, finance, planning and management tools which are suitable to their local situation (Jentoft, 2004).

The state is the custodian of power and should be able to dispense it as it wishes and therefore, in co-management arrangements, power is supposed to devolve from the state to the rest of the actors. Co-management is viewed as having the capability of

overcoming the inertia of CPR's community focus and incorporates the multi-scale and multi-level dynamics in the governance of the commons (Berkes, 2006). Its usefulness is found in its ability to provide an institutional environment in which different actors can participate and contribute to the decision-making process that affects them. Béné *et al.,* (2009) argue that since local people are the end users, their involvement is likely to enhance their sense of ownership and responsibility, therefore helping the self-enforcement of the management system and in principle the system's equity and sustainability.

2.1.2 Informal constraints in natural resource management

Informal institutions include social norms, customs or traditions which shape behavior and thought (Leftwich and Sen, 2010; Berman, 2013). They are usually unwritten socially shared rules which are created, communicated and enforced socially outside the official sanction channels (Nasongo *et al.,* 2015) and form part of people's culture (North, 1994). Culture is the transmission from one generation to the next through teaching and imitation, of knowledge, values and other elements influencing behavior (Boyd and Richerson, 1985). By connecting the past, present and future, cultural constraints help in explaining the path of historical change (North, 1994). These informal rules and norms can either compete, complement or overlap the formal rules (Jutting *et al.,* 2007; Leftwich and Sen, 2010). Conflicts between informal and formal wetland conservation rules can cause wetland resource degradation and overexploitation while a complementarity between the two can lead to enhanced resource sustainability. Informal social norms are important as they can be used to figure the way formal state organizations are designed and implemented (Migdal, 2001; Jutting *et al.,* 2007) for wetland conservation.

Informal institutions in the management of a wetland resource like the case of Nyando wetland include both the local and traditional institutions. Local institutions are location and resource specific and are crafted and enforced by community mechanisms. Acheson (2006) argue that conservation of resources at local level may fail as a result of the local community not being able to devise management rules or due to the failure of the rules once they have been established. Mostly rooted in social capital of a community, local institutions are crucial buffering mechanisms enhancing resilience and sustainability at the interface between society and environment (Mazzucato and Niemeijer, 2002).

Traditional ecological knowledge is the cumulative body of knowledge, beliefs, institutions, practices which evolve by adaptive processes and passed on via generations through cultural transmission (Stori *et al.,* 2019). This traditional ecological knowledge is necessary to provide information concerning disturbances that are either induced naturally and or by humans as well as support ecosystem based management strategies (Berkes *et al.,* 1995). Mapfumo *et al.,* (2016) notes that many local communities make local decisions on resource use and farming based on indigenous knowledge, however, in Africa, this capacity is least tapped for more formal decision making process. The erosion of these traditional knowledge (cultural norms and practices) can have a negative effect on Nyando wetland consequently leading to their degradation.

Traditional institutions are enshrined in the community culture and consist of norms and taboos which are embedded on indigenous belief systems of the local people (Nasongo *et al.,* 2015). Myths which are passed on through generations help to conform human behaviors to what the environment offers and demands. Institutions

based on myths have been shown to affect the use of resources such as wildlife, papyrus, fish and farmlands (Cohen, 1969). The Nyando wetland community attach some cultural beliefs to the wetland some of which have a positive effect to the conservation of its resources and hence should be preserved. Some parts of Nyando wetland are used as shrines to perform special ceremonies such as prayers and special sites for appeasing spirits of the dead. Wetlands are also valued for their religious values i.e. used as sites for baptism by Christians and sources of sacred water for performing special rituals and therefore conserved from destruction (Obiero *et al.,* 2012c).

2.1.3 Rule enforcement in natural resource conservation

North (1994) argue that compliance to rules is important and hence measures to ascertain and measure the extent of rule violations and apprehend the violators needs to be put in place. La Porta *et al.,* (2000) note that rule enforcement is critical and is as important as the content of the rules themselves. Organizations are important in regulating and guiding the way people interact, use and relate with natural resources including wetlands (Gibson *et al.,* 2005; Ostrom, 1999). These organizations influence how institutions change and their enforcement mechanisms (North, 1994). To ensure that formal and informal constraints in wetland management achieve their functional goals, effective rule enforcement is important. Natural resources in which it is difficult to establish and enforce boundaries makes it difficult to enforce conservation rules (Ostrom, 2000). Under such a situation, it will be of no value to invest any resources in conservation efforts since the resource is open to outsiders who frustrate the gains of any resource management efforts (Acheson, 2006).

Kenya aspires to manage its wetlands according to the set out guidelines by the Ramsar Convention since it's ratification in 1990. The Kenya Wetlands Atlas (KWA) provides a general strategy for sustainable exploitation and development of Kenyan wetlands. The National Environmental Policy of 2013 (GoK, 2013b), the National Wetlands Conservation and Management Policy (NWCMP) (GoK, 2013a) and the Wetlands Atlas are the key documents dealing with the wetland adaptation and management in Kenya. These three documents refer to functions that should be undertaken by other government ministries and departments in the implementation of the strategy. They recognize the increase in population and the challenge that this poses to wetland ecosystems especially in a cultural environment where land ownership is largely through inheritance from subdivision of often inadequate land sizes (Oduor *et al.*, 2015).

The need for improved scientific information and the strong knowledge base of the wetland ecosystems is identified in the wetlands policy. It also recognizes the right for the affected societies to decide and assign for themselves cultural and religious significance to wetlands. Additionally, these documents underscore the need for public participation under the wetland governance systems under the different local/regional/international institutional and legal frameworks. These three documents refer to legislations such as Fisheries Act (Cap 378); The Wildlife (Conservation and Management) Act (GoK, 2013c); The Water Act (GoK, 2016b); The National Land Policy (GoK, 2010); Land Use Planning Bill (GoK, 2010); Physical Planning Act Chapter 286; and the Constitution of Kenya.

Marabanyika and Beckedahl (2017) note that organizational participation in wetland conservation is determined by their priorities and various institutional mandates

which are torn between socio-economic and environmental considerations. Some organizations are either concerned in wetland use, conservation or both and therefore their rule enforcement will be geared towards their mandate. New technological advances, increasing population and new markets have an effect on increasing resource competition and this might be a motivator for rule dis-obedience, invasion of other peoples' resource territories and expansion of resource exploitation consequently leading to resource degradation (Aswani, 2002; Becker and Leon, 2000). Political pressures and preferences as well as the available resources have been noted to affect rule enforcement (Kaufmann *et al.,* 2018). This informs this study to investigate the institutional arrangements (i.e. any institutional complementary) governing Nyando wetland resources and their enforcement challenges i.e. any mandate overlaps and other inefficiencies.

2.2 Utilization of wetland ecosystem services

2.2.1 Utilization and threats to wetlands

Wetlands have been valued as they are a source of many goods and services (Macharia *et al.,* 2007; Oduor *et al.,* 2015; Nasongo *et al.,* 2015; Ajwang' *et al.,* 2016). Wetlands provide a diverse range of ecosystem services such as provisioning (fresh water, food, genetic materials), regulating, cultural and supporting services (MEA, 2005; Russi *et al.,* 2013) which are important in supporting livelihoods and human wellbeing (MEA, 2005). Due to the many ecosystem services wetlands provide, local communities have continued to use and exploit their resources and have therefore been referred as amongst the world's most threatened ecosystems (MEA, 2005). Wetlands are utilized to provide food. For instance, Lake Victoria and

its surrounding Nyando wetland is a source of tilapia and Nile perch which provide fish protein to its adjacent communities (Goudswaard *et al.,* 2002). Wetlands are also valued for their vegetation including papyrus reeds which are harvested for making handicrafts (Osumba *et al.,* 2010; Terer *et al.,* 2012; Perbangkhem and Polprasert, 2010). Wetlands are used as a source of water supply for domestic, wildlife as well as human population (Keter, 1992; Postel and Thompson, 2005). Wetlands also provide transportation modes (Abila, 2002; Terer *et al.*, 2004; Kansiime *et al.,* 2007). They are also valued as sources of medicinal plants which are used to treat different types of ailments and generate income after selling of such herbal medicine (Obiero *et al.,* 2012c).

Globally, wetland ecosystems are under increased pressure and threat due to human's dependency on them for their livelihood and their associated activities (Bjerstedt, 2011). The primary direct drivers of degradation and loss of wetlands are land conversion, infrastructure development, water use, pollution and eutrophication, overexploitation, overharvesting of wetland resources, climate change and invasive alien species while population growth and economic activity change are the primary indirect drivers of wetlands degradation and loss (Ramsar Convention, 2015).

In many developing countries especially in Africa, wetland conversion for agriculture has significantly increased as some people perceive them as the "new frontier" for agriculture (Wood, 2009). The contribution to this increase in wetland conversion for agriculture is partly driven by population growth, degradation of excessively exploited upland fields, demand to earn cash income as well as by market opportunities (Wood and van Halsema, 2008). The food security challenges

in the Sub-Saharan region have also contributed to this increased over exploitation of wetlands for agricultural production as they are thought to offer potential solutions to food security (UNEP, 2008; Rebelo *et al.,* 2010). Wetlands in East Africa contribute 10-40% of the rural population annual food needs (Schuyt, 2005). Wetland conversion increase food provisioning service in the short term however with a resulting decline in regulating ecosystem services in the long run (Foley *et al.,* 2005; Van Dam *et al.,* 2013).

Wetlands ecosystems cover an estimated area of more than 9% (1,280 million hectares) of the global land surface (Malabika *et al.,* 2015). Kenyan wetlands cover an area of up to 3-4% (approximately 14,000Km^2) of the total landmass which could increase up to 6% during the rainy season, with many having been converted for alternative use (Oduor *et al.,* 2015). The distribution of Kenyan wetlands depends mostly on the land topography and the rainfall amount received (Macharia *et al*., 2007) and are categorised into riverine, marine, estuarine, lacustrine, palustrine and constructed wetlands. Lakes Naivasha, Elementaita, Bogoria, Baringo and Nakuru have been designated as wetlands of international importance since Kenya ratified the Ramsar Convention in 1990 (Ministry of Environment and Mineral Resources (MEMR), 2012).

Several organizations including World Wildlife Fund (WWF), the Ramsar Convention Bureau and United Nations Environmental Programme (UNEP) have recognized the importance of management and sustainable use of Kenyan wetlands. The continued encroachment and clearing of vegetation cover has resulted to a decline in the usefulness of these Kenyan wetlands. Land tenure insecurity, lack of access to environmental information, lack of civic access, weak sectorial strategy to

resource administration and inefficient governance are some of the threats identified by the Kenya wetlands forum 2017. Due to their many benefits to the society, their loss has led to deprivation of societies of their livelihoods. Turner *et al.,* (2003) observed that many ecosystems including wetlands are affected by climate change and this increases the vulnerability of populations living in their surroundings. The unsustainable use of these wetland ecosystems is likely to cause more adversity as a result of increased effects of climate change disasters as majority of the rural poor rely heavily on natural resources for their livelihoods. Finlayson *et al.,* (2017) observes that a high impact is likely to be felt by the poor societies as water, food and health services become stretched.

Ghermandi *et al.,* (2008) argue that the values of wetlands increase with human uses and pressures, probably due to enhanced level of supply of particular services and the intensity of wetlands use. Conflicts and tradeoffs between livelihood requirements and conservation needs are expected and this requires innovative forms of management to overcome. Senaratna *et al.,* (2008) argue that the objective of addressing these tradeoffs should not be to maximize values for conservation and poverty reduction simultaneously, but rather to produce net benefits for people while at the same time avoiding fundamental ecological threats and ensuring the long term sustainability of different ecosystem services.

2.2.2 Linkages between ecosystem services and human wellbeing

Ecosystem services are the benefits obtained from ecosystems by people (MEA, 2005). Wetlands differ and therefore carry out different roles hence supply different ecosystem services based on the interactions between their physical, chemical and

biological components, and their surrounding catchments. Ecosystem services concept describes the ways that functioning ecosystems contribute to the wellbeing of humans (MEA, 2005) (Figure 2.1). For instance, ecosystem services provide benefits such as water for drinking, property protection, aesthetic value and good health (Boyd and Banzhaf, 2007). Ecosystem services comprise of various forms of direct and indirect benefits produced by ecosystems for people and that are economically significant and are accessible by the users (MEA, 2005).

The MEA framework defines human wellbeing as including abilities to earn a livelihood, to maintain good and health social relations, as well as being secure (Figure 2.1). A basic aspect of human wellbeing however is having freedom of choice and action on how these different kinds of needs are met (MEA, 2005). The ecosystem conditions which are influenced by natural and human-induced drivers enable and constrain both these choices and ways of life. Biodiversity supports ecosystem functioning and healthy ecosystems including wetlands provide services and goods which form the foundation for the wellbeing of humans. The basic material needs for survival as well as other aspects of a good life such as health, security, freedom of choice and good social relations are delivered by these ecosystem services (CBD, 2006) (Figure 2.1).

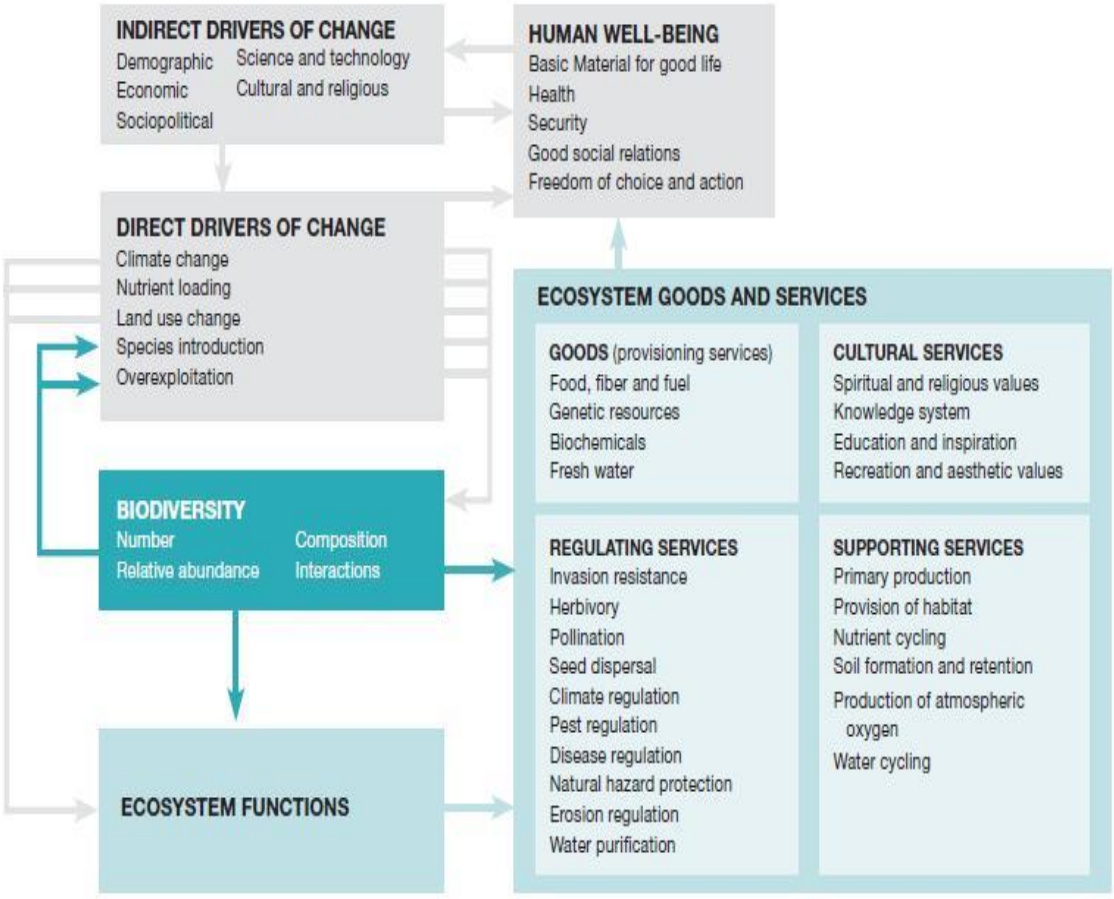

Figure 2.1: Relationship between biodiversity, ecosystem functioning, ecosystem services and drivers of change (CBD, 2006).

2.3 Local community's perception on payment for ecosystem services

Perception is an environmental experience which involves processing of stimuli and the derived actions resulting from it (Gregory *et al.*, 2009). It is also a construction grounded on secondhand information from science and other people (Gregory *et al.*, 2009). Environmental perception assessment is a way of understating the perspectives of the local people such as their knowledge and values as relates to ecosystem services use and management (Brancalion *et al.*, 2014; Meijaard *et al.*, 2013). Social norms, individual characteristics, local culture and personal attitudes

influence environmental perception (Allendorf and Yang, 2013; Vodouhe *et al.,* 2010) and this can influence decision making processes (Gregory *et al.,* 2009). Ecosystem service perceptions by local people is important to provide valuable information to develop and adapt policy and management guidelines (Asah *et al.,* 2014; De Oliveira and Berkes, 2014; Sandhu and Sandhu, 2014). In the case of PES, this information enables a better understanding of PES participants on the driving force towards management decisions and is crucial to help improve management strategies (Balvanera *et al.,* 2012). Most frequently used variables in ecosystem service perception studies of local people include the level of education, age and gender (Smith and Sullivan, 2014; Chen *et al.,* 2017; Xun *et al.,* 2017; Duo *et al.,* 2019).

The practice of PES in Eastern and Central Africa has been considered as part of the most viable approaches to integrate communities in natural resource management (Berttram, 2011). A huge potential for PES for wetlands protection exists while at the same time addressing the high poverty levels of communities inhabiting wetlands areas hence enhancing their livelihoods and human wellbeing (Wanjohi *et al.,* 2011).

The ecological, social-cultural and economic values are the domains in which the value of ecosystem services are understood (de Groot *et al.,* 2010). Though the ecological and economic values of an ecosystem service can be quantified more or less directly (De Marco and Coelho, 2004; Bianchi *et al.,* 2018), the social-cultural values are assigned with a basis on people's perceptions, demands, preferences and the qualities perceived from natural ecosystems which benefit the wellbeing of humans (Bryan *et al.,* 2010; van Riper *et al.,* 2012).

Payment for ecosystem services can contain either use-restricting land use technologies such as reduction in agricultural expansion, rehabilitation, and reduced deforestation as well as reforesting areas which have been degraded. It can also contain use-modification which is based on improvement of cropping systems or practices such as agroforestry, reduced logging, improved conservational agricultural practices and organic agriculture (Wunder & Boerner, 2010). The disadvantage of use modifying schemes is that it reduces the livelihoods of participants at the initial stages. A single or multiple ecosystem services on different geographical scales may be targeted for PES schemes.

Most PES schemes which are already existing focus on carbon sequestration, watershed management, landscape beauty, biodiversity and bundled services (Landell-Mill and Porras, 2002). Bundled services combines payments for ecosystem services such as carbon, water and biodiversity. Karousakis (2010) argue that the importance of bundling services into a single scheme is that it reduces transaction costs, brings together more ecosystem service buyers, targets many ecosystem services coinciding at spatial scales and enables inclusion to a scheme of disadvantaged ecosystem services for them to attract buyers. Rewards or payments can either be based on (i) Commoditized Ecosystem Services (CES); ii) Compensation for Opportunities Skipped (COS) which is connected to use-restricting PES whereby sellers get rewards for actions avoided and (iii) Co-investment in ecosystem Services (CIS) which is connected to use-modification PES schemes (Noorwijk & Leimona, 2010).

Incentives can be given inform of direct money payments or in kind. Land managers or resource stewards can either receive monetary payments for a bundled or a single

ecosystem service or can also receive in kind payments such as market access, access to information and training and land use rights (Swallow *et al.,* 2007). Based on the type of ecosystem service dealt with, payments can be made at a governmental level, to communities, and groups of or individual farmers (Sommerville *et al.,* 2009). Every PES participant of the given scheme can either receive an equal amount which is established on average opportunity usually agreed upon initially or may be based on opportunity cost of an individual, land use technologies adopted and land specific biophysical factors.

2.3.1 Payment for ecosystem services developments in Africa

Studies show that Africa lags behind in PES schemes developments than Asia and Latin America (Ferraro, 2009). Lecocq and Capoor (2005) note that in 2003 and 2004 markets for global carbon offset, when Africa was accounting for only 3% of emission reduction projects, Asia and Latin America accounted for projects totalling to more than three quarters. Out of the African projects, South Africa and Uganda contributed to the bulk of transactions. Additionally, Africa also had few PES projects under preparation by the year 2005 as compared to other parts of the world (Lacocq and Capoor, 2005).

The Katoomba group (an international working group dedicated to advancing markets and payments for ecosystem services) commissioned inventories of PES schemes for Kenya (Mutunga and Mwangi, 2006), South Africa (King, Damon and Forsyth, 2005), Tanzania (Scurrah-Ehrhart, 2006), Madagascar (Randimby and Razafintsalama, 2006) and Uganda (Ruhweza and Masiga, 2005). From the above inventories, 20 biodiversity projects were listed with only 4 of them making cash or

in kind payments, 7 out of the 20 carbon projects listed were making payments while 2 out of the 12 listed water projects were making payments. In Malawi and Zimbabwe, water projects were proposed but later abandoned (Bond, 2006). Based on Wunder *et al.,* (2008) PES definition, not all the above documented cases of African PES qualify as PES schemes as they do not fulfil the PES criteria. For example, biodiversity payment projects are defined by Katoomba group and other documents to include natural resource management initiatives which are community based, technology transfer projects in agriculture, participation in ecotourism markets and rewarding communities with limited access to protected areas. Very few PES programs in Africa apply the conditionality payments (Ferraro, 2009). The inventory on Kenyan PES (Table 2.2) shows that the projects have PES elements but cannot be classified as exhibiting full characteristics of a model of buyer- seller (Ferraro, 2009).

Several reasons have been raised by scholars as to the low adoption pace to PES schemes in Africa. These include lack of enabling legislations and policies (Muramira, 2005; Mwangi and Mutunga, 2005; Waage *et al.,* 2006; Scurrah-Ehrhart, 2006) as well as lack of supporting institutions such as bodies to offer certification and financial intermediaries (Katoomba group, 2006). Other reasons include lack of awareness about PES idea, limited capacity to design and implement such schemes and land tenure insecurity (Katoomba group, 2005, 2006; Muramira, 2005; Mwangi and Mutunga, 2005; Ochieng *et al.*, 2007).

Table 2.2: Examples of PES projects in Kenya

Project name	**Type of ecosystem service marketed**
Lake Naivasha Watershed Management Project	Water
The Kitengela Wildlife Lease Programme	Biodiversity
Bamburi-Lafarge Fuel Conversion	Carbon
Western Kenya Integrated Ecosystem Project	Water
Lake Bogoria Catchments Management Programme	Water
Kwale Forestry Project	Carbon
Arabuko Sokoke Forest Management and Conservation Project	Biodiversity
Mount Kenya & Tana Basin Payments for Water Services	Water
Shompole Ecotourism Development Project	Biodiversity
Narok Conservation and Drought Recovery Programme NCDRP	Water
Amboseli project	Biodiversity
Sasumua Water Treatment Plant project	Water

Source: Mwangi, 2008

While scientists and policy-makers are more and more employing the ecosystem services concept to manage and restore wetland ecosystems, there is limited attention to ecosystem services demand (i.e. the beneficiaries needs) and the relative rating of different services by local communities (Lamarque *et al.,* 2011). Johnson and Pflugh (2008) and Menzel and Teng (2009) point out that consultation of communities on proposed conservation and restoration projects is required so as to understand people's perceptions, values and needs in relation to the ecosystem being conserved. However, different ecosystem services identification or perception by local stakeholders has not been addressed explicitly by many studies (O'Farrell *et al*., 2007; de Chazal *et al.,* 2008; Pieroni and Giusti, 2009; Quétier *et al*., 2010; Lamarque *et al*., 2011; van Riper *et al*., 2012; Hutchinson *et al*., 2013). This informs this study to understand the local communities' perception, needs and values as relates to the conservation of Nyando wetland.

2.3.2 Biodiversity and ecosystem services

Several drivers of change such as land use change, climate change, population and economic growth have increasingly threatened global biodiversity consequently leading to its decline on an unprecedented rates (Butchart *et al.,* 2010; MA, 2005; Stern, 2006; The Economics of Ecosystems and Biodiversity (TEEB), 2010; Turner *et al.,* 2009; United Nations, 2007). The world's governments set a target in 2002 to achieve a significant reduction of the current rate of biodiversity loss at the global, regional and national levels; however this has not been met despite international commitments through conventions such as Convention on Biological Diversity (Secretariat of the Convention on Biological Diversity, 2010). Biodiversity loss impacts are likely to be felt more rapidly and severely in developing countries due to overdependence on biodiversity and ecosystem services for their livelihoods (MA, 2005; Secretariat of the Convention on Biological Diversity, 2010). In order to develop policies that sustain the livelihoods of people and to protect biodiversity and other ecosystem services in developing countries, an understanding of the relationship between biodiversity and the benefits it brings to the local poor is important.

A range of methods which can be applied to measure the value attained from biodiversity and other ecosystem services have been developed by environmental and ecological economists in the past (Christie *et al.,* 2006; Eftec, 2006; TEEB, 2010). Much of this research has however been conducted in the developed countries (Abaza and Rietbergen- McCracken,1998; Georgiou *et al.,* 2006; Van Beukering *et al.,* 2007) with limited data existing on similar researches on the value of biodiversity and ecosystem services from least developed countries (TEEB,

2010). Recent research on biodiversity valuation focus on a more holistic 'ecosystem services approach (Defra, 2007), which takes into account the biodiversity role in supporting ecosystem functions. These ecosystem functions then help in sustaining the delivery of important ecosystem services which are valued by human beings (Haines-Young and Potschin, 2008; TEEB, 2010). Despite having a clear distinguish between social, ecological and economic benefits provided by biodiversity (MA, 2005; TEEB, 2010), economic benefits have received lots of focus on many research on biodiversity valuation in which a certain value is mostly attached in terms of monetary terms (Farber *et al.,* 2002).

Total Economic Value (TEV) framework links the different components of economic value for biodiversity to how they provide benefits to people. TEV includes both use and non-use values of biodiversity. The use values include direct use benefits such as the utilization of provisioning and cultural services, the indirect use benefits such as biodiversity contribution to maintain regulating services and lastly the option value in which human beings attach a certain satisfaction from future use of cultural, provisioning and regulating services (Christie *et al.,* 2012). On the other hand, the concept of non-use values as captured by TEV include altruistic, bequest, and existence values (Christie *et al.*, 2012). Altruistic value is the kind of satisfaction which comes by knowing that others have access to benefits from nature while bequest value is the satisfaction arising from sustainability of a given resource to benefit future generations. Existence value is the satisfaction brought a bought by the existence of an ecosystem or species (Christie *et al.,* 2012). TEV framework has been useful and widely used in valuation of economic benefits from biodiversity.

However, the framework has its own share of limitations and therefore not being able to capture all the benefits provided by biodiversity.

TEEB (2010) provides social and ecological values as an alternative framework to value biodiversity. Social benefits include religious, spiritual, cultural, ethical and mental wellbeing (UNEP, 1999). The ecological benefits delivered by biodiversity include maintenance of essential life support processes such as formation of soils and cycling of nutrients. Despite the contribution of such services to human wellbeing, their indirect benefits and complexity renders them not being able to be valued in monetary terms or techniques (Farber *et al.,* 2002) hence the need to use non-monetary techniques to address their importance.

2.3.3 Methods of assessing value of biodiversity and ecosystem services

Valuation is the understanding of the importance or worth of something. It is the act of assessing, measuring value, as value attribution or as framing valuation (what and how to value and who values) (Dendoncker *et al.,* 2013). Value does not mean only economic value but extends to encompass ecological, aesthetic, bequest, health, spiritual values etc. (Gomez-Baggethun *et al.,* 2014). Economic valuation methods vary depending on the data available and the characteristic of ecosystem services and therefore there is no single valuation technique applicable to all ecosystem services (Department for Environment Food and Rural Affairs (DEFRA), 2007); TEEB, 2010).

TEEB (2010) describes two broad classes used to measure the social, economic and ecological benefits from biodiversity and associated ecosystem services. These are ‘biophysical’ and ‘preference based’ methods. The preference based valuation

includes both non-monetary and monetary approaches (Table 2.3). In investigating of complex ecosystem services, monetary valuation of biodiversity can be challenging (Christie and Gibbons, 2011) and in some occasions my not be appropriate. Under such cases, non-monetary approaches such as consultative methods which elicit people's preference and perceptions have been recommended and used by other researchers (Eftec, 2006; Ormsby and Kaplin, 2005).

These consultative methods employ questionnaires (Terer *et al.,* 2004) and interviews (Kaplowitz, 2001) from survey techniques. Other non-monetary approaches include participatory approaches such as Participatory Rural Appraisals (PRA) (Mendoza and Prabhu, 2005). Despite the weaknesses of these non-monetary techniques not being able to attach any monetary value to biodiversity, they can offer a better understanding on the motivations and perceptions behind people's value for biodiversity and other ecosystem services (Kaplowitz and Hoehn, 2001).

Table 2.3: Monetary and non-monetary biodiversity and ecosystem services valuation techniques

Valuation approach	Examples of methodologies	Description of approach
Monetary techniques		
Market price approaches	Market prices	Prices obtained from actual markets which are related to the environmental good as a proxy to the value of that good are utilised in market price approaches. Examples are: revenues collected from tourists in high biodiversity areas; bio-prospecting value contracts (Nijkamp *et al.,* 2006; Nunes and van den Bergh, 2001); and local trading prices (Le Roux and Nahman, 2005; Turpie *et al.,* 2003).
Market cost approaches	Replacement costs approaches	Costs from a market good which is related to the environmental good as a proxy to the value of that good are utilised in market cost approaches. Some examples include the cost of replacement of an environmental service such as soil erosion (Moller and Ranke, 2006), or environmental damage mitigation cost (Barbier, 2007). The focus of production function approach is on the (indirect) input costs of a particular environmental service to the production of a marketed good such as the ecosystem service inputs into crop production (Amaza *et al.,* 2006). The TEV is not measured by market-cost approaches but rather a proxy to value.
	Damage cost avoided approaches	
	Production function approaches	
Revealed preference	Travel cost method	These methods restrict themselves to measuring use values. A measure of a given

methods		environmental good is provided by utilising observations from actual markets
	Hedonic pricing method	associated to that environmental good in consideration. To evaluate the recreational benefits obtained from a given resource using the method of travel cost, travel costs data to that natural resource is used (Hanley *et al.*, 2002). In studies involving Hedonic pricing, the value of the environmental good is revealed through observations in a related market (usually house prices) (Humavindu and Stage, 2003). For example, valuation of a park in the city can be based on how it contributes to increase prices of houses while bird watching valuation can be based on the amount of bird seed bought (Slucas *et al.*, 2014).
Stated preference methods	Contingent valuation	Studies of stated preference construct a hypothetical market to estimate economic values by engaging respondents in a survey to directly express their willingness to pay (WTP) to get a given good or their willingness to accept (WTA) to give up a given good in consideration (Bateman *et al.*, 2010; Clucas *et al.*, 2014). A single policy option is elicited in WTP in studies involving contingent valuation (Turpie, 2003), while in choice modelling the assessment of the attribute values of the policy are allowed (Kenter *et al.*, 2011). In choice modelling, the individuals WTP is calculated by asking them to choose between a variety of environmental goods which
	Choice modelling	

		are priced differently (Alcon *et al.,* 2014). All the TEV components can be evaluated in stated preference methods.
Participatory approaches to valuation	Deliberative valuation	Stated preference valuation methods are combined with deliberative process elements from political science in valuations involving participatory and deliberative approaches (Spash, 2007). The process of valuation involves small groups of people whereby the participants are given time for gathering information, reflection, and an opportunity to discuss before they can value a good. Through these deliberations and discussions, matters of low public knowledge of complex environmental goods are covered (Alvarez-Farizo and Hanley, 2006).
Value transfer	Value transfer	The environmental goods and services economic value inferences at a given place and time are made by using economic information captured at another one place and time (Wilson and Hoehn, 2006).

Non-monetary techniques

Consultative methods	Questionnaires In-depth interviews	These consultative methods are administered to individual respondents to elicit their perceptions of an environmental issue. Questionnaires are mostly focussed on collecting quantitative data (Struhsaker *et al.,* 2005) while much of the qualitative data is gathered through in-depth interviews (Gareau, 2007). Their weakness is that they do not elicit economic values directly, however they are very crucial as they form the foundation of monetary valuation methods i.e. contingent valuation.
Non-monetary deliberative and participatory approaches	Focus groups Citizen juries Health-based approaches Q-methodology Delphi surveys Participatory rural appraisal (PRA) Participatory action research (PAR)	These engage group based activities to acquire more information on the relationship between people and natural environment. PAR and PRA are geared towards promoting local knowledge to enable local people make their own analysis, appraisal and plans (World Bank, 2008). A court like process is involved in Citizen juries whereby participants review the evidence available before they can make final judgement on the future of a given environmental good (Kenyon *et al.,* 2001).

The value of these non-monetary valuation methods has been in supporting the monetary valuation techniques i.e. Kenter *et al.,* (2011) notes that monetary valuation performance can be improved by a better understanding and application of non-monetary valuation techniques. In stated preference studies, to address complexity issues and biodiversity unfamiliarity by respondents (Macmillan *et al.,* 2002) or political economy concepts embedding into valuation (Lo and Spash, 2012; Spash, 2007) some researchers have found it worthy to incorporate deliberative and participatory approaches so as to offer respondents enough time to think about the environmental benefits before they engage them on the valuation exercise. The knowledge gained from these non-monetary valuation methods is useful in providing insights to improve monetary based methods and to offer opportunities to embed valuation into local decision making (Fazey *et al.,* 2010; Kenter *et al.,* 2011).

The focus of this study is on non-monetary valuation techniques using questionnaires and interviews to assess the motivations and perceptions of the Nyando wetland community value for ecosystem services. Perception information enables a better understanding of PES participants on the driving force towards management decisions and is crucial to help improve management strategies (Balvanera *et al.,* 2012).

2.3.4 Critique over valuation and payment for ecosystem services

Despite many scholars who have supported the concept of economic valuation and PES as an important tool for use in protection of ecosystem services for the societal benefit, criticisms have however been raised. The economic valuation opponents indicate that it can result to ‘commodification’ of nature opening market trade to

previously non-marketed areas which can have some damaging effects such as alienation of people from nature and transforming public services and property into commodities only accessible by the wealthy (Gomez-Baggethun and Ruiz-Perez, 2011; Robertson, 2012). Another drawback to economic valuation is the fact that it does not take into account uncertainties quantification which surround valuations and value mapping which is deemed to be a key information for policy decision (Schagner *et al.,* 2013). Economic valuation also fails to adequately account for non-use values, as the techniques used to account for such non-use values are weak (Parks and Gowdy, 2013; Chan *et al.,* 2012) hence a possibility of excluding such important aspects in decision making. Monetary valuation condenses a complex unit onto a single common unit (Bateman *et al.,* 2014). It is not possible to condense natures multiple values all which have equal importance into only monetary value which is the underlying assumption in economic valuation (Norton and Noonan, 2007; Gomez-Baggethun *et al.,* 2014; De Groot *et al.,* 2002; Parks and Gowdy, 2013).

Studies involving stated preference methods, when using surveys to elicit people's WTP for a service and WTA for the loss of a service, a problem arises in that people tend to value a loss more than a gain of the same magnitude. Therefore they tend to assign a lower value for willingness to pay for a gain than willingness to accept a loss (Science for Environment Policy, 2015). Additionally, depending on the context, people exhibit different preferences i.e. in an interview involving WTP for an ecosystem service (Bateman and Mowby, 2003) found that if the interviewer was wearing formal clothing, the WTP was higher.

Stated preference methods are valuable in the most difficult to value ecosystem services especially the non-use services i.e. heritage values and cultural identity (Chan *et al.,* 2012). However, research has shown that these methods work best if individuals have a better understanding of, and clear preferences of the valued ecosystem services in question which is not the case in most instances for cultural services like existence values (Atkinson *et al.,* 2012; Bateman *et al.,* 2010). Mapping of valuations is needed in-order for them to be of applicable use to policy makers. In such mapping, a challenge arises since ecosystem services may vary spatially both on demand and supply causing the economic value to vary significantly (Schagner *et al.,* 2013). To evaluate policy measures success in such a way that an assessment of changes over time is possible, such maps need to have also a temporal dimension (Atkinson *et al.,* 2012).

Despite the above weaknesses and criticisms, proponents of economic valuation argue that it is an important tool for use to protect and conserve ecosystem services for the benefit of the society (Atkinson *et al.,* 2012). This is by creating awareness on the benefits provided by the ecosystems, and also targeting resources in-order to offer the most efficient protection of ecosystem services with limited funds (Glenk *et al.,* 2013). It also helps in rationalising and framing the decision making process so as to provide points for further deliberations (Laurans and Mermet, 2014).

CHAPTER 3: METHODOLOGY

3.1 Study area

3.1.1 Lake Victoria basin

The Lake Victoria is the largest fresh water lake in Africa and the world's second largest having a catchment area totalling to 250,000 Km^2 out of which 68,000 Km^2 is the actual lake surface area (LVBC, 2011). It is the main livelihood source to the surrounding riparian communities within the three East African countries sharing it namely Kenya (6%), Uganda (43%) and Tanzania (51%). Burundi and Rwanda are within the upper watershed that drains into the lake through river Kagera (Swallow *et al.,* 2003). Lake Victoria is valuable for its wetland resources in which the surrounding riparian community depend upon for their livelihood. Within the Kenyan side, the Lake Victoria wetland occupy approximately 37% of the total wetland surface area in the country (Koyombo and Jorgensen, 2006). Lake Victoria basin and the inshore areas of the lake, papyrus wetlands including the Nyando wetland dominate (Kansiime *et al.,* 2007).

These papyrus wetlands have been described as highly productive and supporting ecological services of great importance due to them occupying the transitional zone between permanently dry and wet environments (Osumba *et al.,* 2010). Early in the 20^{th} century, Twongo and Sikoyo (2004) observed that the lake's shoreline was covered by extensive riparian wetlands as a result of low disturbance and low human settlement. Population increase along the Lake Victoria basin exerted much pressure on the wetlands as people cleared them for agricultural production, settlement and intensive fishing hence shrinking the lake's shoreline (Balirwa, 1998; Morrison *et*

al., 2012; Osumba *et al.,* 2010; Twongo and Sikoyo, 2004). Hassan *et al.,* (2005) argue that a major consequence of wetland ecosystems reclaimed for agricultural production is poor performance of other functions apart from productivity of crops and a reduction in biodiversity. The water levels of the Lake Victoria has been fluctuating and this fluctuation has had a profound influence on the development and status of wetlands of the Lake Victoria basin (Ogutu *et al.,* 2003; Kiwango and Wolanski, 2008).

Nyando wetland like other wetlands in the world are facing the threat of being drained and reclaimed in spite of Kenya having ratified the Ramsar Convention (Verhoeven and Setter, 2009). This could be attributed to institutional failure which has been argued to enhance resource degradation (Acheson, 2006). Nilsson *et al.,* (2009) note that the sustainable management of wetland ecosystems is influenced by resource competition among individual users, their diverging perceptions and institutional responses. This informs this research to understand the relationships between the pressures on the Nyando wetland ecosystem services, perceived state of its ecosystem services, and mitigation interventions by Nyando society and conservation organizations to mitigate the impacts.

3.1.2 Nyando wetland

The study was conducted in Nyando wetland which is the second largest wetland ecosystem in Kenya (Okotto-Okotto *et al.,* 2016) after the Tana Delta (Njuguna and Howard, 1992). The wetland is part of Nyando and Nyakach sub-counties which fall within Kisumu County according to the current Kenyan constitution (Figure 3.1). The wetland lies between 0^{o} 11'- 0^{o} 19'S/34^{o}47'- 34^{o}57'E (Raburu *et al.,* 2012;

Figure 3.1) and is a substantial floodplain forming major Nyakach and Kano swamps with an average elevation of 1134m above the sea level. The main source of water to the wetland is from River Nyando, which has its origin from the Mau escarpment. Nyando River has a catchment area of 3,600 Km^2 and a discharge rate of $15m^3$ S^{-1} into Lake Victoria and has been described as the main contributor to sediment and phosphorous pollution into Lake Victoria (Opere and Okello, 2011).

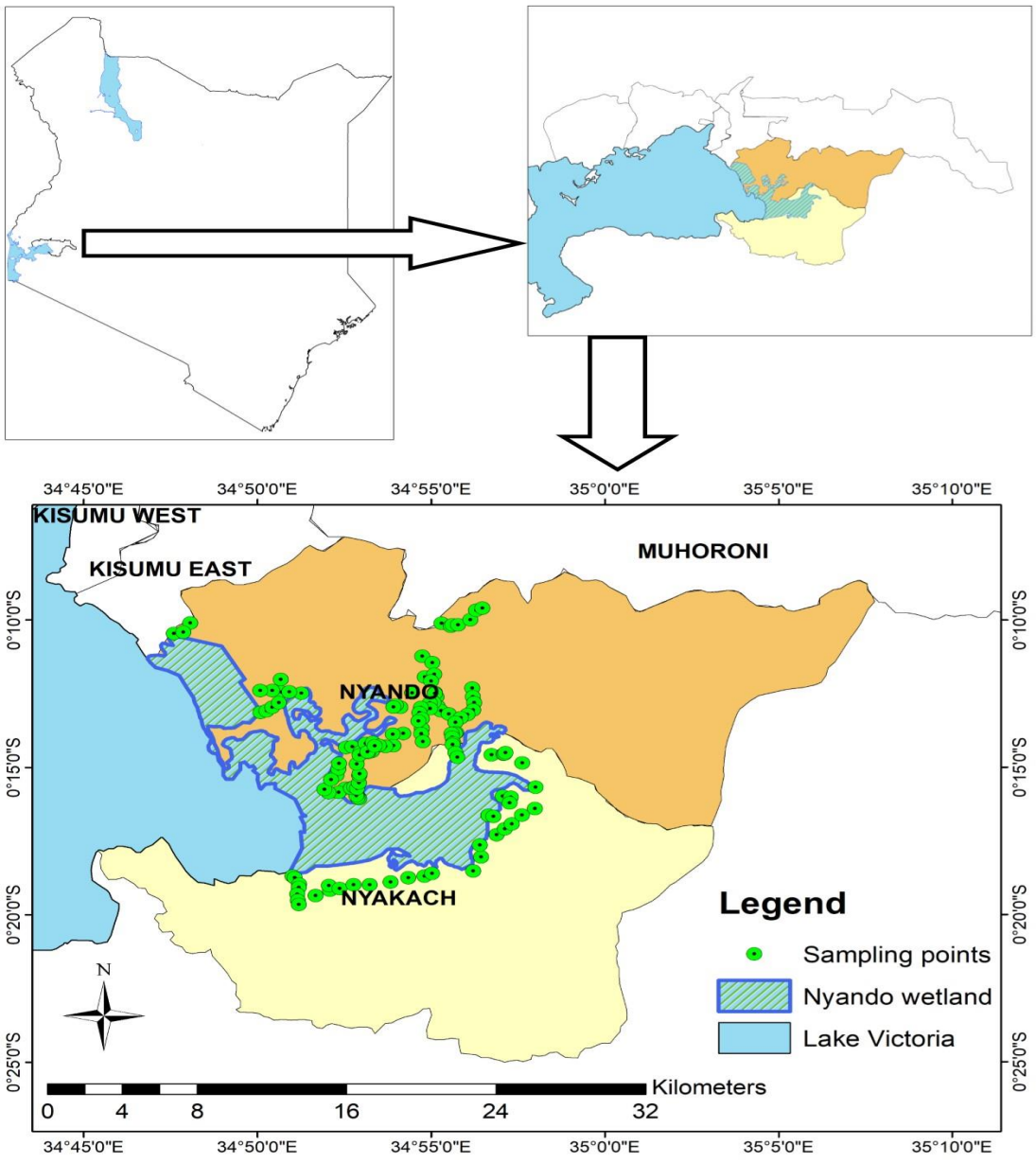

Figure 3.1: Nyando wetland and sampling points

The size of Nyando wetland ranges from 3,000 Ha during the dry season to 5,000 Ha during the wet season (Kipkemboi, 2006; Mwakubo and Obare, 2009). The wetland lies in the Kano plains at the mouth of the Nyando River and along the Lake Victoria shores (Figure 3.1).

The area receives a bimodal rainfall with long rains falling in the months of March and May while October to December is the period for the short rains (Khisa *et al.,* 2013). Due to the changing climatic conditions, the seasons are normally not consistent. Most a times the area experiences flooding during the long rains due to their heaviness and intensity. In contrast, this flooding is followed by extremely dry spell in the months of June to September and December to February. The northward and southward movement of the Inter-Tropical Convergence Zone (ITCZ) along the equator dictates the rainfall patterns as the wetland is mapped along the equator (McClain, 2013). Nyando climate is sub-humid with the mean annual rainfall ranging between 1000-1800mm and a mean annual temperature range of 20-23°C (GoK, 2005).

The soil is deep clay which is rich in organic matter and poorly drained (Jaetzold and Schmidt, 1982; Khisa *et al.,* 2013), hence influencing the crops grown and natural vegetation distribution. The human communities living in the floodplain is predominantly the Luo ethnic group who practice subsistence farming, livestock herding and fishing (Kipkemboi, 2006). The main crops under cultivation in this wetland include sugarcane, rice, maize and vegetables. Other activities in the wetland are cattle grazing, domestic washing, macrophyte harvesting, and fishing (Orwa *et al.,* 2012). Communities around Lake Victoria and its surrounding wetlands depend on the lake and the wetlands resources for their livelihood.

Nyando wetland is of great ecological importance and supports the livelihoods and subsistence economy of the riparian communities. This is evidenced through subsistence agriculture, transport, fishing, tourism as well as providing water sources for livestock and domestic use (Gichuki *et al.,* 2001; Ogutu *et al.,* 2003). A wide range of biodiversity is supported by this wetland ecosystem i.e. the endangered Sitatunga, African civet and flora such as the papyrus (Obiero *et al.,* 2012a). Lake Victoria water level changes have affected water availability for domestic use, catches in fish, prevalence of water borne diseases and agricultural production hence resulting to conflicts in resource use (LVBC, 2006).

3.2 Research design

This research study applied a case study survey design approach. Case studies enable a researcher to have a holistic study of complex social networks (i.e. local, national and regional wetland conservation organizations) and actions (i.e. wetland resource utilization and conservation initiatives) due to their ability to allow information gathering from multiple sources. It also allows observation grounding of social action and social structures (i.e. political landscape, education status, family size and economic activities), which are studied at a close range (Feagin *et al.,* 1991). Case study design approach is appropriate for this study so as to understand the Nyando wetland resource utilization by the local community and the types of conservation initiatives made and the underlying factors influencing these decision making.

Case study survey design approach relies on multiple data sources therefore increasing data credibility (Patton, 1990; Yin, 1994). Methods of data collection in a

case study survey design approach can either be qualitative, quantitative or both and this depends on the nature of the study (Crotty, 1998). Qualitative approach is a research that evokes accounts of meaning, experience or perceptions by participants while quantitative research methods apply numbers so as to describe and show the relationship between variables (De Vos *et al.*, 2002). Rubin and Babbie (2001) further argue that a deeper understanding of the participants' experience is pursued in qualitative research, particularly when reduction of observations and theories to numbers is not easy. Yin (1998) argue that the most desirable case studies will likely combine research strategies involving qualitative and quantitative data types. For example, in a case study, quantitative data can be relevant when enumerating particular intervention outcomes, then the qualitative data may be used to depict a particular compelling explanation for the outcomes (Yin, 1998).

Quantitative data from household questionnaire survey was intended to enumerate outcomes of wetland resource utilization and conservation strategies and is organized in nominal and likert scales. Qualitative data was collected using questionnaires and interview schedules. To elicit respondent's perceptions on utilization and conservation of Nyando wetland resources, non-monetary valuation techniques using questionnaires and interview schedules are used to gather both quantitative (Struhsaker *et al.*, 2005) and qualitative data (Gareau, 2007). This study therefore employs both qualitative and quantitative methods. Data sources for this study include questionnaires, interviews, documents and records and field observations.

3.3 Sample size and sampling procedure

A stratified random sampling survey was conducted to collect data at the household level in two administrative sub-counties surrounding the Nyando wetland namely Nyando and Nyakach.

In Nyando sub-county; East Kano (Wawidhi), Ahero, Kobura, Kobonyo (Kanyagwal) wards were sampled. In East Kano (Wawidhi) ward, Magina sub-location with 564 households was sampled while Tura, Ahero, Kakola Ombaka, South Kochogo, and Kochogo Central sub-locations in Ahero ward were sampled having 1,885, 2,283, 710, 802, and 297 households respectively. Nyamware South and Nyamware North sub-locations in Kobura ward having 971 and 1,309 households respectively were sampled. In Kabonyo (Kanyagwal) ward; Kolal, Kwakungu, Irrigation Scheme, Kapiyo, Nduru and Ogenya sub-locations having 728, 512, 532, 561, 171, 531 households were sampled. In Nyakach sub-county; North Nyakach and Central Nyakach wards were sampled. For North Nyakach ward; Gem-Rae and Kasae sub-locations having 910 and 225 households were sampled while Kabodho North, Kabodho West and Jimo West sub-locations in Central Nyakach ward having 620, 1,072 and 1,543 households were sampled (KNBS, 2009). The total number of households which formed the population for this study was 16,226 households.

The sample size was derived using Yamane (1967) formula.

$$n = \frac{N}{1+N(e)^2}$$

Where n is the sample size, N is the population size, and ‘e’ is the level of precision (at 5%). Therefore from a total of 16,226 households within the sampled sub-locations, the total sample size is calculated as follows:

$$n = \frac{16{,}226}{1+16{,}226\,(0.05)^2} = 391 \text{ households}$$

The questionnaires were distributed proportionately per sub-location households in the two sub-counties (Table 3.1).

3.4 Data collection procedures

Secondary and primary methods of data collection were employed. A combination of both quantitative and qualitative methods of data collection using questionnaires and structured interviews was used so as to have a deeper understanding of the case being investigated in Nyando wetland. Secondary data sources consisted of literature from publications such as journals, reports from governmental and non-governmental agencies (e.g. Kenya National Bureau of Statistics, Ministry of Agriculture, Livestock and Fisheries, and Lake Victoria Environmental Management Project (LVEMP). The primary data sources included; household survey questionnaires, key informant interviews and physical observations.

The survey questionnaire was administered to households of the local communities living next to the wetland areas within Nyando and Nyakach sub-counties. The questionnaires include questions on wetland resource utilization, conservation institutions and PES (Appendix 1). The open-ended questions evoke wider discussions of some of the matters brought out as well as help to cross-check responses (Infield, 1988).

Table 3.1: Sampling frame for data collection in Nyando wetland

	Sub-county	Ward	Sub-locations	Households	Sample size
Household survey	Nyando	East Kano /Wawidhi	Magina	564	14
		Ahero	Tura	1885	45
			Ahero	2283	55
			Kakola	710	17
			Ombaka South	802	19
			Kochogo Kochogo Central	297	7
		Kobura	Nyamware South	971	23
			Nyamware North	1309	32
		Kobonyo/Kanyagwal	Kolal	728	18
			Kwakungu	512	12
			Irrigation scheme	532	13
			Kapiyo	561	14
			Nduru	171	4
			Ogenya	531	13
	Nyakach	North Nyakach	Gem Rae	910	22
			Kasae	225	5
		Central Nyakach	Kabodho North	620	15
			Kabodho West	1072	26
			Jimo West	1543	37
Total					**391**
Key Informants					
	National Environment and Management Authority (NEMA)				1
	Ministry of Agriculture, Livestock and Fisheries				2
	Beach Management Units (BMUs)				2
	County Government of Kisumu – Department of Environment and Natural Resources				2
	Kenya Wildlife Service (KWS)				2
	NGOs and CBOs (VIRED, SCC Vi Agro-forestry, and Community Rehabilitation and Environmental Protection Program (CREPP)				3
Total					**12**

Some of these open ended questions include perceptions and attitudes towards conservation institutions and PES, relationship with the conservation authorities, suggestions for an effective sustainable wetland conservation strategy and threats to the conservation strategies.

A series of in-depth interviews (Appendix 2) were undertaken with key informants (Table 3.1). The interviews were administered in a semi-structured and open-ended manner giving an opportunity for the respondents to have freedom of expression and give a detailed explanation so as to get a deeper insight and understanding of the problem under investigation (Gillman, 2000; Ritchie and Lewis, 2003). This was necessary to capture the interviewee's opinions on a given subject under study.

Physical observation was also conducted through field visits to observe the state of the wetland resources, kinds of destruction and also observing the existing conservation institutions. This is helpful in social studies to identify data discrepancies and any possible systematic distortions from the study participants by checking facts on the ground against descriptions (Holstein and Gubrium, 2003). The data was captured in photographs and on a notebook.

Research assistants were recruited and trained to help in administering out the questionnaires to the respondents. The research assistants were conversant with the local (Dholuo) language and helped interpret the questions for those who could not understand or read.

3.5 Land use/cover change detection

Satellite images from Landsat-5 Thematic Mapper (TM), Landsat-8 Operational Land Imager (OLI) and Aster (Table 3.2) were used for mapping of wetland cover change detection. Landsat-5 TM, Landsat-8 OLI images were downloaded from United States Geological Survey (USGS) earth explorer while Aster images were downloaded from Google earth engine. The selection of the images was based on data availability, suitability in terms of time series and clarity of images.

Table 3.2: Satellite images for land use/cover change analysis in Nyando wetland

Year	Images/ Data type	Date of acquisition
1985	170/060 Landsat TM	5th March 1985
1995	170/060 Landsat TM	17th March 1995
2005	Aster	4th March 2005
2015	170/060 Landsat OLI	8th March 2015
2020	170/060 Landsat OLI	21st March 2020

3.6 Data analysis

The data collected using the interview guide and household questionnaires was summarized and classified into categories. The data was edited, coded, tabulated and analyzed using SPSS version 20. Quantitative data from household questionnaire survey was organized in nominal and likert scales. This involved using scores to measure the respondent's level of agreement or disagreement with a given statement or question using a five ordered response scores 1 to 5. Were possible, standardization of the responses using a standard scale of 1 to 5 was first conducted; where variables numbered 1 were given 5 scores, 2 given 4 scores, 3 = 3 scores, 4 =

2 scores and 5 = 1 score. The quantitative data was subjected to descriptive statistics, Chi-square test and correlation analysis which were performed in SPSS version 20. The Chi-square test and correlation analysis were conducted at 5% level of significance. A Pearson correlation was conducted to understand the relationship between wetland resource use and the respondent's occupation. A correlation co-efficient (*r)* ranges between -1 and 1 and indicates strength of the correlation. A correlation coefficient towards -1 refers to a strong negative while one towards 1 refers to a strong positive correlation.

Data presentation was done using tables, figures and pie charts which were generated in Microsoft Office Excel version 2013. Qualitative data from the interview guide and household questionnaire was analyzed through content analysis whereby the collected data was ordered into distinct themes and categories, crucial to describe a given phenomenon based on the respondents' responses (Braun and Clarke, 2006). Responses referring to similar or related meaning were grouped together and then descriptive statistics were performed. Where necessary, qualitative data from the household respondents and key informants were coded. This involved giving a unique code for each respondent. For example, the code used for household respondents was (HHR) while (KI) was used for the key informants. These codes were then followed by a number representing a given respondent or key informant. For instance, HHR01 represents household respondent one while HHR02 represents household respondent two and so forth. KI01 represents key informant one while KI02 represents key informant two and so forth.

ArcGIS 10.1 was used in image pre-processing and analysis for land use/cover change detection so as to understand the changes which have been occurring in the

Nyando wetland for the last three and half decades due to changing utilization demands for its ecosystem services. Image enhancement involved the modification of the images to make them visually suited for interpretation. Image enhancement was performed through composite generation. Landsat TM Bands 4, 3, 2 and Landsat OLI bands 5, 4, 3 which correspond to Aster bands 3, 2, 1 were used to generate colour composites. The band combination produced false colour composites (Appendix 3) where dense vegetation appeared as shades of dark red, soils varied from dark brown to green, lighter reds signified grasslands or sparsely vegetated areas while built up areas appear in shades of light blue.

Unsupervised classification technique was used to develop interpreted maps from the colour composites generated (Appendix 3) during image enhancement. It involved generation of spectral signatures of known land cover classes. The land cover classes developed were wetlands, water bodies and agriculture and settlements. The colour red was assigned to wetlands, green was assigned agriculture and settlements, and blue was assigned water bodies. The land cover classification was aided by field visits which were conducted to explain land cover changes detected for the period between 1985 and 2020. Area computation was done by calculation of areas under the different land cover classes for the year 1985, 1995, 2005, 2015 and 2020.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses research findings according to research objectives. The research objectives are: (1) to investigate institutional arrangements governing conservation of Nyando wetland resources (2) to examine the utilization of Nyando wetland ecosystem services (3) to examine the local community's perception on payment for ecosystem services in Nyando wetland.

4.2 Institutional arrangements governing Nyando wetland resource conservation

As explained in section 1.8 and 2.1, institutions are humanly devised constraints that structure human interaction. They are made up of formal constraints (e.g. rules, laws, regulations), informal constraints (e.g., norms of behavior, conventions, self-imposed codes of conduct), and their enforcement characteristics (North, 1994). To address the first objective, this section looks at the role of organizations, formal and informal institutions and institutional design for conservation of Nyando wetland resources.

4.2.1 Role of organizations in management of Nyando wetland resources

Nyando wetland resource utilization, management and conservation is driven by several formal organizations including government departments (i.e. NEMA, Ministry of Tourism and Wildlife; the Ministry of Agriculture, Livestock, Fisheries and Irrigation; the Ministry of Environment and Forestry; the Lands and Physical Planning Ministry; and the Ministry of Water and Sanitation), NGOs, and CBOs.

These organizations are mainly involved in either wetland use, conservation or both. Organizational participation in wetland conservation is influenced by their priorities and diverse institutional mandates which are torn between environmental and socio-economic considerations (Marabanyika and Beckedahl, 2017). A high proportion of the respondents are of the view that the local community (34.4%) and the government (30.9%) are mandated to conserve the Nyando wetland as compared to 7.6% and 2.8% for CBOs and NGOs respectively. However, 24.3 % of the respondents are of the view that conservation mandate is vested on all the four organizations (government, local community, CBOs and NGOs).

NEMA is the principal body of environmental governance in Kenya (GoK, 1999, 2015). It is mandated to supervise, coordinate and oversee the implementation of all policies which relate to the environment (GoK, 1999, 2015). Under Section 42 and 43 of the Environmental Management and Coordination Act (EMCA) (GoK, 1999, 2015), elaborate provisions for protection and conservation of wetlands are made. The Kenya Forest Service established under the Forest Conservation and Management Act No. 34 (GoK, 2016a) has functions including to manage water catchment areas for the purpose of soil and water conservation, carbon sequestration and other environmental services. The Forest policy objective is to promote the participation of communities, private sector and other stakeholders in management of forests so as to conserve water catchment areas. Wetlands are important water catchment areas. The policy also expands forest management to include categories that touch on wetlands including preservation of cultural and religious sites, water catchments, sources of traditional medicine and habitats for threatened and endemic

species of flora and fauna. The Kenya Forest Service therefore complements NEMA in Nyando wetland conservation.

The Water Resources Authority established under the Water Act (GoK, 2016b) has the mandate to, among other things, enforce standards, procedures and regulations for use and management of water resources. It has also the mandate to determine, issue, and enforce conditions of the water permits. Though the Act does not address wetlands directly, its definition of 'water resource' (any pond, lake, marsh, swamp, stream, watercourse, estuary, aquifer, artesian basin or other body of flowing or standing water either below or above the ground) definitely encompasses wetlands.

The Kenya Wildlife Service (KWS) provides the framework for protection, conservation and management of the Kenyan wildlife (GoK, 2013c). The KWS is mandated with the oversight of utilization, conservation and management of all types of flora and fauna (excluding domestic animals) (GoK, 2013c). Wetlands are habitats for flora and fauna and with the presence of such animals as hippopotamus, Sitatunga antelope, snakes and birds found in the Nyando wetland, the role of KWS in wetland resource utilization and conservation cannot be underrated.

The Agriculture, Fisheries, and Food Security Authority developed under the Agriculture, Fisheries, and Food Authority Act No. 13 (GoK, 2013d) is mandated to promote best practices in production, processing and marketing of agricultural and aquatic products (excluding livestock products) as provided for under the Fisheries Act and Crops Act. The Kenya Fisheries Service established under the Fisheries Management and Development Act (GoK, 2016c) is vested with the responsibility

of ensuring sustainable use and protection of Kenya's fisheries resources which doubtlessly includes wetlands.

These governmental organizations together with other NGOs and CBOs are crucial either for wetland resource use, conservation or both. Most of these organizations play a crucial role in capacity building through educating the local community on sustainable wetland resource utilization and supporting alternative livelihood strategies (Table 4.1) hence acting as important institutions of resource management. In the category of NGOs, VIRED is mentioned by majority of the respondents (26.6%) while the Ministry of Agriculture, Livestock, Fisheries and Irrigation in the category of governmental organizations operating within the Nyando wetland is mentioned by majority of the respondents (21.3%). VIRED is promoting alternative livelihood strategies and capacity building through training the local community on wetland conservation (Table 4.1) hence acting as an important organization for wetland conservation. The Ministry of Agriculture, Livestock, Fisheries and Irrigation is promoting agricultural activities and practices (Table 4.1) within the area hence acting as an important organization for wetland use. Officials from the Ministry of Agriculture, Livestock, Fisheries and Irrigation help in provision of extension services to farmers on better farming methods and soil conservation (Table 4.1) which promotes wetland use and conservation. KWS engages in conservation awareness campaigns within the Nyando wetland by organizing an annual Sitatunga boat race.

"*To create awareness on the conservation of Sitatunga antelope, a threatened species, the KWS organizes an annual Sitatunga boat race and awards prizes to the winners as they educate the community on conservation issues"* (KI05).

Table 4.1: Roles of the organizations engaged in conservation of Nyando wetland

Organization name	Frequency (N)	Percentage (%)	Organizational roles in Nyando wetland
VIRED	161	26.6	Flood control. Construction of access roads and tree planting. Education and capacity building on wetland conservation. Provision of tree seedlings, beehives, boats and support food for work program. Support famers in poultry and horticultural farming.
LVEMP	75	12.4	Fish pond construction, provision of fishing boats, regulation of fishing activities and provision of tree seedlings. Construction of boreholes, flood control and tree planting along river banks. Help in educating the local community on environmental conservation.
County Government of Kisumu	62	10.2	Help in flood control through building of dykes and opening up of drainage canals. They also construct and improve access roads.
Department of Fisheries	39	6.4	Through the beach management units, they are engaged in beach management advising fishers on better fishing methods and enforcing the fishing regulations, capacity building on fish pond rearing and wetland conservation
SCC Vi- Agroforestry	36	6.0	Provide tree seedlings to the locals for planting. Capacity building on sustainable land use management (intercropping, compositing and water conservation)
NEMA	2	0.3	Wetland conservation by giving guidance on development of wetland management plans
CREPP	3	0.5	Providing tree seedlings through cost sharing and sometimes free of charge. Capacity building on wetland conservation
Ministry of Agriculture, Livestock, and Irrigation	129	21.3	Train farmers on good agricultural practices and conservation agriculture. Provide certified seeds and tree seedlings. Educate the locals on wetland conservation. Help in provision of irrigation water through the National Irrigation Board. Help in flood control, tree and cover crop planting. Help farmers in marketing of their rice produce.
Smallholder Irrigation Support Organization (SISO)	9	1.5	Maintenance of rice irrigation canals, regulate irrigation water
World Vision	42	6.9	Support community projects i.e. goat and dairy cattle rearing and provide water tanks and greenhouses. Educate farmers on good farming practices and environmental conservation. Provide tree seedlings and help in tree planting
Ministry of Environment and Forestry and Ministry of Tourism and Wildlife	42	6.9	Environment and wildlife conservation, awareness creation, damage compensations, tree planting
Water Resources Authority	5	0.8	Protecting and management of water resources
TOTAL	**605**	**100.0**	

NGOs such as VIRED and SCC Vi-Agro-Forestry provide planting seeds and tree seedlings and also help in planting of trees (58.7%) (Figure 4.1). The tree planting exercise takes place in the farms of the local community or as part of river bank stabilization to prevent soil erosion. Both the governmental and NGOs operational in the area help in conservation efforts by supporting the local community in flood control (33.4%) by building of dykes, gabions and planting of grass along the dykes (Figure 4.1), to cushion farmers and households from floods which are prone in the area.

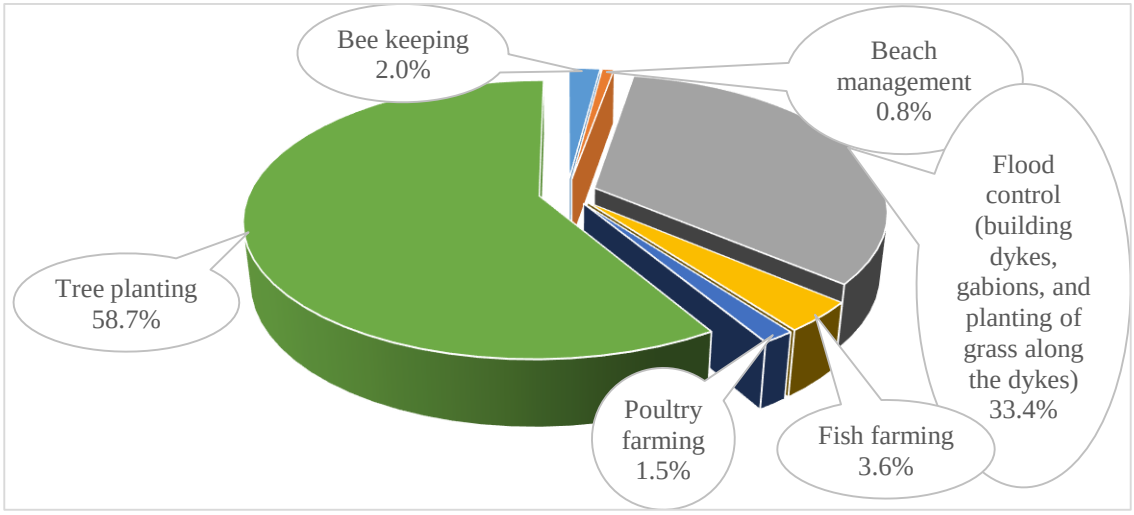

Figure 4.1: Alternative livelihoods and conservation initiatives by organizations operating in Nyando wetland

They also support them on alternative livelihood strategies i.e. educating and helping the community in bee keeping (2%), fish farming (3.6%) and poultry farming (1.5%) to reduce their over reliance on wetland resources. Coordination on awareness creation through joint stakeholder meetings to discuss conservation issues and capacity building by the governmental and Non-governmental organizations

involved in the management of Nyando wetland resources is reported by 88.9% of the key informants.

4.2.2 Formal institutions in management of Nyando wetland

Guidelines and rules exist to ensure sustainable resource utilization and conservation of Kenyan public or private wetlands for domestic or other uses (GoK, 2009). Activities which compromise wetlands integrity are prohibited and approvals are only done by the relevant authority only after an EIA has been conducted and a licence issued. Majority of the respondents (73.5%) noted that government has the final say on utilization and management of the wetland therefore supporting the role of NEMA in regulating access to and utilization of Nyando wetland resources. However, despite this requirement, NEMA did not seem to offer much regulation to Nyando wetland resource utilization as majority of the respondents (81.8%) reported that they freely access most of the wetland resources without restrictions. This was also supported by all the key informants who stated that the local community has access to and use of most of the wetland resources. There were no restrictions on the extent and the amount one could harvest in the communal wetland areas. This open access with no control poses a threat to the wetland resources which are subject to exploitation. Households whose homes bordered the wetland areas believed that the wetland belongs to them and therefore have some level of control on access and utilization of the wetland resources by other users (KI04). Permission for use was sought from them which was either denied or accepted depending on the requested resources to be harvested. Majority of the respondents (54.6%) accuse NEMA and other governmental conservation agencies of poor policy enforcement as they take no action and don’t arrest defaulters despite continued destruction. Poor surveillance

and monitoring of Nyando wetland resources and activities going on is reported by 14.8% of the respondents who accuse the governmental conservation agencies of laxity and not making frequent visits to the wetland which has contributed to continued degradation of its resources.

The Water Quality regulations provides for the rules of wetland management practices including restriction of water abstraction without conducting EIA (GoK, 2006). This regulation was not effectively enforced as water abstractions for agriculture and other uses were carried out without conducting EIA. This could have been so since the same mandate to provide irrigation water was also vested under the National Irrigation Board (NIB) which only required farmers to pay a certain amount of money for them to access irrigation water. The regulation also requires an observation and setting aside a wetland riparian zone of 6-30m from the highest flood mark of a water body (GoK, 2006). This riparian zone rule was not observed as noted by key informant KI02 who reported:

"Different government departments declare different riparian zone lengths".

During transect walk in Wawidhi wetland, farming activities were observed taking place even up to a distance of 2 meters from the Nyando river banks. The wetland and the river banks were highly disturbed with much of the papyrus vegetation having been cleared to pave way for vegetable farming. This was also supported by key informant KI04 who reported:

"Cultivation along the Nyando river banks especially during the dry spell is very common amongst the local community as the soils are fertile and moist, and no one prohibits them".

The Water Act (GoK, 2016b) provides the rules of use and management of Kenya's water resources with the Water Resources Authority being the enforcing body. Before a permit for water use is issued and depending on the nature of the project, public participation and an EIA is required which has to be done in accordance with the requirements of EMCA (GoK, 1999, 2015). The regulations prohibits discharge of wastes and other pollutants into water resources which compliments the mandate of NEMA. Despite the two bodies (NEMA and the Water Resources Authority) which have a mandate to enforce the policy on water resources pollution, effluent discharge by sugar factories and pollution from agricultural activities found their way into Nyando wetland and the Lake Victoria as reported by 4.7% of the respondents. This clearly indicates that the policy is poorly enforced probably as a result of compromise on the side of the enforcing authorities, lack of resources or political influence.

The wildlife conservation and management regulations of 2013 prohibit hunting of wild animals and this has made the local community to refrain from hunting activities due to harsh penalties for the defaulters, which has aided in conservation of some of the remaining stock of animals in the Nyando wetland. Majority of the respondents (90.6%) acknowledged that illegal hunting activities for such animals as hippopotamus, sitatunga antelope, hare, and birds within the Nyando wetland have reduced. A high proportion (48.3%) (Figure 4.2) stated that the main reason for such an observation was due to disturbance of Nyando wetland, which acts as their hiding place consequently leading to their migration. The other reasons (Figure 4.2) are that fewer species are believed to be remaining in the wetlands (18.5%) and hunting is prohibited by the Kenya Wildlife Service (14.1%) who protect the wild animals.

Hunting was considered by others primitive due to modernization (6.3%) and therefore they could not engage in it. Resource use conflicts i.e. human-wildlife conflicts (HWC) and human-human conflicts were reported during the acquisition and utilization of the wetland resources by the respondents. HWC has been reported as amongst the important threats to the survival of many wildlife species (Madden, 2008; Johansson, 2002). KWS handled most of the HWC providing compensations to those who followed the set out rules which required one to take precautionary measures like fencing their farms and not to encroach the wetland wildlife habitats.

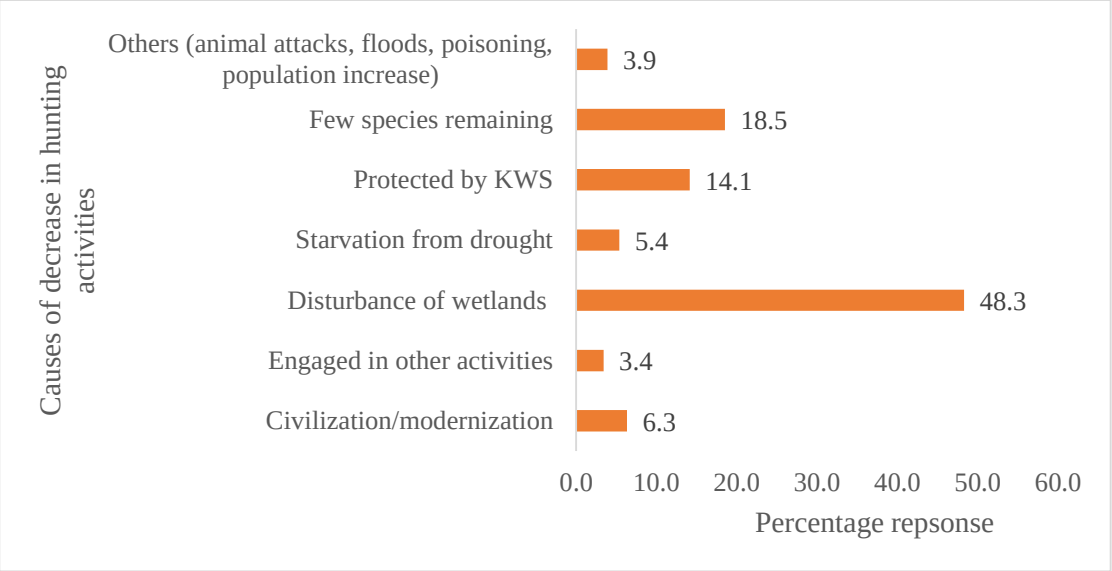

Figure 4.2: Drivers of decrease in hunting activities in Nyando wetland

The Agriculture, Fisheries, and Food Authority Act No. 13 (GoK, 2013d) empowers the Cabinet Secretary (CS) upon advice of the authority and after consulting National Land Commission to make rules for the preservation, utilization and development of aquatic resources and agricultural land (which touches on wetlands). Additionally, as a compliment to the mandate of NEMA, the Act also empowers the CS to prescribe national guidelines prohibiting, regulating and controlling undertaking of any agricultural activity such as setting fires, clearing of vegetation

in order to protect water catchment areas and curb land degradation. However, due to the mandate of the Ministry of Agriculture, Livestock, Fisheries and Irrigation to promote food security by enhancing agricultural production, Nyando wetland has continued to face increased vegetation clearing and degradation from the associated agricultural activities.

Land acquisition and access in the Nyando wetland was majorly through inheritance (73.5%). Other forms of land access are self-allocations (12.8%), buying (7%), allocations by authorities and self (4.3%), allocations by authorities alone (2.7%) as well as leasing or getting a portion from a friend (0.3%). As population increased, further land subdivisions occurred resulting to smaller land portions contributing to further encroachment and draining of the wetland (which is prohibited under the EMCA Act without a permit). Despite prohibition under Section 42 (1) of the EMCA Act to erect, reconstruct, place or extend any structure in or under the wetland, construction of houses for settlements was taking place in Ugenya wetland in Nyando sub-county (KI04).

The Fisheries Management and Development Act (GoK, 2016c) provides the guidelines for development, management and conservation of fisheries and other aquatic resources so as to enhance the fishing community's livelihoods. The fisheries (Beach Management Unit) regulations under the Fisheries Act (Cap 378) – Legal Notice No.42 came to effect in 2007 in Kenya giving the BMUs the rights to manage resources at a given beach landing site (GoK, 2007b). A BMU is an organization of fish folk at the beach (boat crew, boat owners, managers, charterers, fish processors, fishmongers, local gear makers or repairers and fishing equipment dealers) within a fishing community (Lake Victoria Fisheries Organization (LVFO),

2007). The BMU is a form of co-management between the government and the fishing communities so as to decentralize the fisheries polices enforcement and development.

The operation of the BMUs is restricted to a given delineated geographical area. Their functions include recording of fish landings, enforcement of fisheries regulations (registration of boats, gear regulation restrictions, protection of fishing grounds), conflict resolutions and welfare matters, handling of emergencies, and beach development at the areas of their jurisdiction (Cinner *et al.,* 2008). The Fisheries (Prohibitions) Regulations forbid fishing for, landing, moving, processing and trading in Nile perch of a size less than 85cm total length from the Kenyan waters of Lake Victoria. This regulation is not adhered to probably due to poor enforcement which has led to much of the Nile perch fish biomass in the lake to be dominated by juveniles (LVFO, 2015b, 2017). The same regulation also prohibits fishing for, landing, moving or trading in Omena (*Rastrineobola argentea*) from the Kenyan Lake Victoria waters during the closed season (April 1st to July 31st every year).

Access to fishing required one to register with the BMUs at their jurisdiction and adhere to the set out rules. *"Registration with the BMUs involves a one off payment of Ksh. 500 and a weekly service charge of Ksh. 90 to maintain membership"* (KI01). However, as noted during an interview with some BMU officials from KUSA beach, these BMUs were faced with a couple of challenges. One of the BMU official reported: *"Enforcement of the fisheries regulations is one of the challenges as these BMUs lack the legal capacity to prosecute offenders and confiscate illegal fishing gears" (KI01).* The ineffectiveness of the BMUs was highlighted by the

fishers themselves. *"The BMU officials are corrupt and do not enforce the set out regulations governing fishing activities in the area and allow illegal gears and trading in the juvenile fish to go on in their presence" (HHR01).*

"Low education levels, high poverty rates among the fishing community who totally depend on the wetlands for their livelihood and poor facilitation from the government" (KI02) were some of the challenges faced in the enforcement of the fishing regulations within the area. This has led to the continued disregard in observation of the closed season, use of illegal fishing gears which has resulted to over exploitation of the fish resources. The open access policy syndrome by the fishers in the Nyando wetland and the Lake Victoria at large has resulted to the increased excessive and destructive fishing pressure exerted by the use of undersized meshes, beach seines and poison (Kolding *et al.,* 2008).

Majority of respondents (57.8%) pointed the government's inefficiency in Nyando wetland conservation. The reasons raised for such an observation was that the government did not take action to prosecute defaulters despite continued destruction (54.6%), rarely visited the wetland to monitor ongoing activities (14.8%), were accused of being corrupt (14.8%) hence allowed illegal activities to go on. Others (5.6%) accused the government conservation agencies of not doing much to educate the local community on conservation, 4.6% noted that there was continued pollution from sugar factories, 3.7% argued that the government has not demarcated the Nyando wetland boundaries and 1.9% noted the conflicts between the many governmental departments operational in the wetland.

The ineffectiveness of Nyando wetland conservation was also noted by 50% of the key informants. The results of qualitative data analysis from the interviews revealed lack of resources (33.3%) in terms of enough personnel who have the required capacity and lack of financial support as the main challenge to effective enforcement of conservation rules by the key informants (Table 4.2). This lack of enough resources as well as corruption by the enforcing authorities affects monitoring and surveillance efforts and this leads to poor policy enforcement consequently resulting to resource over-exploitation. High poverty and limited knowledge amongst the local community (28.6%) (Table 4.2) has led to over-reliance on the wetland resources and this has also posed a conservation challenge. Policy conflicts and duplications resulting to poor organizational coordination and enforcement (23.8%) has also greatly affected conservation efforts in Nyando wetland. The conservation organizations did not have a significant effect on coordination of wetland conservation (χ^2= 2.022, df=3, p>0.05).

Table 4.2: Nyando wetland conservation rule enforcement challenges by organizations

Enforcement challenges	**Frequency (N)**	**Percentage (%)**
Policy conflicts and duplications hence poor organizational coordination	5	23.8
Lack of enough resources hence enforcement challenges	7	33.3
Poverty and limited knowledge of the local community	6	28.6
Un-receptiveness by the local community	3	14.3
Total	**21**	**100.0**

Some of the policy conflicts and duplications raised by the key informants include; wetland draining by the Agriculture department for crop production while NEMA prohibits the same, issuance of effluent discharge permit by both NEMA and Water

Resources Authority which serves the same purpose. Different government ministries declaring varying riparian zone lengths and the subdivision and issuance of building permits by the Physical Planning department to some locals to build in the wetland. The multiplicity of institutional mandates results in inconsistences in the articulation of policies by different institutions involved in management of Nyando wetland which may result into confusion, conflicts and inefficiencies. The wetland users are therefore left in a state of confusion and result to unsustainable wetland resource utilization hence the need for policy harmonization of the different legislations contained in many pieces of government frameworks in-order to achieve coherence in sustainable management and conservation of wetlands.

4.2.3 Informal institutions governing management of Nyando wetland

Two types of informal institutions namely traditional and local informal institutions are identified in the management of Nyando wetland resources. On the traditional institutions, majority of the respondents (41.7%) indicated the use of traditional fishing gears (*Osadhi, Ounga and Sienyo)* (Figure 4.3) which were locally made to be one of the significant ways to the management of fishing activities within the Nyando wetland during the pre-colonial era. These traditional gears were carefully made and caught only the big sized fish ensuring sustainability. Other scholars have reported similar findings (Graham, 1929), who report that there was sparse fishing within the Lake Victoria at the start of the 20th century.

Access to the fishery was through membership to clans who owned the beaches which were close to their homelands and members were supposed to adhere to the set out clan-based rules (Opondo, 2011). There were however no restrictions on how

far one could go into the lake beyond the confines of the beaches (Opondo, 2011). The observation of closed season of no fishing and a total ban on fishing at certain times of the year (15.3%) (Figure 4.3) was adhered to by the local community in the wetland and the Lake Victoria at large. This closed season was between February and June while the total ban was decided based on the fish stocks by the clan elders who managed the beaches (Opondo, 2011). This closed season and total ban whereby no one was allowed to do fishing is necessary to allow for fish regeneration and protection of the over fished species. These traditional institutions controlled the fishing sector by enforcing prohibitions on the fish sizes to harvest, when to harvest and where to and where not to harvest to enhance sustainability of the fish resource in the Nyando wetland.

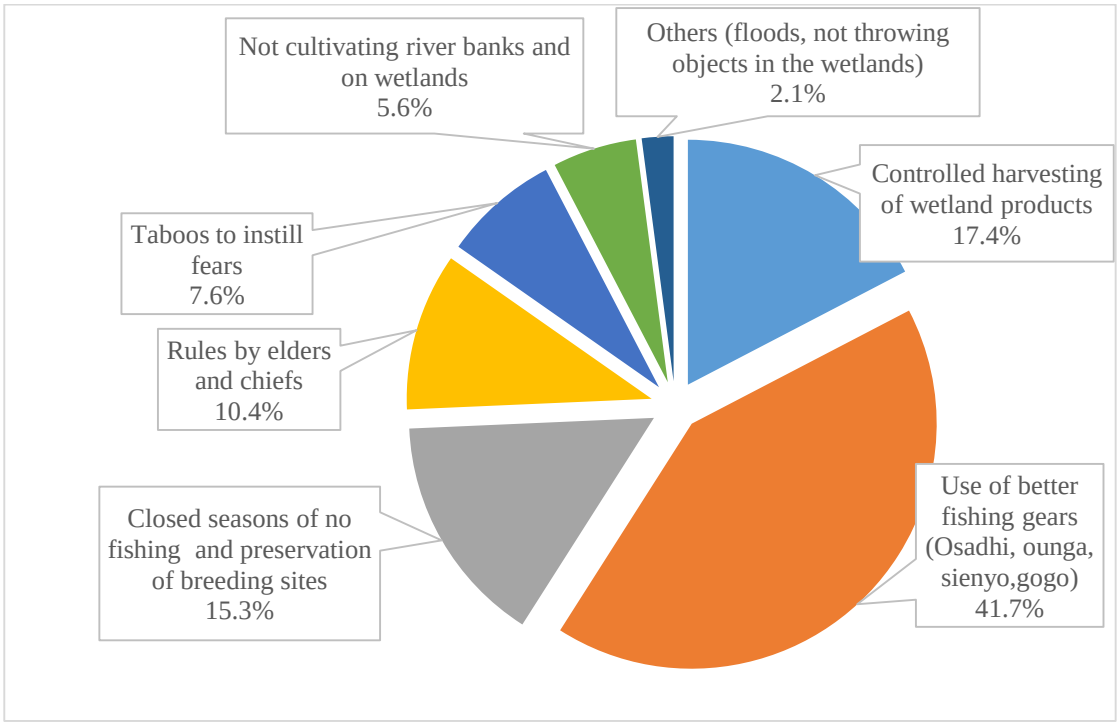

Figure 4.3: Traditional wetland management systems used to conserve Nyando wetland resources by the local community

However, the respondent's acknowledged that the use of these traditional fishing gears has evolved over time with the introduction of boats and fishing nets noting that *"nowadays the fishers not only use fishing nets but also use the undersized ones including mosquito nets which catch even the juvenile fish"* (HHR02). The advent of colonialism especially introduction of commercial fishing threatened the local traditional management system and rule adherence (Opondo, 2011). The introduction of fishing nets in 1970s has changed the fishing activities in the Nyando wetland (Nasongo *et al.,* 2015). Fish breeding areas restricted in the past by traditional institutions have now been invaded for fishing as a result of enhanced fish demand at local and international levels (SOFIA, 2010).

Cultivation and harvesting of Nyando wetland materials was controlled by the set out traditional institutions. Some of these traditional conservation ways stated include controlled harvesting of wetland products (17.4%) and not cultivating along the river banks and in the wetlands (5.6%) (Figure 4.3). This controlled harvesting was based on prohibitions not to cut some plant species, not to burn papyrus, harvesting only the mature papyrus as well as observation of time of not going to the wetlands which is important to allow for the regeneration and sustainability of the wetland resources. This is in contrast to the current management system of the formal institutions whereby there is open access and no much control of when and quantities to be harvested in the communal wetland.

The enforcement of theses traditional rules of resource utilization was done by the council of elders and chiefs (10.4%). The respondents stated that *"those who did not observe the set out rules were punished by the elders by sanctioning them from fishery for months"* (HHR03). Other ways used to enforce these rules was through

taboos (7.6%) (Figure 4.3) to instil fear i.e. burning of papyrus without cutting it was considered a taboo as they believed this could result to death of their child. *"Devils and evil spirits were believed to dwell in the wetlands therefore scaring people away"* (HHR04). Polluting the wetlands by either throwing dirt or even urinating was prohibited. *"The river banks were believed to be paths of evil spirits hence no cultivation took place"* (HHR05). Instilling fear through taboos scared people away from the fish breeding and spawning areas as well as other wetland resources which enhanced their conservation.

The traditional social control systems that ensured sustainability of these resources due to regulated use have most of them disintegrated and been replaced by modern and formal institutions. A high percentage (91.9%) of the respondents acknowledged that most of the traditional cultural activities (i.e. cleansing and circumcision ceremonies, appeasing the spirits of the dead in the wetlands) have eroded and decreased over time and are no longer practiced as they have been replaced by other modern religious practices. The major reason stated for the decrease of these cultural activities is influence of Christianity (85.5%) (Table 4.3). Subdivision of land which was initially held communally to portions which are held by households has also contributed to the evolution of the traditional farming institutions. Decisions which were made by the council of elders have been left to individual land owners and other government entities as changes in land tenure systems and immigration and emigration of people within the area have taken place.

Table 4.3: Reasons for decrease in cultural activities in Nyando wetland

Reason	**Frequency (N)**	**Percentage (%)**
Christianity influence	188	85.5
Lifestyle change/civilization	31	14.1
Destruction of wetlands	1	0.5
Total	220	100.0

Due to disasters such as droughts, floods, drowning of people in the lake and rivers, these wetland ecosystems formed sacred places in the past for offering sacrifices to avert such calamities and hence were conserved from destruction. Christianity has shaped and changed the belief systems by people as these teachings empower them; for example, nowadays many people prefer to pray than offer cleansing ceremonies in the wetlands which was a common practice in the past. Westernization has been taking place since the colonial era with the mastery and literacy of the European language considered an important entry into modern sector. The respondents consider themselves civilized (14.1%) (Table 4.3) as a result of formal education and consider the African way of doing things primitive. The Christian missionaries inculcated western values into African Christians leading them to challenge traditional beliefs and institutions and therefore promoting diffusion of new modes of life and ideas (Arowolo, 2010).

Influences by the western religions, education, technological advances and increased availability of health facilities within the area have contributed to the changing systems and their inherent resource conservation traits. Places which were held sacred and conserved are no longer preserved as the new religions give people power to destroy them. For example, one respondent (HHR06) reported *"wetland places conserved for medicinal herbs and circumcision ceremonies have been cleared as a result of the evolution and increased preference of hospitals compared*

to these traditional ones". Cultivation along the river banks, which were believed to be paths for evil spirits, was prohibited under the traditional institutions; however, this has changed in Nyando wetland as river banks and wetlands have been encroached and opened up for farming and settlement.

The local community has organized themselves by forming community conservation groups as part of local informal institutions for resource conservation. An example is the management of the restored Okana wetland by the local community members in Nyando sub-county. The community members have formed a conservation group composed of members who are engaged in its restoration. They have appointed a leadership in place consisting of a chairperson, secretary and a treasurer. A control mechanism to access Okana wetland resources has been put in place by the leadership as noted by KI03.

"*Members of the conservation group are free to access the wetland resources while outsiders have to seek permission from the group's leadership and even pay some amount of money to be allowed to access and harvest the wetland resources with a bale of papyrus going for around Ksh.100- 200 for non-members"*.

Harvesting is also controlled even to the group members as noted by KI03: "*during the dry season we regulate by minimizing and restricting harvesting to ensure the papyrus is preserved"*. This control of access and monitoring has ensured that the Okana wetland ecosystem is well conserved and continues to thrive. Despite the funding having come to an end, the project has been sustainable as a result of the controlled access and monitoring by the local community group members.

4.2.4 Institutional design for conservation of Nyando wetland resources

Institutions to be sustainable in management of common pool resources should be clearly designed by establishing clear defined boundaries, costs and benefits are in equivalence, rules are based on collective choice agreements, based on accountability and monitoring, have clear sanctioning systems, have clear conflict resolution mechanisms and rights to re-organize are recognized by external governmental authorities (Ostrom, 1990).

The first Ostrom's (1990) design principle of clear defined boundaries requires that the resource system, involved households and individual units have to be clearly defined and demarcated. There was some level of control on who could access and the extent of harvesting the wetland resources in the community restored Okana wetland. Access was either through membership to the conservation group or if not a member seeking permission and paying the required amount of money (KI03). However, this level of control was not applied in the communally owned naturally occurring wetland resources. The extent to which the local communities could harvest wetland products was not well defined. In-fact, access and harvesting of these wetland resources was free. Majority of the respondents (81.8%) acknowledged that they did not pay anything to harvest the wetland products and no much restrictions were imposed on them. Only those who were engaged in fishing and rice farming made some payment to the BMUs and the National Irrigation Board respectively.

The extent of resource use either for grazing, actual harvesting of wetland products and farming activities within the wetland was decided by the local resource users

especially those who neighbour the wetland areas (KI04). To some extent the persons neighbouring the wetlands seemed to have some sort of control over who can access the wetland resources (KI04). This is so because they consider themselves to have ownership rights just by the virtue of them settling immediate to the wetland. The issue is aggravated by the fact that there is no clearly defined wetland geographical boundaries. The pre-assumed boundaries keep on changing depending on the season and the extent of exploitation and therefore it is difficulty for the conservation institutions to impose the minimum distance which should be left from the wetland area by the local resource users.

The fishing sector however seems to have some form of co-management organized through the BMUs. It was a requirement for the fishers to be members of their local BMUs through a one off payment of Ksh. 500 and a weekly service charge payment of Ksh. 90 and were supposed to adhere to the set out rules (KI01). The BMUs had formed networks whereby several BMUs came together to help achieve their roles. The BMUs had a defined zone of operation and therefore the fishers registered through a given BMU were required to stick to the zone of operation in their fishing efforts. However, it emerged that there was no proper and structured way of managing the fish landing beaches.

The other Ostrom's (1990) design principle is based on costs and benefits being in equivalence. This rule requires that the allocated resource units have to be based on specifying rules that are context dependent and consider the opportunity costs. The harvesting rules of CPRs should be appropriate to restrict the quantities harvested, where to harvest, when to harvest and how to harvest (technology used). The fisheries sector had some level of control on the size of fish to harvest by restricting

the fishing gears to use. They also controlled harvesting seasons through closed seasons of no fishing between April 1st to July 31st in order to enhance fish regenerations. The harvesting of other wetland products did not have much control on how much one could harvest, the time of harvest and the tools to be used as long as they had access to the wetland. Tractors, ox-drawn ploughs, jembes and pangas were used for land preparation for cultivation depending on one's ability. No restrictions were imposed on the modes of resource transportation from the wetland which included use of foot (65.2%), motor vehicles (13.5%), bicycles (12.4%), animal drawn power (4.5%) and a combination of the above (4.4%). This lack of restriction on the control of harvesting has contributed to over exploitation of the Nyando wetland resources.

Accountability of officials and a monitoring and a sanctioning system are the other Ostrom's (1990) design principles. Several governmental organizations and departments having conservation policies were engaged in the management of Nyando wetland which creates some policy disharmony. The enforcement of conservation rules, monitoring and sanctioning of the violators was not conducted effectively and sometimes corruption took lead. The fishery department has some level of local monitoring system which is well stipulated in the fisheries BMU regulations. However, the BMU personnel did not have the capacity to arrest the violators who did not adhere to the set out rules of engagement (KI01) and had to report them to government authorities who have been accused of corruption. The other wetland resources, except in the community conserved Okana wetland, did not benefit much from local community monitoring systems. Developing a local monitoring and rule enforcement mechanism by the local community members can

help them devise sustainable ways of conserving these resources. A collaborative monitoring effort system in a co-management manner (involving the local community and the government conservation bodies) will ensure success of enforcing the set out rules of engagement in the use of Nyando wetland resources.

The principle of conflict resolution, the Kenya Wildlife Service through the county compensation committees which are directly linked to the community handled most of the cases arising from Human Wildlife Conflict (HWC). However, no compensations took place if the farmer was found to have encroached the wetland or had not taken some precautionary measures like fencing his/her farm (KI05). In case of human to human conflicts arising from farmland boundaries or harvesting of wetland vegetation, there was no clear set out guidelines to resolve them. As a result the affected members opted to leave the resource which was under conflict for the sake of their peace (HHR07 and HHR08).

4.3 Utilization of Nyando wetland ecosystem services

4.3.1 Land use/cover change in Nyando wetland

The land use/cover change analysis of Nyando wetland indicate a continued encroachment into the intact portions of the wetland over the years between 1985 and 2020 (Figure 4.4).

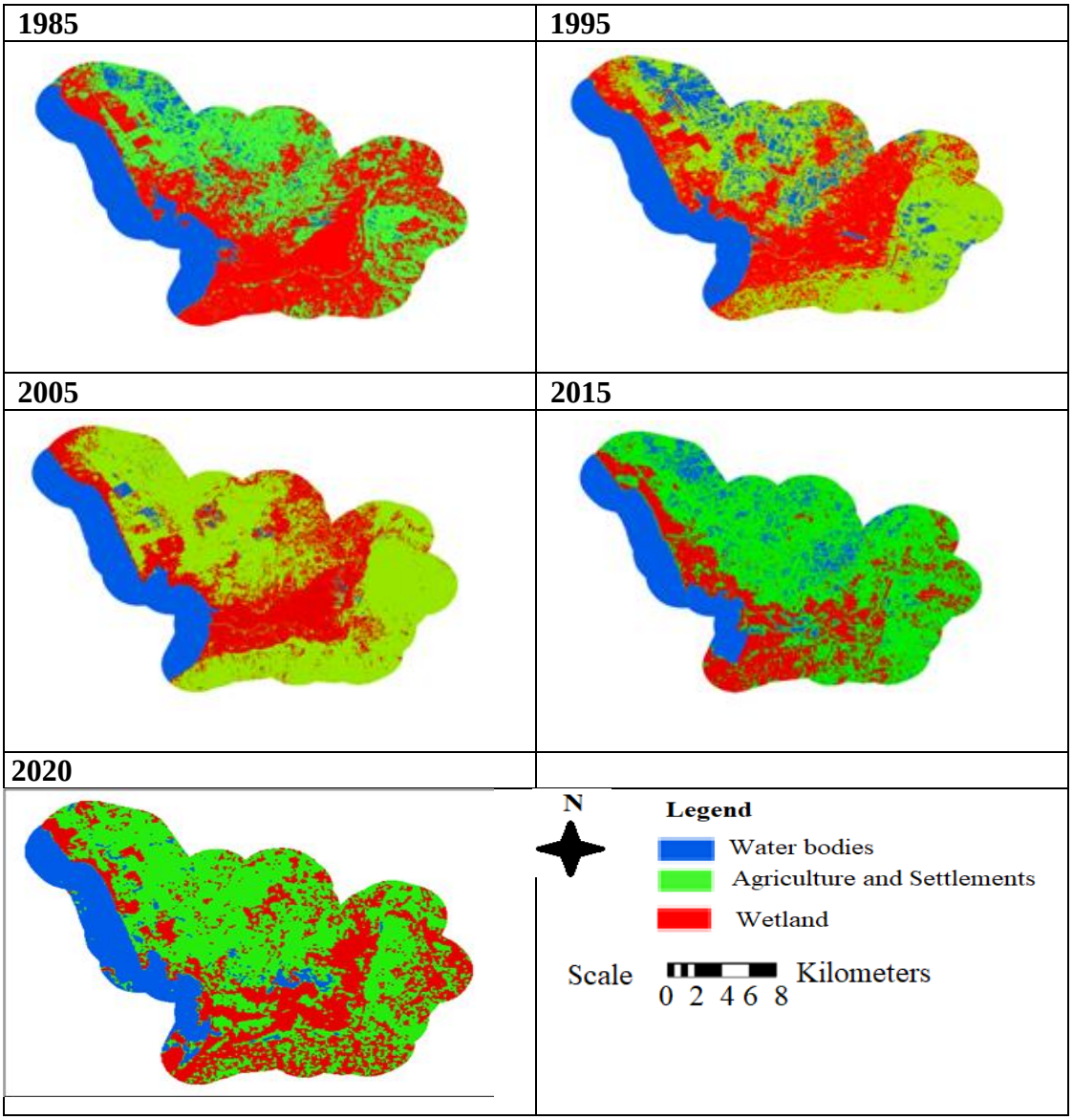

Figure 4.4: Satellite images of land use/cover types of Nyando wetland in 1985-2020

The area under major land use/cover classes was calculated for the year 1985, 1995, 2005, 2015 and 2020 (Table 4.4) so as to support and increase reliability and validity of the survey data. The area under wetland decreased from 12,028.1 Ha in 1985 to 9,095 Ha (-24.4%) in 2020 (Table 4.4). This decrease could be attributed to wetland clearance and draining for agricultural activities, settlement and harvesting of papyrus in unsustainable manner (30%) and droughts (46%) as a result of climate change.

Table 4.4: Area under different land use/cover types in Nyando wetland for 1985-2020

Land Use/ Cover type	**Area (Ha) 1985**	**Area (Ha) 1995**	**Change in area (Ha) 1985-1995**	**Area (Ha) 2005**	**Change in area (Ha) 1995-2005**	**Area (Ha) 2015**	**Change in area (Ha) 2005-2015**	**Area (Ha) 2020**	**Change in area (Ha) 2015-2020**	**Change in area (Ha) 1985-2020**
Wetland	12,028.1	8894.1	- 3134 (-26.1%)	8003.2	- 890.9 (-10 %)	6382.6	-1620.6	9095.0	2712.4 (42.5%)	- 2933.1 (-24.4%)
Water bodies	5434.2	6515.6	1081.4 (19.9%)	4405.9	-2109.7 (-32.4%)	5817.1	1411.2	4106.5	-1710.6 (-29.4%)	-1327.7 (-24.4 %)
Agriculture and settlements	10551.9	12604.5	2052.6 (19.5%)	15605.1	3000.6 (23.9%)	15814.4	209.3	14812.7	-1001.7 (-6.3%)	4260 (40.4 %)
Total	**28014.1**	**28014.1**		**28014.1**		**28014.1**		**28014.2**		

The area under water bodies has been increasing and decreasing across the years probably due to flooding and droughts which occasionally occur within the area resulting to recession or expansion of Lake Victoria.

The reduction in the area under wetland has happened at the expense of increase in the area under agriculture and settlements (Table 4.4). An increase of 4,260 Ha (40.4%) in the area under agriculture and settlements is recorded between 1985-2020. The demand for wetlands for agricultural production correlates with land use change and this possess a great challenge to wetlands in Africa (Rebelo *et al.*, 2010). However, despite the observed decrease in the area under the Nyando wetland between 1985-2015, the trend seems to change between 2015-2020 indicating an increase of 2,712.4 Ha (42.5%) (Table 4.4). This could be attributed to wetland restorative programs and increased rainfall taking place in the area. For instance, several hectares of Okana wetland that had dried up have been restored and is currently thriving with luxuriant vegetation (Raburu *et al.*, 2012).

Validity of the Landsat imagery data was ascertained by an assessment of disturbance status of different wetlands within the two sub-counties (Nyando and Nyakach). This was done by physically walking across the wetlands within the sampled sub-locations. Wawidhi wetland in Wawidhi location which is a riverine wetland was observed to have high rates of farming taking place especially during the dry spell. Lots of vegetable farming takes place as the area is very fertile due to siltation from the flooding Nyando River. Much of the wetland papyrus was observed to have been cleared. Wasare wetland in Rangul location and Gem Rae wetland in North Nyakach location both of which are riverine wetlands, were

observed to have a high rate of human disturbance. Rice paddies right in the wetland (Plate 4.1), wetland vegetation burning and plantations of eucalyptus woodlots (Plate 4.2) were taking place in these wetlands. Kusa wetland in Nyalunya location, which is both a riverine and a lake shore wetland has a high rate of vegetation harvesting and some parts just inside the wetland are fenced for fish farming (Plate 4.3).

Ugenya wetland in Kanyagwal location has a high rate of settlement right in the wetland (KI04). Though some parts of this wetland were observed to be intact, the rate of conversion was high on areas where water had receded from the lake. In Nyamware wetland in West Kochieng location, lots of agricultural activities were taking place with the wetland being converted for agricultural production. Fishing and fish trade was also observed taking place in Ugenya and Nyamware wetlands. Most of these human induced activities and encroachment have contributed to the observed decrease in the size of the wetland which has happened at the expense of increase in the area under agriculture and settlements.

Plate 4.1: Rice paddies in Nyando wetland (Source: Author, 2020)

Plate 4.2: Wetland burning and woodlot plantation in Nyando wetland (Source: Author, 2020)

Plate 4.3: Part of Nyando wetland conversion for fish farming (Source: Author, 2020)

4.3.2 Utilization and changes in Nyando wetland resources

A variety of wetland resources were accessible by the local community surrounding the Nyando wetland. These include macropytes for thatching and craft industry, firewood, sand and smearing soil, water for drinking and animals, fish, grazing land, livestock feed, medicinal plants, poles, vegetables and other crops (Plate 4.4 & 4.5) (Table 4.5).

Plate 4.4: Wetland products and uses of Nyando wetland (Source: Author, 2020)

Plate 4.5: Fish products and activities in Nyando wetland (Source: Author, 2020)

Vegetable cultivation was cited by majority of the respondents (16.5%) as one of the main product sourced from the Nyando wetland. This is followed by firewood collection (12.9%), cultivation of other crops (other than vegetables) and fishing at 10.5% and 9.4% respectively (Table 4.5). Much of the cultivation of vegetables and other crops takes place especially during the dry spell as these wetland areas remain moist and are very fertile due to deposition of silt making the production of both indigenous and other types of vegetables to give high yields (Maithya *et al.,* 2011). Nyando wetland resource extraction and use was significantly influenced by the respondents occupation and the duration of residence within the area ($p<0.05$; Table 4.5). This could be so as the respondents who were not in formal employment

Table 4.5: Types of resources sourced from Nyando wetland by the respondents

Wetland resource type	**Frequency (N)**	**Percentage (%)**	**Chi-square (χ^2)**	
			Occupation	Duration of residence
Medicinal plants	103	4.9		
Roofing thatch	121	5.8	99.21*	74.85*
Papyrus reeds	182	8.7		
Sand and smearing soil	155	7.4		
Poles	55	2.6		
Firewood	269	12.9		
Water for animals	120	5.8		
Water for drinking	182	8.7		
Grazing land	1	0.1		
Fish	196	9.4		
Bricks	17	0.8		
Livestock feed	120	5.8		
Vegetables	345	16.5		
Other crops	219	10.5		
Other resources	1	0.1		
Total	2086	100.0		

*χ^2 significant at $p<0.05$

sustained themselves economically from exploitation of wetland resources while those in formal employment could be investing in wetland use activities to diversify their income. A Pearson correlation was conducted to understand the relationship

between wetland resource use and the respondent's occupation whereby a positive correlation was established (r= 0.09, p< 0.05; Appendix 4).

Obiero *et al.*, (2012a) notes that part of the firewood was obtained by uprooting of papyrus rhizomes from the burnt and overgrazed areas. This means that even when it rains in future, it is difficult for papyrus from such areas to regenerate. Additionally, fuel wood from papyrus vegetation is usually uneconomical as it burns very fast. This means that much wood is consumed which leads to continued deforestation and hence wetland ecosystem degradation.

Majority of the respondents (71.1%) were engaged in farming while 13.9% were involved in making papyrus goods (Table 4.6). 96.7% (N=381) of the respondents own land within the wetland with 44.9% (N=211) and 41.5% (N=195) attributing farming in the wetland to high fertile soils and availability of moisture respectively (Table 4.7). The wetland lies in the Kano flood plains therefore huge deposits of silt is deposited through erosion from the upper catchment areas contributing to high fertility hence high crop production leading to high preference for cultivation. Out of the sampled respondents, 67.1% acknowledged that over 50% of the wetland farm returns contributes to their domestic food. Additionally, 81.9% reported on-wetland activities to have a greater contribution to their livelihood than off-wetland activities further supporting the high dependency on these wetlands by the local community.

Table 4.6: Main economic activities of the respondents

Economic Activity	**Frequency (N)**	**Percentage (%)**
Keeping livestock & cultivating	291	71.1
Fishing	26	6.4
Making papyrus goods	57	13.9
Business	35	8.6
Total	**409**	**100.0**

Table 4.7: Reasons for farming in the Nyando wetland

Reasons for farming in the wetland	Frequency (N)	Percentage (%)
Availability of moisture	195	41.5
High soil fertility	211	44.9
Land readily available	13	2.8
Boost production due to small off-wetland land	38	8.1
Others	13	2.8
Total	**470**	**100.0**

The intensification of farming activities has caused a reduction in most of the ecosystem goods and services within the Nyando wetland. Majority of the respondents attributed the decrease in wetland size to drought conditions (46%) which has caused the water levels in the wetland to go down and less rate of vegetation regeneration. Cases of droughts and floods have been reported in the Lake Victoria basin. In the year 1980, drought is reported which was followed by floods in 1985 and the El-nino rains in the year 1997 and 1998. The year 1999 and 2000, droughts were experienced which were followed by floods in April – June 2002. Both droughts and floods were experienced in the year 2004 followed by droughts in 2005 and floods in the year 2006 and 2009 (Kenya Red Cross Society (KRCS), 2006; Achoka and Maiyo, 2008; Obiero *et al.,* 2012b).

Climate variability has had a profound effect on the wetland and the livelihood of the local community. Obiero *et al.,* (2012a) reports a major impact on the household farming activities in Nyando wetland with a significant increase in the quantity of food resources obtained from these wetlands as a result of the declining water levels in Lake Victoria due to climate variability. Due to loads of fertile soils being deposited in these flood plains, floods are a blessing to the wetland plants and animals as it allows for regeneration of the wetland vegetation. However, excessive floods threaten the Nyando wetland as it causes wetland area loss in some parts

where huge deposits of silt are deposited (Masese *et al.*, 2012). Despite the floods acting as a natural measure to protect the wetlands, a negative impact is felt by the local community. Crops and property are destroyed and people displaced leading to increased food insecurity and increasing poverty levels within the area (Masese *et al.*, 2012). One of the key informants reported; *"during floods majority of people living around the wetland are forced to move out to higher drier grounds" (KI04)*.

The reduction in the wetland size is also attributed to settlement and opening up of wetland areas for farming and harvesting of the wetland vegetation (30%). During the dry spell, most of the local community members who are farmers are forced to move to the wetlands to sustain themselves economically from agricultural activities as the wetlands remains moist. Lots of grazing especially during the dry spell takes place in the wetlands. During transect walks across the Nyando wetland, cattle were observed grazing deep in the wetland where there was plenty of pasture and water. In areas where the transitional zone between the wetland and the Lake is so small, overgrazing was observed to take place as the animals could not move deep into the wetland due to water logging.

Shift cultivation was reported with majority of farmers (74.9%, N=289) reporting to change their farming location within the wetland in the course of the year. Climate variability played a major role in contributing to this observed change in farming location, for instance, 54.6% (N=213) attributed the change due to floods, 25.6% (N=100) to drought while infertility of the soil and pest and disease attack is 10% (N=39) and 5.6% (N=22) respectively. Human wildlife conflict is another reason reported for the shifting form of cultivation (2.8%, N=11) while 1.3% (N=5) reported to have land use conflicts forcing them to abandon the disputed portion and

open up other wetland areas. This shifting form of cultivation results to loss of flora and fauna.

Majority of the respondents (76.7%) reported that the wetland vegetation has decreased due to clearing and burning to pave land for agricultural production and settlement (44%) (Figure 4.5). This destruction and over-exploitation of vegetation negatively impacts the biodiversity and the wetlands' filter function. Consequently, this results to nutrient loading into the Lake Victoria leading to growth of water hyacinth which has chocked some parts of the wetland and the Lake (Raburu and Okeyo-Owuor, 2005). The respondents who reported an increase in the Nyando wetland vegetation associated such an observation due to flooding (17.7%) which caused the local community to abandon their land portions and re-vegetation (2.2%) through wetland restorative programs (Figure 4.5).

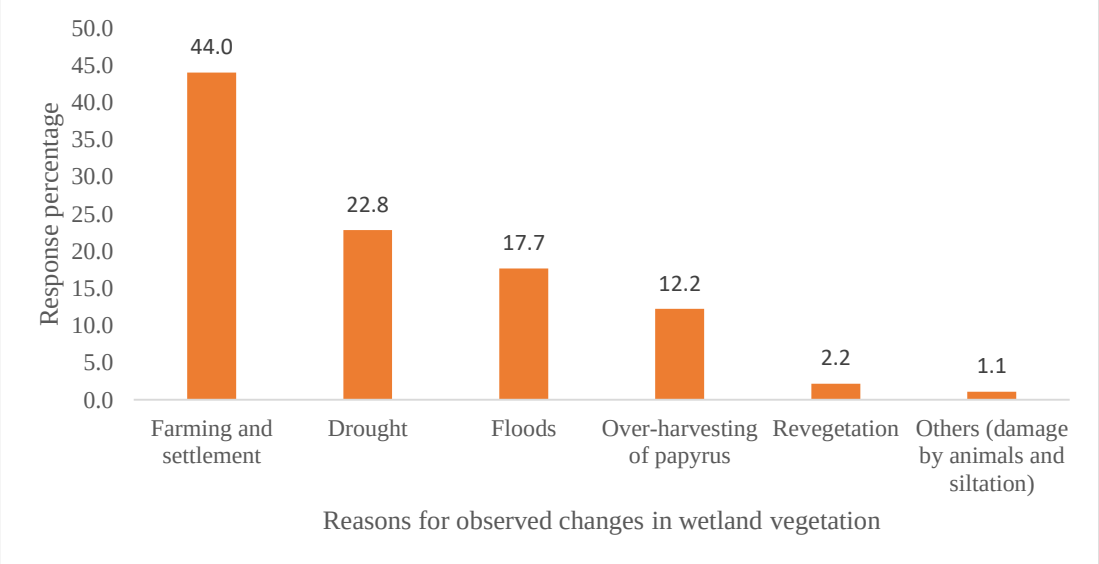

Figure 4.5: Drivers of change in Nyando wetland vegetation

Flooding, subdivisions of the available land for settlement due to population increase and opening up of new virgin wetland areas due to increased intensification

of crop cultivation contributed to the decrease in area left for grazing (Figure 4.6). However it is worth noting that despite crop intensification having increased, the area under crop cultivation per household is cited to have decreased mostly as a result of frequent flooding (31.8%) and land subdivisions for settlement (22.8%) due to population increase (Figure 4.6).

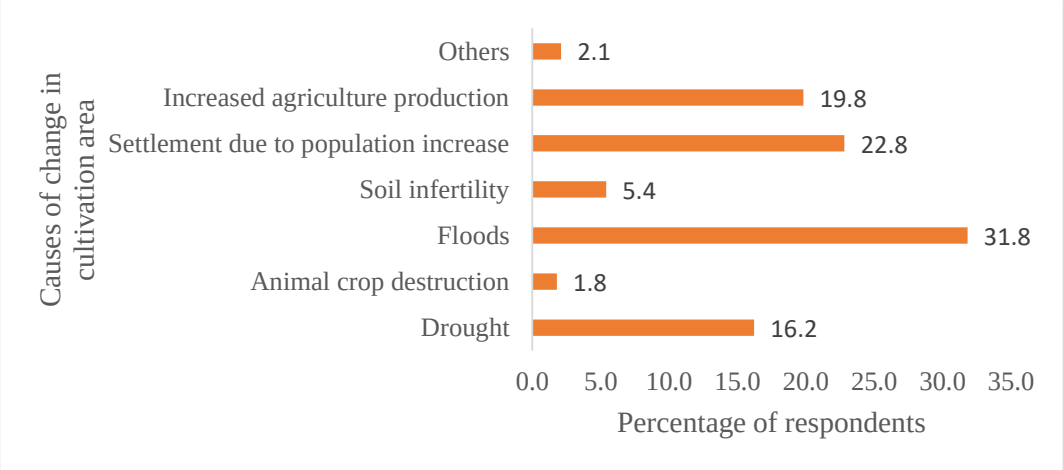

Figure 4.6: Drivers of change in size of cultivation area in Nyando wetland

Majority of the respondents (95.6%) acknowledged fish landings to have reduced as compared to only 3.8% and 0.8% who reported there was an increase and no observable change respectively. The Lake Victoria commercial fishery is dominated by three species: Nile perch (*Lates niloticus*), Nile tilapia (*Oreochromis niloticus*), and Dagaa (*Rastrineobola argentea*) which constitute more than 95% of the fish caught from the lake (LVFO, 2015a). The results of hydro-acoustic surveys on Lake Victoria indicate a decline in the biomass (standing stock) of Nile perch from 1.44 million tonnes in 2006 to 1.23 million tonnes in 2014 and a further decline to 1.12 million tonnes in 2017 (LVFO, 2015b, 2016, 2017). Much of the Nile perch fish biomass is reported to be dominated by juvenile fish with 5.9% of the parent stock being above the low limit of slot size (50cm, total length) (LVFO, 2015b, 2017).

The hydro-acoustic survey results indicate a decline in the Dagaa biomass from 1.29 million tonnes in 2014 to 0.718 million tonnes in 2016 and a further decline to 0.706 million tonnes in 2017 (LVFO, 2015b, 2017). Tilapia landings decreased from 71,531 tonnes in 2005 to 59,681 tonnes in 2014 (Africa Union – Inter African Bureau for Animal Resources (AU-IBAR, 2016).

The main drivers of fish decline within the area are presented in figure 4.7 which have also been reported by other scholars (Obiero *et al.,* 2012a). Drought which caused decrease in water levels in the Lake Victoria and drying up of the wetland and the fish breeding and hiding sites is stated as the main reason (42.8%) (Figure 4.7) for the decreasing fish landings. Increased use of illegal fishing gears as reported by 20.6% of the respondents (Figure 4.7) has also contributed to the declining fish landings. For instance, monofilament nets increased from 16,488 in 2010 to 72,101 in 2016, cast nets increased by 6.5% and beach seines by 30.3% between the years 2000 to 2014 (AU-IBAR, 2016). Long line hooks increased from 3,496,247 in 2000 to 14,244,518 in 2014. This increase in long line hooks is mainly on the smaller illegal hook sizes (>10) with a marked decrease in the big sized hooks. The increase in small sized hooks is to target smaller Nile perch below the lower limit of slot size which has enhanced overfishing and harvesting of immature fish (AU-IBAR, 2016).

Destruction of fish breeding sites (13.9%) (Figure 4.7) through wetland vegetation clearance and shallow water fishing is another reason reported by the respondents for the declining fish stocks. Similar findings have also been reported by LVFO (2014) and AU-IBAR (2016) noting that most fishing in the Lake Victoria takes

place in the shallow waters which are sensitive breeding and nursery grounds for fish.

Another contributing factor for the declining fish stocks is over fishing as reported by 10.3% of the respondents (Figure 4.7). Fishing efforts have increased in the lake and the surrounding wetlands with the number of fishers reported to increase from 194,172 in 2010 to 219,919 in 2016. The number of fishing boats increased to 74,257 in 2016 from a total of 64,595 in 2010 while the number of outboard motors increased from 16,188 in 2010 to 25,733 in 2016 (LVFO, 2010; LVFO, 2016; LVFO, 2017). The Nyanza gulf of Lake Victoria has been reported to have a high intensive fishing with more than ten fishermen per Km^2 as compared to two fishermen per Km^2 in other parts of the Lake (LVFO, 2008). This intensive fishing coupled with the use of illegal fishing gears used to harvest fish in the region have had a negative impact on the fish habitats and the fish stocks which consequently threatens the survival of close to half a million fish depended communities on the Kenya's Lake Victoria fishery (Njiru *et al.*, 2005, 2006).

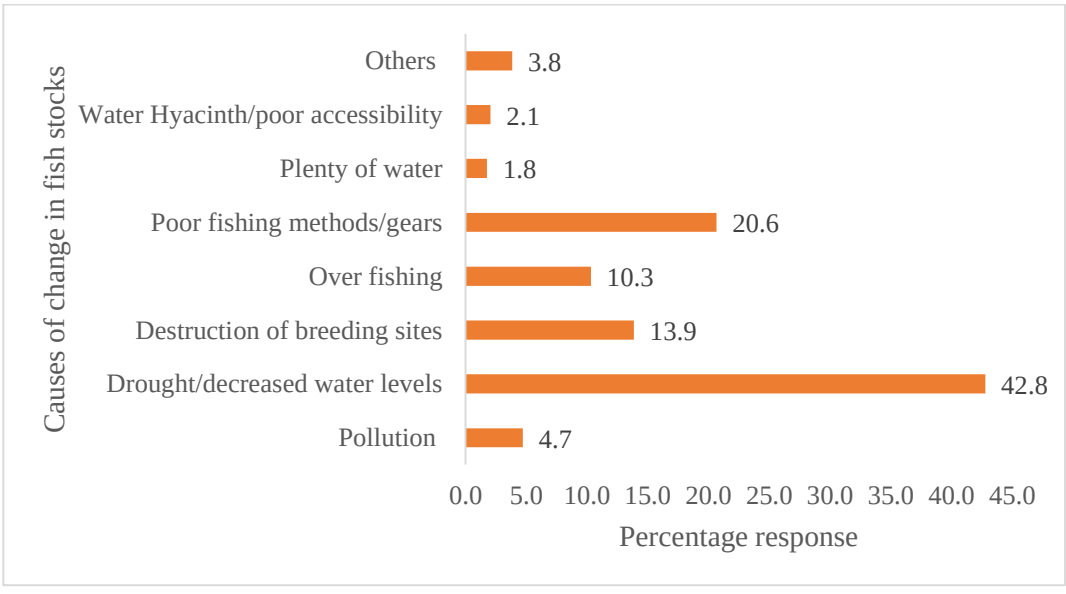

Figure 4.7: Drivers of change in fish landings in Nyando wetland

Other anthropogenic factors which have caused the reduction in fish stocks include pollution from both agricultural activities and effluent discharge to the Lake by sugar factories (4.7%) (Figure 4.7) and eutrophication (Goudsward & Wanink, 1994; Seehausen *et al.,* 1997; Verschuren *et al.,* 2002; Kolding *et al.,* 2008; AU-IBAR, 2016). However, a positive change in fish stocks was reported as a result of increasing water levels (1.8%) in the wetland.

A great reduction in fish sizes, catches and beach landings have been observed by other scholars with many fish species being almost extinct (Twong'o and Sikoyo, 2004; Odada *et al.,* 2006; LVFO, 2015b, 2016, 2017). The introduction of the Nile perch in the early 1960s has resulted to reduction in native fish stocks (Pringle, 2005). As a result of the declining fish populations in the area, destructive cutting and clearing of wetland vegetation has been occurring consequently leading to biodiversity loss. "*Due to the dwindling of fish populations in the area, the fishermen therefore cut papyrus to get deeper into the waters in search of fish"* (KI02). The poor performance of the fisheries due to infestation of Lake Victoria by water hyacinth (*Eichhornia crassipes*) in 1990s and low market prices for fish has been attributed to influence the high dependency on the Nyando wetland for farming, grazing and harvesting of papyrus for mat making as alternative livelihood sources (Bennun and Njoroge, 1999; Aseto and Onganga, 2003).

Sand and smearing clay is reported (7.4%) as one of the wetland products collected by the local community from the Nyando wetland. Part of it is used by the local community to plaster their houses. Smearing clay has been reported to have a long history of economic and social-cultural value. Traditionally, the wetland smearing clay was preferred than clay from other sources to plaster the walls and floors of

houses by the Luo community (Odak, 1987). The traditional grass thatch of houses is being replaced by corrugated iron sheets, however, the former remained the only source of roofing material for the poor households. This shift from grass thatch to use of iron sheets is partly associated with the decreasing sources of these traditional thatch from the wetlands due to over exploitation.

4.3.3 Nyando wetland resource use and marketing

Majority of the products sourced from Nyando wetland by the respondents are for household use i.e. 89.3% of medicinal plants, 91.7% of roofing thatch materials, 81.3% of sand and smearing soil, 67.3% of poles, 91.4% of firewood, 98.4% of drinking water, 64.8% of fish harvest, and 95.8% of livestock feeds (Table 4.8).

Table 4.8: Resource types from Nyando wetland and their uses

Wetland resource type	**% of different resource uses**					
	Commercial use		**Household use**		**Commercial & Household use**	
	N	**%**	**N**	**%**	**N**	**%**
Medicinal plants	8	7.8	92	89.3	3	2.9
Roofing thatch	1	0.8	111	91.7	9	7.4
Papyrus reeds	127	69.8	38	20.9	17	9.3
Sand & smearing soil	29	18.7	126	81.3	0	0.0
Poles	18	32.7	37	67.3	0	0.0
Firewood	20	7.4	246	91.4	3	1.1
Water for animals	1	0.8	119	99.2	0	0.0
Water for drinking	3	1.6	179	98.4	0	0.0
Grazing land	0	0.0	1	100.0	0	0.0
Fish	59	30.1	127	64.8	10	5.1
Bricks	15	88.2	2	11.8	0	0.0
Livestock feed	5	4.2	115	95.8	0	0.0
Vegetables	187	54.2	96	27.8	62	18.0
Other crops	103	47.0	75	34.2	41	18.7
Other resources	1	100.0	0	0.0	0	0.0
Total	**577**		**1364**		**145**	

However, for each product there is a substantial number of respondents who harvest it for either commercial or both commercial and household use (Table 4.8). Products which were majorly sourced for commercial use include papyrus reeds, bricks, cultivation of crops (sugarcane, rice and vegetables) (Table 4.8). Bee keeping, though not many respondents were engaged in it, was mainly practiced for commercial purpose and as an alternative livelihood to reduce much overreliance on direct dependence on wetland products.

The main challenges cited by the respondents in acquisition, utilization and marketing of the wetland resources (Figure 4.8) is lack of markets (42.6%) resulting to low market prices. Poor prices for wetland products could result in their over-exploitation as the local community harvest more to meet their financial needs. Different types of transport modes were used to transport the wetland products both for commercial and household use.

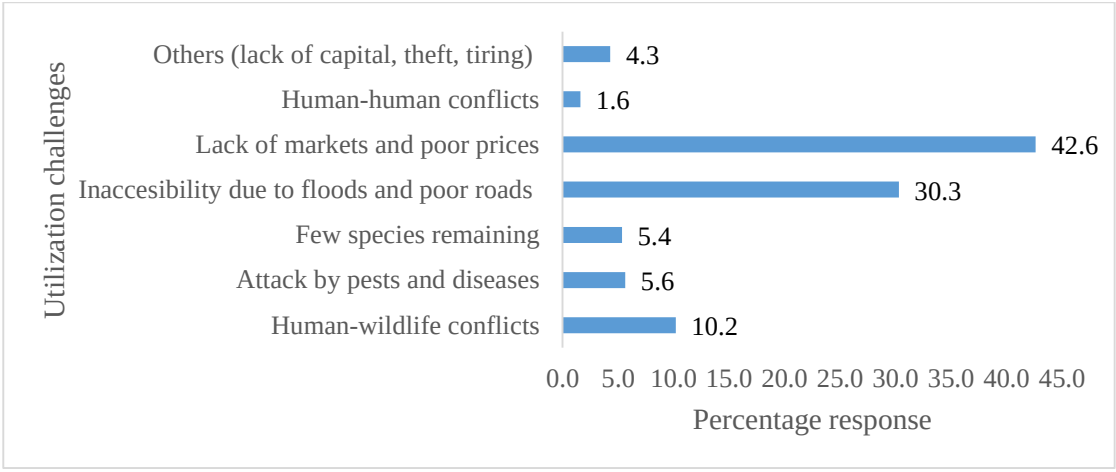

Figure 4.8: Challenges experienced by the respondents in acquisition, utilization and sale of wetland products

The major transport mode (Table 4.9) which was commonly used for all the wetland products was by foot (65.2%) whereby the local community carried the products either on their backs, shoulders or their heads. The lack of markets and low prices for the wetland products also contributed to the low use of motorized transport as it was uneconomical to hire vehicles. The use of motorised transport was also hindered by inaccessibility to the wetland areas due to poor infrastructure and floods especially during the rainy seasons as reported by 30.3% of the respondents (Figure 4.8).

Table 4.9: Modes of transport for transporting wetland products in Nyando wetland

	Number of respondents who use a given transport mode									
Resource type	Foot	Bicycle	Animal drawn power	Motor vehicle	Foot and Bicycle	Bicycle and Motor vehicle	Foot and animal drawn power	Bicycle and animal drawn power	Animal drawn power and motor vehicle	Foot and motor vehicle
Medicinal plants	101 (97.1)	3 (2.9)	0	0	0	0	0	0	0	0
Roofing Thatch	101 (83.5)	13 (10.7)	4 (3.3)	0	2 (1.7)	1 (0.8)	0	0	0	0
Papyrus reeds	151 (82.5)	19 (10.4)	0	7 (3.8)	4 (2.2)	1 (0.55)	0	0	0	1 (0.55)
Sand and smearing soil	86 (54.8)	7 (4.5)	13 (8.3)	48 (30.6)	0	0	2 (1.3)	0	1 (0.6)	0
Poles	10 (17.9)	12 (21.4)	9 (16.1)	23 (41.1)	1 (1.8)	0	0	1 (1.8)	0	0
Firewood	260 (95.9)	6 (2.2)	0	2 (0.7)	3 (1.1)	0	0	0	0	0
Water for animals	89 (74.2)	8 (6.7)	17 (14.2)	4 (3.3)	2(1.7)	0	0	0	0	0
Water for drinking	163 (89.1)	12 (6.6)	0	3 (1.6)	4 (2.2)	0	0	1(0.5)	0	0
Fish	133 (70.4)	28 (14.8)	1 (0.5)	18 (9.5)	6 (3.2)	1 (0.5)	0	0	0	2 (1.1)
Bricks	0	0	0	18 (100)	0	0	0	0	0	0
Livestock feed	41 (34.2)	63 (52.5)	0	10 (8.3)	5 (4.2)	1 (0.8)	0	0	0	0
Vegetables	192 (55)	53 (15.2)	2 (0.6)	74 (21.2)	17 (4.9)	1 (0.3)	0	1 (0.3)	0	9 (2.6)
Other crops	30 (14.2)	35 (16.6)	48 (22.7)	75 (35.5)	7 (3.3)	4 (1.9)	0	2 (0.9)	1 (0.5)	9 (4.3)
Total	1358(65.2)	259 (12.4)	94 (4.5)	282 (13.5)	51 (2.4)	9 (0.4)	2 (0.1)	5 (0.2)	2 (0.1)	21 (1)

() = units in %

Both human-wildlife conflicts (HWC) (10.2%) and human-human conflicts (1.6%) are reported during the acquisition and utilization of the wetland resources. Some of the commonly reported HWC include snake bites especially when people are harvesting wetland resources and attacks by hippos causing deaths and crop destruction. "*As the local community encroach the wetland areas to farm deep inside the wetlands, hippos find their way into their farms especially at night with crop destruction and loss of life being reported"(KI05).*

Opening and encroachment into wild habitats is increasing interaction and competition for space and resources between humans and animals (Ellis *et al.,* 2010; Kate, 2012). Joseline (2010) and Mwamidi *et al.,* (2012) report that as a result of increased encroachment to wetland habitats due to expansion of agricultural activities, further destruction of these habitats results into increased HWC causing farmers to lose their crops to animals. Wild species have been forced to exploit new human resources for their survival as a result of increased occupation and disturbance to their habitats by humans finally leading to an increase in HWC (Strum, 2010). Human-human conflicts reported include women being raped as they harvest papyrus and conflict over boundaries and how far one should harvest, graze or farm from their neighbour.

4.4 Local community's perception on payment for ecosystem services in Nyando wetland

Local people perceive and value ecosystem services surrounding them and therefore it is important to assess their knowledge and values in connection to ecosystem services use and management (Meijaard *et al.,* 2013; Brancalion *et al.,* 2014). This perception of ecosystem service by local people is important to avail valuable information to develop and adapt policy and management guidelines (Asah *et al.,* 2014; De Oliveira and Berkes, 2014; Sandhu and Sandhu, 2014). In the case of PES, this information enables a better understanding of PES participants on the driving force towards management decisions and is crucial to help improve management strategies (Balvanera *et al.,* 2012).

4.4.1 Approaches to payment for ecosystem services in Nyando wetland

The Western Kenya Smallholder Agricultural Carbon Finance Project, is a PES scheme within the Western Kenya region on carbon sequestration. The PES scheme has an objective of reducing greenhouse gas emissions through carbon sequestration by trees and soil through application of sustainable land management practices (Berttram, 2011). Adaptation to climate change, diversified and increased food supply, strengthened farmer organizations, enhanced tree cover and diversification of income are some other objectives of the PES project. This PES scheme promotes use-modification land use mainly focusing on agroforestry.

Different sustainable land management practices are being promoted within the Nyando wetland i.e. restoration of degraded lands and crop land management (Berttram, 2011). Most of these schemes are under public-private payment schemes

for a local catchment conservation. The local community farmers who are the buyers are contracted to be engaged in wetland conservation projects which aid in soil and biodiversity conservation. The sellers are the governmental organizations (Ministry of Agriculture and the Kenya Forest Service) and NGOs (United Nations Development Programme (UNDP), VIRED, and VI-Agroforestry). These wetland conservation projects included tree and grass planting along the river Nyando banks (40%), digging of dykes for flood control (36.2%), digging of drainage canals (13.3%) and removal of water hyacinth (10.5%) (Table 4.10). These sustainable land management projects are dependent on availability of donor funding and hence when the funds are not available, the projects are not sustainable. The lack of donor funding and knowledge on the concept of PES as a conservation tool could be the reason for low adoption of PES projects in the region as only 15% of the respondents reported to be engaged in such a scheme.

The mode of payment included cash payments (N=33) food for work (N=28) and in kind payments (Table 4.10). The type of sustainable land management practice and their payment modes were statistically significant ($p<0.05$; Table 4.10). This is so because the sustainable land management practices were conducted and sponsored by different organizations (governmental and Non-governmental organizations) operating in the study area. For example, since the area was prone to flooding, the local community members were recruited by VIRED to be engaged in projects of flood control by opening up of drainage canals, digging of water pans, and stabilization of dykes. Initially for such kind of work, the participants used to get some vegetable oil and beans as their reward or pay hence referred to as food for

work project. However, the pay was revised and by then those involved were getting a shopping voucher worthy Ksh. 400 for a day's work.

Table 4.10: Sustainable land management practices and their payment modes in Nyando wetland

	Payment mode (N)							
Land use practice	Given money	Food for work	Free services such as knowledge sharing	Free planting materials	Infrastructure improvement	**Total (N)**	**%**	**Chi-square (χ^2)**
Digging drainage canals	2	7	1	2	2	14	13.3	21.216*
Digging dykes for flood control	13	15	5	3	2	38	36.2	
Tree and grass planting	15	3	6	12	6	42	40.0	
Water hyacinth removal	3	3	2	1	2	11	10.5	
Total	**33**	**28**	**14**	**18**	**12**	**105**	**100**	

*χ^2 significant at $p<0.05$

VIRED in collaboration with UNDP together with Kenya Forestry Service (KFS) on their tree planting partnership project were engaged in establishing tree nurseries and issuing tree seedlings to schools for planting. Additionally, some respondents (40%) were also engaged in planting of bamboo tree seedlings and grass along the Nyando river banks to control soil erosion and also help in its stabilization. This sustainable land management practice project was being run by VIRED in the same project of food for work. Other organizations including CBOs and NGOs such as Community Rehabilitation and Environmental Protection Program (CREPP) and VI-Agroforestry were also giving the locals some tree seedlings for them to plant in their homes and for agroforestry.

There was significant difference on respondents locality and their participation in these sustainable land management practices for PES ($p<0.01$; Table 4.11), however no significant differences on respondent's level of education, age and gender ($p>0.05$). This could be attributed to the fact that the respondents from different sub-counties were engaged in different sustainable land management practices for PES at varying levels (Table 4.11) and also due to availability of donor funding to support the projects. For example, respondents from Nyando sub-county were more engaged in the project of digging of dykes for flood control (N=29, 58%) while majority of the respondents from Nyakach sub-county were more involved in projects pertaining planting of trees and grass (N=24, 43.6%) (Table 4.11).

Table 4.11: Proportion of sustainable land management practices by respondents from Nyando and Nyakach sub-counties of Nyando wetland

	Respondents locality					
	Nyando		**Nyakach**			
Activity	N	%	N	%	**Total (N)**	**Chi-square (χ^2)**
Digging drainage canals	2	4.0	12	21.8	14	25.710*
Digging dykes for flood control	29	58.0	9	16.4	38	
Trees and grass planting	18	36.0	24	43.6	42	
Water hyacinth removal	1	2.0	10	18.2	11	
Total	**50**	**100.0**	**55**	**100.0**	**105**	

*χ^2 significant at $p<0.01$

Majority of the respondents (72.4%) were satisfied and embraced the way the sustainable land management practices for PES were conducted in the region stating that it diversified their income and therefore enhancing their livelihoods. However despite this satisfaction, several challenges were experienced in the running of these projects with majority of the respondents (78.6%) indicating poor pay which was not commensurate to the amount of work done. Other challenges raised were lack of

transparency (corruption) among the project leaders when it comes to payment (14.3%) and preferring cash to the in-kind payment mode (7.1%).

4.4.2 Perception of the provisioning, supporting, regulating and cultural ecosystem services in Nyando wetland

A high percentage of the respondents (90.8%) have knowledge of the Nyando wetland ecosystem with 96.9% attributing the wetland as having lots of value to them and the community at large. Majority of them felt that they were informed (41.9%) on the ecosystem services from Nyando wetland (Table 4.12). These responses on the level of awareness on ecosystem services were significantly influenced by the level of education and respondents locality ($p< 0.01$; Table 4.12). Chen *et al.,* (2018) and Xun *et al.,* (2017) note that respondents having more years of formal education can perceive many ecosystem services. The level of education varied across the two sampled sub-counties and this could have contributed to the above differences as knowledge on a variety of environmental resources requires some level of education. Overall, 64.8% of all the sampled respondents had primary level education, 21.6% had secondary level education while 3.3% and 10.3% had college and no education respectively. Of those with the highest level of education (college level), 69.2% were from Nyakach sub-county as compared to 30.8% from Nyando sub-county. Those with higher levels of education are able to understand and value nature better and therefore this explains the above observed differences.

Education is key component in the implementation of conservation activities and attainment of any national development. Education provides trainable man power in the management of environment and opens up people's minds to have a positive

Table 4.12: Respondents level of awareness on ecosystem services from Nyando wetland

Response	**Frequency**		**Chi-square (χ^2)**	
	N	%	Education level	Respondents locality
Fully informed	26	6.6	26.677*	14.592*
Informed	164	41.9		
Moderately informed	111	28.4		
Partly informed	76	19.4		
Not informed	14	3.6		

*χ^2 significant at $p<0.01$

mind-set towards conservation of wetland resources. The generations of most communities riparian to wetlands depend on these resources for their livelihood hence highly educated communities can have a positive mind set towards population control as this will ensure less future population pressure on these wetland resources. Education is also key to formal employment and therefore a means of diverting direct reliance and over exploitation of wetland resources hence helping in conservation (Obiero *et al.,* 2012a).

The respondents were asked to rank the kind of ecosystem services they knew from the wetland based on the four main classes (MEA, 2005) of ecosystem service categories. Majority of them (37.7%) were aware of the provisioning services (goods) with regulating services ranking second (32.1%) (Figure 4.9). This high perception of provisioning services could possibly be as a result of the fact that majority of the respondents derive direct benefit from them for their livelihood. The results (Figure 4.9) also show that the respondents rarely identified supporting ecosystem services and this also concurs with other studies (Lamarque *et al.,* 2011; Lugnot and Martin, 2013; Silvano *et al.,* 2005). This could probably be due to the

indirect impact the supporting services have on the local people of Nyando wetland and the fact that one requires some knowledge on ecological aspects to understand them. The age of the respondents significantly influenced their perception on supporting ecosystem services ($p<0.05$; Table 4.13). This could be so as those who had attained the highest level of education (secondary and college) were between the ages 36-62 years and were able to identify many supporting ecosystem services (Table 4.13).

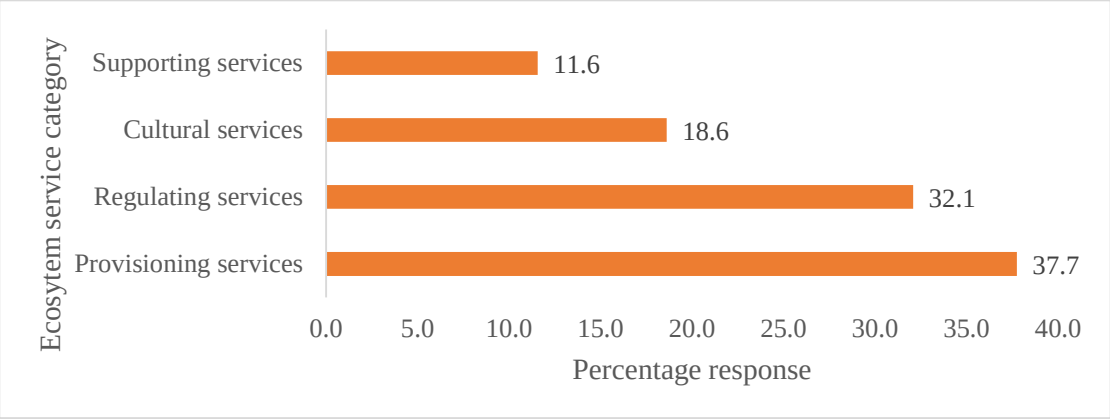

Figure 4.9: Awareness of ecosystem services by local community in Nyando wetland

Table 4.13: Perception on supporting ecosystem services as influenced by respondents age

	Supporting ecosystem services				
Age category (Years)	Primary production	Nutrient cycling	Soil formation	**Total**	**Chi-square (χ^2)**
18-26	4	1	1	6	
27-35	10	9	7	26	21.523*
36-44	24	8	18	50	
45-53	15	16	13	44	
54-62	20	4	20	44	
>63	8	8	20	36	
Total	**81**	**46**	**79**	**206**	

*χ^2 significant at $p<0.05$

Probing was done to enquire the specific ecosystem services from each class which the respondents were familiar with from the wetland (Table 4.14). The gender of the respondents did not influence their perception on provisioning, regulating, cultural and supporting services ($p>0.05$). This could be so as both women and men are directly involved in wetland use activities causing them to have almost similar effects in their observations and experiences. On the provisioning services, food scored high (37.6%) with fresh water, fuel and fiber scoring at 27.2% and 23.9% respectively.

Table 4.14: Community familiarity with different categories of ecosystem services in Nyando wetland

Ecosystem service	Frequency (N)	Percentage %
Provisioning		
Food	381	37.6
Fresh water	275	27.2
Fuel and fiber	242	23.9
Medicinal extracts from plants	113	11.2
Others	1	0.1
Regulating		
Climate regulation	307	35.7
Pollination	60	7.0
Erosion regulation	180	20.9
Water purification	136	15.8
Natural hazard regulation	177	20.6
Cultural		
Spiritual and religious value	56	11.2
Recreation	101	20.2
Aesthetic	166	33.3
Educational	176	35.3
Supporting		
Primary production	81	26.1
Nutrient cycling	87	28.1
Soil formation	141	45.5
Others	1	0.3

Climate regulation (i.e. influence of local temperatures and precipitation) ranked high (35.7%) in the category of regulating services (Table 4.14). This is probably because majority of the respondents stayed very close to the wetland and enjoyed a cool micro-climate provided by the wetland and the Lake Victoria.

Spiritual and religious value attachment to the wetland scored 11.2% below education (35.3%) and aesthetic value (33.3%) in the cultural services category (Table 4.14). This also supports the fact that majority of the respondents reported that cultural activities especially the spiritual attachment to the Nyando wetland had decreased in the area over the last decades. This observation could be attributed to probably the inculcation of western values, religions and education leading to people challenging their traditional beliefs and promoting dissemination of new modes of life (Arowolo, 2010). The duration of residence within the Nyando wetland significantly influenced the respondent's perception on cultural ecosystem services ($p<0.05$; Table 4.15), however it had no effect on provisioning, regulating and supporting services. Those who had stayed in the area for a longer duration of time were able to identify and value many cultural ecosystem services of the Nyando wetland as compared to those who had a shorter duration of stay. The more the number of years the local people have stayed in a given area, the more they interact and acquaint themselves with the culture of the area and therefore this could explain the above observed differences.

The role of the wetland to offer educational services, aesthetic and recreational services is gaining much appreciation from the local community in comparison to the traditional cultural value attachment. The respondents believe that Nyando wetland offers an aesthetic function by its natural beauty which is provided by the

presence of birds and other fauna, vegetation, fish landing beaches and a cool micro-climate. This appreciation of the wetland to offer scenic beauty by the locals could be explored as a potential factor for venturing into a payment for ecosystem service scheme in the region within the area of ecotourism.

Table 4.15: Respondents perception on cultural ecosystem services as influenced by duration of residence in Nyando wetland

Duration of residence (years)	**Cultural ecosystem service**					**Chi-square (χ^2)**
	Spiritual and religious values	Recreational	Aesthetic	Educational	Total	
1-5	0	0	0	2	2	25.209*
6-10	1	0	2	1	4	
11-15	2	4	5	4	15	
16-20	8	5	8	7	28	
21-25	10	5	4	2	21	
>25	34	57	72	35	198	
Total	**55**	**71**	**91**	**51**	**268**	

*χ^2 significant at $p<0.05$

Majority of the respondents (54.3%) have knowledge of the producers of the above ecosystem services. Majority of them (84.1%) associate the wetland ecosystem as the main producer while other producers such as forests ranked second at 11.9% and 4.1% for Lake Victoria and river Nyando. However, the number of those who reported they either do not know or were partly aware of the producers of these ecosystem services were quite significant (45.7%) and this calls for more enlightenment through education on the value of the wetland ecosystem.

The local community believe they are the main beneficiaries of the ecosystem services from Nyando wetland (53.9%) as compared to other organizations (Figure 4.10). In line with conservation, a strong appreciation of something could translate

to high level of endowment and hence more efforts to safeguard it from misuse. However this should be taken with caution as not all people especially in a common pool resource like the case of Nyando wetland who will be in for conservation as some will compete for its use. These responses were significantly influenced by the respondents occupation ($p<0.01$). This could probably be due to different ecosystem service benefits derived from the wetland by people of different occupation and also different levels of association with different organizations operational in the area.

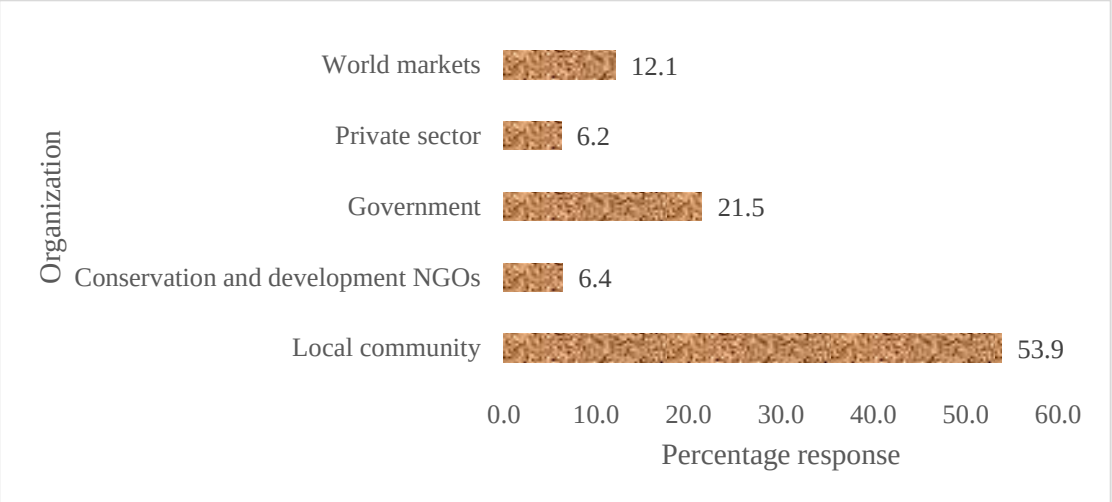

Figure 4.10: Respondents perception on beneficiaries of Nyando wetland ecosystem services

There was a strong feeling from the sampled respondents that they need to conserve the environment. Majority of them ranked environmental conservation as being very important (55.6%) (Table 4.16). This perception could probably be as a result of high value of attachment the respondents have to the wetland as their source of livelihood. The major issues which the respondents believe should drive conservation of Nyando wetland are; agriculture (N=374, 49.0%), climate regulation

(N=315, 40.5%) and conservation of plant and animal species (N=254, 34.2%) (Table 4.17).

Table 4.16: Respondents' perception on importance of environmental conservation

Responses	**Frequency**	**Percentage**
Very Important	212	55.6
Important	152	39.9
Moderately important	13	3.4
Of little importance	1	0.3
Not important	3	0.8
Total	**381**	**100.0**

The respondents from Nyando sub-county scored high on wetland conservation for agriculture, climate regulation and aesthetics as compared to Nyakach sub-county respondents who scored high on wetland conservation for plant and animal species, history, heritage and culture, scientific value and tourism development (Table 4.17).

Table 4.17: Comparison of proposed conservation initiatives by Nyando and Nyakach sub-counties' respondents of Nyando wetland

	Sub-county					
	Nyando		**Nyakach**			**Chi-square (χ^2)**
Conservation initiative	N	%	N	%	Total (N)	
Agriculture	288	25.4	86	23.6	374	7.221*
Plant and animal species	191	16.9	63	17.3	254	
History, heritage and culture	79	7.0	33	9.1	112	
Scientific value	71	6.3	34	9.3	105	
Tourism development	112	9.9	37	10.2	149	
Aesthetics	145	12.8	43	11.8	188	
Climate regulation	247	21.8	68	18.7	315	
Total	**1133**	**100**	**364**	**100**	**1497**	

*χ^2 not significant at p>0.05

However, the results were not statistically significant ($p>0.05$) (Table 4.17) implying that locality does not influence the proposed conservation initiative as perceived by the respondents.

4.4.3 Perception on payment for ecosystem services in Nyando wetland

Majority of the respondents (74.3%) acknowledged that the continued existence of the Nyando wetland resources is not secure as a result of continued over-exploitation, negative impacts brought about by climate change and pollution resulting from the nearby factories. Despite the locals being involved in community based natural resource conservation initiatives, quite a high proportion of the respondents (69%) were not familiar with the concept of payment for ecosystem services (PES) due to lack of information. However after the PES concept was explained to them, almost all the respondents were willing to be engaged in its design. Majority of the respondents (88.5%) showed their readiness to change their land use practices to other sustainable uses with 69.3% saying that if compensated, they would release their land portions for wetland restoration. The respondents motivating factors to entry into such PES schemes was that they expect them to bring additional income (33.2%), better infrastructure (20.5%) and technical assistance (16.1%) (Figure 4.11).

Majority of the respondents listed lack of capacity (41.3%) as the main barrier they perceived would hinder the adoption of PES schemes in the area. Milder *et al.,* (2010) argue that in addition to showing willingness to engage in PES schemes, possession of knowledge, skills, resources and properly defined tenure rights are needed by ecosystem service stewards. Such a possession will enable the

participants to reliably deliver ecosystem services. This study has revealed that apart from provisioning goods, most of the respondents were not so much conversant with the other classes of ecosystem service benefits derived from the Nyando wetland. To upscale PES schemes in the region, there is need to build the capacity of the locals through training and education programs. Information and knowledge on how such PES programs would be designed, the markets (buyers and sellers) and the possible drawbacks are necessary to the locals so as to avoid confusions and suspicions once the scheme is implemented.

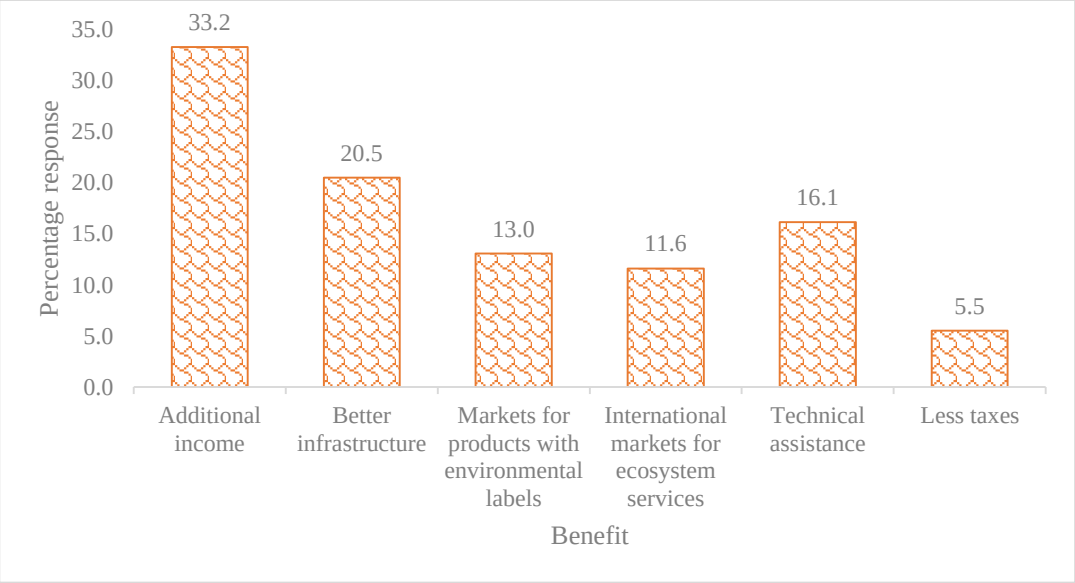

Figure 4.11: Respondents expectations from PES schemes in Nyando wetland

Other barriers perceived to hinder PES schemes in the area are lack of market information (28.4%), lack of community organization (22%) while 8% said they were not interested. On the markets for ecosystem services, only 30.2% were aware of them with majority showing knowledge of only local markets for provisioning goods. One of the reasons raised for the low knowledge of markets for these ecosystem services was lack of information on these ecosystem services and how

each can be sold. This was despite many organizations operating in the area and having involved themselves in capacity building probably indicating that the concept of PES was not being fully addressed as part of the conservation strategies by these organizations. The presence of community institutions which have been engaging the locals in running of conservation projects is very crucial in the design and up-scaling of PES schemes in the region. Strengthening community organizational and administrative structures is needed for them to have a successful negation role in PES schemes (Rosa *et al.,* 2003). Proper community organization provides a means of ownership and true participation by the members involved and therefore these institutions could help in building such organization. Local institutions are important as they also help demystify PES and help local poor PES participants negotiate favourable terms of ecosystem service markets. They also play a crucial role in providing technical, financial and scientific skills to the ecosystem service market participants especially the local poor (Milder *et al.,* 2010). In the Nyando wetland, these institutions are key to help in facilitation of collective action in cases were small holders might be involved in ecosystem service markets helping them to compete with larger service providers at either national or global market.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the study findings

This study set out to investigate wetland resource utilization and community perception on payment for ecosystem services in conservation of Nyando wetland. It had three objectives namely; (1) to investigate institutional arrangements governing conservation of Nyando wetland resources, (2) to examine the utilization of Nyando wetland ecosystem services, and (3) to examine the local community's perception on payment for ecosystem services in Nyando wetland. The hypothesis were; the existing institutional arrangements governing Nyando wetland have significantly enhanced its resource conservation, unsustainable wetland resource utilization has significant negative impacts on Nyando wetland ecosystem services and the respondent's level of education, age and duration of residence within the Nyando wetland have significantly influenced their perception on ecosystem services and their payment.

In the case of objective one, both formal and informal institutions governing resource use exist within the Nyando wetland. Traditionally, the Nyando wetland local community set out its own rules to govern the use and management of their natural resources. Enforcement of these traditional rules was done by Chiefs and council of elders by sanctioning the offenders. Taboos were also used to instil fear to keep the local community away from the wetland. The local community had also formed conservation groups having their own rules to help in Nyando wetland resource conservation and restoration initiatives. Several governmental conservation organizations were operational in the study area with overlapping mandates and

policies which also result to conflicts in discharge of their conservation mandates lending them ineffective. However, both the governmental organizations and the NGOs were engaged in capacity building and promotion of alternative livelihood activities which has helped in the conservation efforts of the Nyando wetland resources. Due to lack of clearly defined wetland geographic boundaries, having no proper mechanism to control access and quantities one could harvest from the wetland, and limited financial and human resources incapacitated the performance of these governmental conservation organizations. Enforcement of the set out rules, monitoring and sanctioning of violators under these formal institutions was not effectively conducted and sometimes corruption took lead which has contributed to the increased over-exploitation of the wetland resources. The existing conservation organizations didn't have a significant effect on coordination of wetland conservation (χ^2=2.022, df=3, p>0.05). From the results, the hypothesis that the existing institutional arrangements governing Nyando wetland have significantly enhanced its resource conservation was rejected.

In the case of objective two, this study has established a high dependence on the Nyando wetland resources by the local community for both household and commercial use which has resulted to over-exploitation. The main activities taking place within the Nyando wetland which have a negative effect on the wetland is conversion for settlement and agriculture; while firewood, papyrus, water, sand as well as fish are the main resources obtained from the wetland by the local community. Crop intensification and commercialization of farming activities, ever changing geographical wetland boundaries with either dry or rainy seasons, poor resource governance, land tenure system, droughts and floods, population growth

and high levels of poverty have all contributed to poor performance and a reduction in the Nyando wetland resources. The main challenges faced by the Nyando wetland resource users in acquisition, utilization, and resource marketing are poor infrastructure and lack of market access resulting to poor product prices. The wetland has reduced in size by - 2,933.1 Ha (-24.4%) between 1985-2020 due to unsustainable utilization, climate change and variability and inefficient resource governance. From the results, the second hypothesis that unsustainable wetland resource utilization has significant negative impacts on Nyando wetland ecosystem services was accepted.

In the case of objective three, several projects on sustainable land management practices including river bank protection through tree and grass planting, digging of dykes for flood control, digging of drainage canals and removal of water hyacinth were taking place in Nyando wetland. Engagement into these projects helped the local community to raise and diversify their livelihood hence reducing direct overreliance on the wetland products and consequently helping in conservation of the Nyando wetland. Lack of knowledge, funding and good institutional organization are some of the reasons as to why these projects on sustainable land management practices for PES were not well developed. The mode of payment for these projects involved cash and in-kind payments. There is lots of willingness by the local community of the Nyando wetland to be engaged in PES schemes and to adopt other sustainable land use practices such as agroforestry. The barriers raised that would hinder proper PES adoption in Nyando wetland are lack of capacity, lack of market information and lack of proper community organization. Therefore, with proper organization and restructuring, the existing conservation initiatives in the

Nyando wetland could form the basis for proper PES design in the area with the already existing NGOs and governmental organizations coming in handy to offer trainings and guide the process. Despite the Nyando wetland supplying several ecosystem services to the local community, this study has revealed that apart from provisioning services, most of the respondents were not so much conversant with the other classes of ecosystem service benefits derived from the wetland hence their low perception. The respondent's level of education, duration of residence and age significantly influenced their perception on ecosystem services. From the results, the third hypothesis that the respondent's level of education, age and duration of residence within the Nyando wetland have significantly influenced the local community's perception on ecosystem services and their payment was accepted.

5.2 Conclusion

This study concludes that; in the case of objective 1, the existing institutional arrangements governing Nyando wetland are not suitably designed to enhance sustainable conservation of the Nyando wetland ecosystem services. Though both formal and informal institutions governing Nyando wetland resource access, utilization and management exist, there is an overlap particularly caused by the formal institutions which leads to policy disharmony hence conflicts. Lack of clearly defined wetland boundaries, poor monitoring and sanctioning systems, poor organizational coordination and poor rule enforcement have contributed to ineffective resource conservation.

In the case of objective 2, the rural livelihoods in the Nyando wetland is so dependent on the wetland ecosystem services and this has led to unsustainable

wetland resource utilization which has negatively impacted on the wetland ecosystem. They depend on the wetland for farming, harvesting of firewood, papyrus and fishing though in unsustainable way as well as wetland conversion for settlement, tree plantations and fish pond constructions leading to degradation of the wetland ecosystem services.

In the case of objective 3, Nyando wetland is endowed with several ecosystem services including provisioning, regulating, cultural and supporting services. The local community is more conversant with the provisioning ecosystem services hence their high perception as compared to the other three categories of ecosystem services. The local community has a positive perception to PES adoption as it may lead to the conservation of the wetland and improve their livelihoods.

5.3 Recommendations

The following recommendations need to be addressed in order to enhance sustainable utilization of Nyando wetland resources.

In the case of objective 1, this study recommends:

- Harmonization of wetland conservation institutions: Several institutions exist with different roles in wetland management and conservation in Kenya. There is therefore a need for harmonization of the different legislations contained in many pieces of government frameworks in-order to achieve coherence in sustainable management and conservation of wetlands.
- Co-management for the entire Nyando wetland ecosystem: The government should involve all the stakeholders (local community, NGOs and CBOs) in co-management of the ecosystem resources. This co-management approach

will ensure that the local community derives some benefits from the wetland at the same time have some level of control on access, quantities to be harvested and technology to be used as well as be able to enforce rules and sanction violators hence enhancing sustainable management.

- Nyando wetland boundary demarcation: The Nyando wetland boundaries are not clearly defined and keep on changing depending on the season. In order to help in conservation and enforcement of the wetland conservation policies, the government should therefore urgently map, delineate and make known the Nyando wetland boundaries by all the stakeholders concerned.

In the case of objective 2, this study recommends:

- Designing of alternative livelihood strategies: The locals should be encouraged to adopt other sustainable alternative livelihood activities such as bee keeping, poultry farming, fish farming and dairy farming. This will help in reducing pressure on the already constrained wetland resources. The county government can provide initial financial support to the locals either through organized farmer groups or through any other agreements to be agreed upon.

- Encouraging of alternative source of fuel wood such as improved jikos, use of gas and electricity to avoid over-reliance on wetland vegetation which is unsustainable. Adoption of agro-forestry could as well provide alternative source of firewood at the same time enhancing the on farm biodiversity.

- Wetland product value addition: To enhance sustainability of the wetland products and increase direct benefits to individual sellers, the local community should be trained on value addition of their products.

In the case of objective 3, this study recommends:

- Strengthening of the capacity of the local organizations: The conservation authorities (both the government and NGOs) should continue to engage the local community through trainings and capacity building on the ecosystem services and conservation approaches. This will help to create awareness on the value of the Nyando wetland ecosystem for enhanced management. Awareness should also be done on PES scheme design, ecosystem markets and the anticipated challenges and how to address them. Well trained communities have a better understanding and are able to understand and sign conservation contracts.

- Developing of a PES policy: An enabling policy is required to provide community level guidance to PES implementation in Kenya. This calls for a framework for ecosystem service markets embedded in the natural resource management strategy.

- Gazetting of Nyando wetland as a protected area: The government should ensure that the wetland is gazetted as a protected area. This will go a long way in enhancing its conservation, promoting biodiversity and help in promotion of ecotourism activities in the area such as nature walks, sport fishing and cultural enjoyment through preservation of areas of cultural importance.

5.4 Contribution of the study

This study has contributed to knowledge by first, providing information for better understanding of the interrelationships between wetland ecosystems, conservation

institutions and human wellbeing which is important in the provision of efficient governance for sustainability of wetland resources. Secondly, this study has successfully utilized quantitative and qualitative data, remote sensing and GIS to conclude on the implications of wetland resource use by communities living adjacent to wetlands. Thirdly, the study also addressed the potential and perceived barriers specifically within Nyando wetland context which needs to be overcome in-order to design a working PES scheme that can enhance conservation and utilization of ecosystem resources. This assessment also provides better insights that can offer opportunities that may include ecosystem valuation into local decision making process for sustainable wetland resource utilization and management. Finally, though the study was conducted at Nyando wetland ecosystem, the results may be applicable in helping policy makers and communities in the management, utilization, decision making and conservation of wetlands in developing countries having wetlands with similar characteristics such as Nyando.

5.5 Further research

This research recommends further investigation into:

- Quantification of different ecosystem services from Nyando wetland
- Establishing the willingness to pay (WTP) by the beneficiaries of these ecosystem services and willingness to accept (WTA) by the sellers
- Establishing the current status of biodiversity within the Nyando wetland.

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APPENDICES

Appendix 1: Community survey data collection questionnaire guide

KENYATTA UNIVERSITY

SCHOOL OF ENVIRONMENTAL STUDIES

DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT

This questionnaire forms part of the data as partial requirement for a PhD degree at the school of Environmental Planning and Management, Kenyatta University. The aim of this study is to evaluate Nyando wetland utilization, conservation and community perception on Payment for Ecosystem Services. You are kindly requested to participate in the study.

(Tick the box and provide written responses where applicable)

Section A: Location data

Questionnaire identification	Enumerator Name
County	Date of interview
Sub-county	
Ward	
Sub – location	
Village	
Questionnaire serial No.	

Section B: Background Information and Household Characteristics of the Respondent

B/1 Gender

Male		Female	

B/2 Marital status

Married	Single	Divorced	Windowed

B/3 Education level

None	Primary	Secondary	College	University

B/4 Number of people living in your household

1	2	3	4	5	6	7	8	9	10	>10

B/5 For how long have you lived here?

1. 1-5 years	6-10 years	11-15 years	16 -20 years	21-25 years	> 25 years

B/6 Occupation

Unemployed	Casual worker
Domestic worker	Business owner
Civil servant	Farmer
Retired	Other (specify)

B/7 Main economic activities of respondent

Keeping livestock and cultivation	
Fishing	
Making papyrus goods	
Business	

B/8 Age category of the respondent

1. 18–26 yrs	27-35 yrs	36-44 yrs	45-53 yrs	54-62 yrs	>63 yrs

B/9 What is the nature of land tenure of the household?

Private (with title deed)	Communal	Others (specify)
Private (without title deed)	Tenancy	

B/10 How was land acquired here at first (historically)?

Self-allocation	Rented	Not sure how
Government settlement scheme	Bought	

B/11 How far is your homestead from the wetland?

a). Respondent …….. (m) b). Enumerator ……. (m)

Section C: Wetland utilization

C/1. How important is the wetland verses other income, livelihood (employment) income resources?

i = on-wetland has a greater contribution than of wetland

ii= off- wetland activities a greater contribution than on wetland

iii=same (both contribute equally to income in the household)

C/2. Does your household own land in the wetland? Yes …….. No ……..

C/3. If Yes, how many acres a) 1…. b) 2…….. c) 3…….. d) 4…….. e) 5…….. f) >5 ……

C/4 How much of that land owned in the wetland is under cultivation? a) 0.5 acres …… b) 1 acre …… c) 1.5 acres …… d) 2 acres …… e) 2.5 acres …… f) others …….

C/5. By what percentage does the wetland farm contribute to domestic food?

a) 0-25%..... b) 26-50%..... c) 51-75%..... d) 76-100%..... e) 100% ……...

C/6. How did you acquire land in the wetland?

a) Self allocation …… b) allocated by authority …… c) allocated by authority as well as allocated a portion by myself …… d) inherited ….. e) Bought ……

C/7. Why did you start farming in the wetland? List the reasons:

……
……
……

C/8. Does the preferred location of farming change in the course of the year? a) Yes…b) No…

C/9. If Yes, state the reasons why?

……
……

C/10. How would you say about the following activities within the wetland?

	Has increased	Has decreased	Reasons for the observed change
Cultivation area			
Grazing area			
Fish catch			
Hunting activities			

Number of animal species			
Size of the wetland			
Wetland vegetation			
Recreation activities			
Cultural activities			
Others (specify)			

C/11. List the products you obtain from the wetland

Type of resource	Mode of resource transport i.e. carried by foot, bicycle, animal drawn power, motor vehicle etc	Use of the the resource (i.e. human/animal consumption, selling/commercial use, building, household products, cultural activities)	Total income per month where applicable
Medicinal plants			
Thatch roofing			
Thatch for household items			
Reeds for market goods e.g. mats, chairs etc			
Sand			
Poles			
Firewood			
Water for animals			
Water for drinking			
Grazing land			
Fish			
Bricks			
Livestock feed			
Vegetables			
Other crops			
Others resources (specify)			

C/12. Do you pay for the wetland use? a) Yes……. b) No……

C/13. If yes, state the authority where the payment is done and the amount paid
Authority …… mount paid per month …….

C/14. Are the wetland products accessible easily? a) Yes…….. b) No……..
If No, what are the hindrances to accessibility?
……
……
……..……..

C/15. List some of the challenges/problems/risks you face in the utilization of the wetland resources and the sale of wetland products
……
……
……

Section D: Conservation institutions
D/1. How was the traditional management systems of the wetland instituted?
……
……
……
D/2. Are you involved in any community conservation institution? a) Yes… b) No……

D/3. If Yes, what kind of institution? Kindly list them

Community based organization (CBO)	
Non-governmental organizations (NGOs)	
Self-help groups	
Others (specify)	

D/4. What wetland community conservation initiatives exist in the area?
……
……
……

D/5. What governmental institutions and non-governmental organizations exist in the area for the conservation of the wetlands? Name them according to the following categories:

Governmental organizations	Non-governmental organizations (NGOs)	Community based organizations

1	1	1
2	2	2
3	3	3
4	4	4
5	5	5

D/6. List down the organization (s) and its role in wetland conservation

Organization	Role

D/7. According to you, who is mandated to conserve the wetlands? a) Government…….. b) NGOs…… c) Community Based Organizations…… d) individuals …….. e) All the above ……..

D/8. Between the government, NGOs and the Community based Organizations, who has the final say on the wetland utilization and management?

……
……
……

D/9. Do you think the government is doing enough to conserve the wetlands? a) Yes …… b) No……

D/10. Please explain your answer above

……
……

D/11. Is there a link between the government conservation institutions, NGOs, and community based organizations in the co-ordination of wetland conservation activities? a) Yes…. b) No……

D/12. Please explain your answer above

……
……
……

D/13. Do the conservation authorities support local development initiatives? a) Yes ….. b) No….. c) Don't know…….

D/14. If Yes, what types of development initiatives?

Educating the community on wetland conservation	
Health	
Infrastructure development	
Help with village projects	
Provision of tree seedlings	
Job creation	
Provision of crop seeds	
Others (specify)	

D/15. How would you describe the relationship between the community and the government conservation institutions in the region?

1. excellent	2. very good
3. good	4. satisfactory
5. poor	

D/16. Give the reasons for your choice above

……
……
……

D/17. How would you describe the relationship between the community and the Non-governmental conservation institutions in the region?

1. excellent	2. very good
3. good	4. satisfactory
5. poor	

D/18. Give the reasons for your choice above

……
……
……

D/19. To what extent (if any) is the local community involved in the activities, decision making and management of the wetlands?

1. not highly involved	2. somewhat involved	5. don't know
3. involved	4. Highly involved	

D/20. Do you know of any wetland conservation policies? a) Yes …… b) No……..

D/21. What is your view on government policies on wetland conservation?

……
……
……

Section E: Community Awareness on ecosystem services and perception to Payment for Ecosystem Services

E/1. How important is environmental conservation to you. Tick once

Score	**1**	**2**	**3**	**4**	**5**
	Not important	Of little importance	Moderately important	Important	Very important

E/2. Do you have any knowledge about Nyando wetland ecosystem? Yes…… No…..

E/3. Do you think the wetland is of any value to you and the community? Yes…. No ….

E/4. If yes which is the most important issue of conserving the wetland?

	Activity	**Tick the applicable**
1	Agriculture	
2	Plant and animal species	
3	History, heritage and culture	
4	Scientific value	
5	Tourism development	
6	Aesthetics	
7	Climate regulation	
8	Others (please specify)	

E/5. How well do you feel informed about the ecosystem resources from the wetland?

1	Fully informed	2 Partly informed	3 Not informed

E/6. Is the supply or continued existence of the wetland resources secure? Yes ….. No …..

E/7. Do you belong to any conservation or social group? Yes ….. No ….

E/8. Are you familiar with this concept of Payment for Ecosystem Services (PES)?

1 Very familiar	2 Familiar	3 Heard of it once	4 not familiar at all

E/9. Would you like to be involved in the project design of such a scheme?

1 Definitely	2 Probably	3 Undecided	4 Probably not	5 Very probably not

E/10. What would be your expectations for such schemes? Tick all that apply

Additional income	Technical assistance
Better infrastructure	Less Taxes
Markets for products with environmental labels	Others (Please specify)
International markets for ecosystem services	

E/11. What do you consider the hindrance to you from adapting such schemes? Tick all that apply

Lack of markets information	not interested
Lack of capacity	Other (Please specify)
Lack of Community organization	

E/12. If you were to be compensated, can you release the portion of your land next to the wetland for wetland restoration? Yes ….. No …..

E/13. If No, please give reasons why

……
……
……

E/14. Would you be willing to adopt any other land use if complementable with agriculture for instance eco-tourism, non-timber products, Agro-forestry or other activities?

1. Definitely	2. Probably	3. Undecided	4. Probably not	5. Very probably not

Section F: Approaches to PES and Institutional organization activities capacity

F/1. What ecosystem services do you know from the wetland? Tick all applicable

1. Provisioning	**3. Cultural**
Food	Spiritual (spiritual and religious values)
Fresh water	Recreational
Fuel and fiber	Aesthetic
Biochemical (medicinal extracts from plants)	Educational
Others (specify)	Others (specify)
2. Regulating	**4. Supporting**
Climate regulation (influence local and regional temperature and precipitation etc)	Primary production

Pollination	Nutrient cycling
Erosion regulation	Soil formation
Water purification	Others (specify)
Natural hazard regulation (i.e. flood control)	

F/2. Do you know the producers of such services? Yes … Partly …. No …..

F/3. If yes please explain

……
……

F/4. Who do you think are the beneficiaries of such services?

1.Local community	2. Conservation and development NGOs	3. Government	4. Private sector	5. World markets	6. others (specify)

F/5. Are you involved in community conservation activities Yes … No…

F/6. If yes what kind of institution?

1. Community based organization	2. NGO	3. Government	4. Self-help group	5. other (Please specify)

F/7. Please give the name (s) of the organization (s) above

……
……

F/8. What community conservation activities are you involved in?

S/No.	Activity	Tick all the applicable
1	Tree planting	
2	Wetland restoration	
3	Eco-tourism	
4	Education and awareness	
5	Beekeeping	
6	Capacity building	
7	Flood control	
8	Others (specify)	

F/9. Are you involved in any mode of Payment for Ecosystem Services (PES)? Yes … No …..

If yes, please explain what you are involved in and how you benefit

……
……

F/10. How is the payment mode?

S/No.	Activity	Tick the applicable
1	Given money	
2	Food for work	
3	Free services i.e. benefit from knowledge sharing/ advice from experts	
4	Given free planting materials i.e. tree seedlings	
5	Better infrastructure	
6	Others (specify)	

F/11. Which organizations/institutions are involved in the design of PES schemes in the area? Kindly list them

……
……

F/12. Do you have local and foreign institutions that you collaborate with? Yes …. No ….

F/13. In which areas do you collaborate? Tick all that are applicable

Community development	wetland conservation and restoration	soil erosion control	Funding	other (Please specify)

F/14. Do you know of any markets for ecosystem services? Yes …. No ……

F/15. Explain your answer

……
……

F/16. Is there available source of information about ecosystem services and their markets? Yes … No ….

F/17. Who is creating and disseminating information about ecosystem services and their markets?

Institution	**Give the specific name of the institution**
Community based organizations	
NGOs	
Private sector	
Government	
Other (Please specify)	

F/18. Do you wish to know more on ecosystem services? Yes … No …..

F/19. Which organizations would you recommend to lead or initiate the PES schemes? Tick as appropriate

NGOs	Community based organizations	Private sector	Government	Others (specify)

F/20. State the reasons for your choice above

……

……

F/21. Do you think there is potential in this region for PES schemes?

Totally Agree	Partially Agree	Neither Agree or Disagree	Partially disagree	Totally disagree

F/22. If you are engaged in any Payment for Ecosystem Service scheme, are you satisfied with the way it is run?

Yes ……. No……..

F/23. If No, please explain the reasons why

……

……

F/24. What challenges are you facing in the running of the PES schemes? List them

……

……

……

Appendix 2: Interview schedule guide for key informants

KENYATTA UNIVERSITY

SCHOOL OF ENVIRONMENTAL STUDIES

DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT

This interview questionnaire forms part of data as partial requirement for a PhD degree at the school of Environmental Planning and Management, Kenyatta University. The aim of this study is to evaluate Nyando wetland utilization, conservation and community perception on Payment for Ecosystem Services. You are kindly requested to participate in the study.

Name of Authority/organization ……..

Name and Position of the interviewee ……..……..

Institutions/organizations mandate in wetland conservation? ……..……

Resource use, management and conservation issues

1. Which are the most common resources the community depends on within or close to the wetland?
   .....
   .....
   ....

2. Do the local communities have access to, and use of all of the wetland resources? If NO please explain under what conditions is access to and use of the resources not permitted
   ……
   ……
   ……

3. What management practices/actions does your organization/institution undertake to enforce the conservation of the wetland resources?

..……
……
……
……
…

4. What are the current concerns/threats (if any) to the wetlands concerning resource conservation?
.....
.....
.....
.....

5. Which other organizations are involved in the conservation of the wetlands
……
……

6. Are there institutional/policy conflicts in the conservation of the wetland resources? Kindly explain some of the inter-institutional challenges faced in the management of the wetland resources
……
……

7. Is there a link in the co-ordination of wetland conservation activities between the government conservation institutions, NGOs, and community based organizations? a) Yes…. b) No……

   Please explain your answer above
   ……
   ……
   ……

Impacts of community–oriented conservation initiatives

8. i). Does the management support local community initiatives? Yes.… No….
   ii) If Yes, what type (s) of development initiatives?
   ……
   ……
   ……

   iii) If No, what developments is the authority considering to initiate?
   ……
   ……
   ……

9. What are some of the community conservation initiatives which exist within this area?
   ……
   ……
   ……

10. Has the community-oriented conservation and development approaches improved conservation attitudes among the local people?
    ……
    ……
    ……

Relationship with the local community and sustainable conservation strategies

11. Does anyone from your organization visit the local people? Yes…. No….
    If YES state how often and purpose of the visit
    ……
    ……
    ……

12. How would you describe the relationship between the community and management / staff of your organization? 1.very bad 2.bad 3.good 4.very good 5.excellent

13. To what extent (if any) is the local community involved in the activities, decision making and management of the wetlands?

1.Not highly involved	2.Somewhat involved	3. Involved	4.Highly involved	5. Don't know

14. i) Are there any wetland conservation policies?
    ……
    ……

    ii) Does the local community know these policies and what is their response?
    ……
    ……

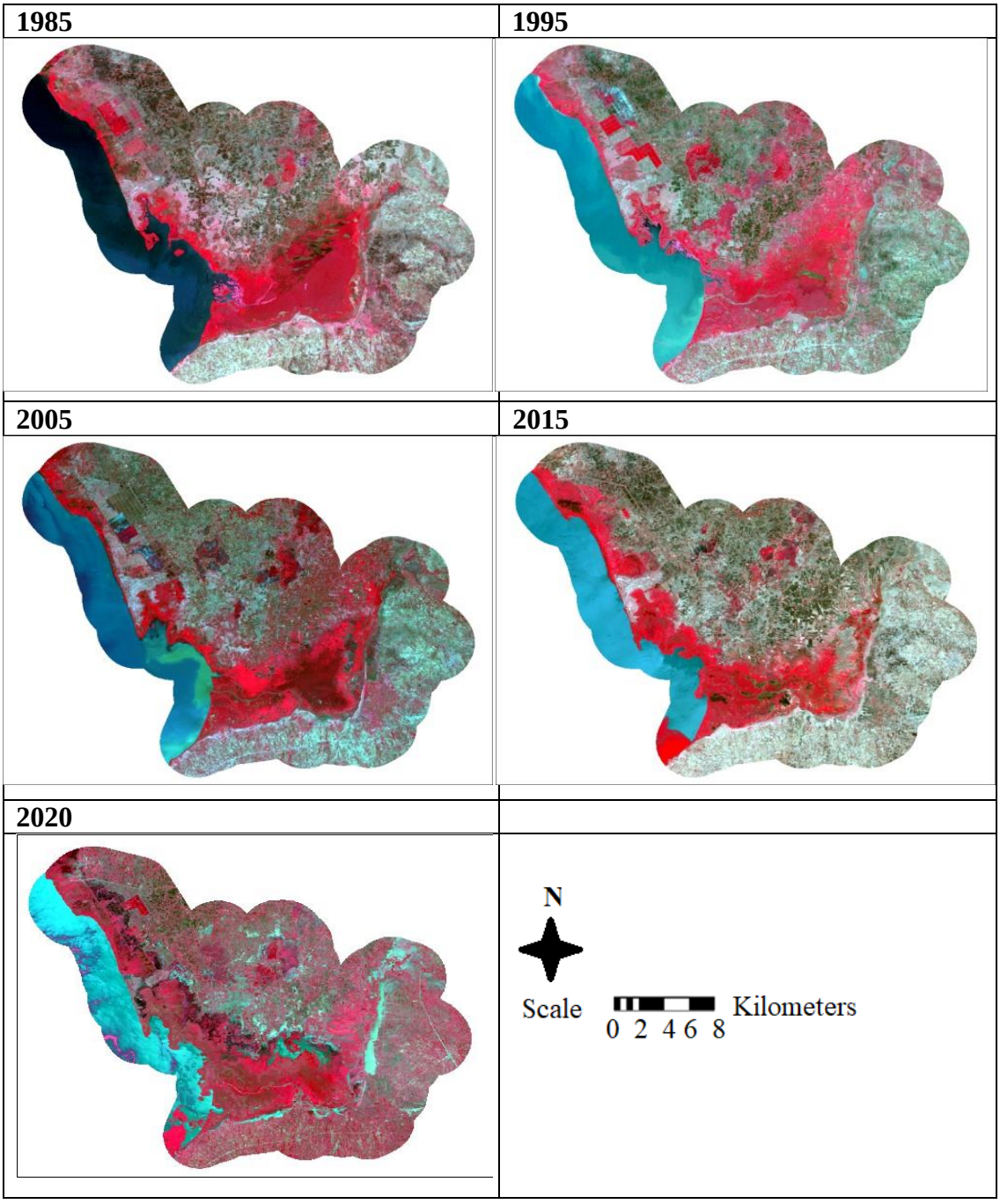
    iii) What is your view of government policies on wetland conservation?
    ……
    ……
    ……

15. On a scale of 1-5 where 1= very bad and 5= excellent, compare the performance of the different institutional arrangements of wetland resource conservation?

	1.very bad	2.bad	3.good	4.very good	5.excellent
Indigenous systems					
Community based organizations					
NGOs					
Government					
Other (Please specify)					

16. In what ways do you think your organizations/institutions' management authority can improve the livelihoods of the local people without compromising the state of wetland resources?
    .....
    .....
    .....
    .....
    .....
17. What are the main challenges you/your organization faces in the wetland conservation?
    …….....
    .....
    .....
    .....
18. Is there any mode of Payment for Ecosystem Services (PES) within the Nyando wetland? Yes …… No …...
    If yes, please explain
    ……
    ……..…….
    ……
19. What are some of/will be the hindrances to implementation of PES schemes in the area?
    ……
    ……
    ……

Appendix 3: False color composite satellite images of Nyando wetland in 1985-2020



Appendix 4: Correlation between wetland resource use and respondents occupation

Descriptive Statistics			
	Mean	Std. Deviation	N
Occupation	5.71	1.950	503
Wetland resource use	8.08	4.239	2108
Correlations			
		Occupation	Resource use
Occupation	Pearson Correlation	1	.094*
	Sig. (2-tailed)		.035
	N	503	500
Wetland resource use	Pearson Correlation	.094*	1
	Sig. (2-tailed)	.035	
	N	500	2108
*. Correlation is significant at the 0.05 level (2-tailed).			

Appendix 5: Research approvals

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School

DATE: 20th June, 2015

TO: Mr. Joseph Kasua Maithya
C/o Environmental Planning & Management Dept.
Kenyatta University

REF: N85/22977/12

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that Graduate School Board at its meeting of **17th June, 2015** approved your Research Proposal for the Ph.D. Degree. **Entitled "Wetland Utilization and Community Perception on Payment for Ecosystem Services in Conservation of Nyando Basin Wetlands".**

You may now proceed with data collection, subject to clearance with the Permanent Secretary, Ministry of Higher Education, Science and Technology.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking forms per semester. The form has been developed to replace the progress report forms. The supervision Tracking Forms are available at the University's website under Graduate School webpage downloads.

By copy of this letter, the registrar (Academic) is hereby requested to grant you Substantive registration for your Ph.D studies.

Thank you.

KENYATTA UNIVERSITY OFFICE OF DEAN GRADUATE SCHOOL P.O. BOX 43844 NAIROBI
30 JUN 2015

JULIA GITU
FOR: DEAN, GRADUATE SCHOOL

c.c. Chairman, Environmental Planning & Management Department.

Registrar (Academic)

Supervisors:

1. Dr. Sammy Letema
   Department of Environmental Planning & Management
   Kenyatta University

2. Dr. Felix M. Ming'ate
   Department of Environmental Studies & Community Development
   Kenyatta University

JG/nn

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No

Date:
28th October, 2015

NACOSTI/P/15/9451/7197

Joseph Kasua Maithya
Jomo Kenyatta University of Agriculture
And Technology
P.O. Box 62000-00200
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Wetland utilization and community perception on payment for ecosystem services in conservation of Nyando Basin Wetlands,"*** I am pleased to inform you that you have been authorized to undertake research in **Kisumu County** for a period ending **27th October, 2016.**

You are advised to report to **the County Commissioner and the County Director of Education, Kisumu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

SAID HUSSEIN
FOR: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Kisumu County.

The County Director of Education
Kisumu County.

THIS IS TO CERTIFY THAT:
MR. JOSEPH KASUA MAITHYA
of JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY , 0-200 nairobi,has been permitted to conduct research in *Kisumu County*

on the topic: *WETLAND UTILIZATION AND COMMUNITY PERCEPTION ON PAYMENT FOR ECOSYSTEM SERVICES IN CONSERVATION OF NYANDO BASIN WETLANDS*

for the period ending:
27th October,2016

Permit No : NACOSTI/P/15/9451/7197
Date Of Issue : 28th October,2015
Fee Recieved :Ksh 1,000

Applicant's Signature

Director General
National Commission for Science, Technology & Innovation

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
State Department of Education

Telegrams:"schooling",Kisumu
Telephone: Kisumu 057 - 2024599
Email:
countyeducation.kisumu@gmail.com

COUNTY DIRECTOR OF EDUCATION
KISUMU COUNTY
PROVINCIAL HEADQUARTERS NYANZA
3RD FLOOR
P.O BOX 575 – 40100
KISUMU

When replying please quote

CDE/KSM/GA/19/3A/(156)

20th June 2016

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION
JOSEPH KASUA MAITHYA

The above named is a student at Kenyatta University.

This is to certify that he has been granted authority to carry out research on ***"Wetland utilization and community perception on payment for ecosystem services in conservation of Nyando Basin Wetlands"***, for a period ending **27th October 2016**

Any assistance accorded to him to accomplish the assignment will be highly appreciated.

SILVESTER MULAMBE
COUNTY DIRECTOR OF EDUCATION
KISUMU COUNTY