SPATIO-TEMPORAL IMPACTS OF LAND COVER CHANGES ON NAMANVE WETLAND HEALTH AND COUNTER MANAGEMENT STRATEGIES IN MUKONO DISTRICT, UGANDA

By

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A Research dissertation Submitted to the Directorate of Graduate Studies, Research, and Innovations in partial fulfilment of the requirements for the award of Master of Science in Climate Change and Disaster Management of Busitema University

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DECLARATION

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I the undersigned, declare that this research dissertation is my original work, except where due acknowledgement has been made. I declare that this work has never been submitted to this University or to any other Institution for funding/ for partial fulfilment for any award.

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SUPERVISOR(S) APPROVAL

This research dissertation submitted as a partial fulfilment for the award of Master of Science in Climate Change and Disaster Management of Busitema University of Busitema University, with my/our approval as the academic supervisor(s)

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DEDICATION

I dedicate this piece of work to my entire family and specifically to my daughters Abigail Charlene Arinaitwe and Alison Kareen Karungi who endured my absence from home for two years of advanced studies.

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ABSTRACT

The study examined the spatio-temporal impacts of land-lover changes on Namanve wetland health and counter management strategies in Mukono district. The objectives of the study were:- to characterise land cover changes in Namanve wetland from 1996 to 2016; to determine the effects of land cover changes on Namanve wetland health using the WET-Health assessment tool; and to assess the contributions of formal and informal institutional arrangements in managing land cover changes in the wetlands in Mukono district.

In the study, both qualitative and quantitative methods of data collection and analysis were used based on a case study and longitudinal spatial analysis study design. Longitudinal spatial analysis with the help of GIS tools was used to generate data on the pattern of land cover changes in the Namanve wetland system for a period between 1996 and 2016. Other quantitative data was collected using household questionnaires and WET-Health assessment tools to assess the impact of the change in land cover patterns on the health of the wetland. Qualitative methods used include expert interviews, Focus group discussions, field observations and documentary reviews.

The results of the study confirm the long-held view of many Government and Research Agencies that wetland coverage has drastically deteriorated in the last 20 years from 15.6% % or 37,575km^2 of the total land surface area in 1994 to 10.9% or 26,330 km^2 in 2014 (Water & Environment SPR,2016). Namanve wetland is therefore not exceptional in experiencing degradation within the same time frame. The main drivers include unemployment, population growth and land shortage. Settlements, including factories and infrastructure, crop cultivation and brick making are the most dominant human activities with significant impact on wetland health measured in terms of vegetation, hydrology and geomorphology. The overall impact of the land cover change on the wetland health has been assigned level C representing a moderately modified Namanve wetland system. Inadequate enforcement of wetland laws and regulations and corruption were found to be the main reasons wetland related policies and strategies are not being implemented to conserve wetlands including Namanve wetland.

The recommendations of this study, therefore include :- a deliberate policy shift from the more powerful but inefficient central government approach to decentralized, participatory and empowered management of environment resources; comprehensive land use planning (both urban and rural) and zero tolerance to corruption at all levels. E-monitoring of sensitive ecosystems such as wetlands and forest reserves using the latest technologies like drones and GPS; enactment of wetland specific law and wealth creation will guarantee high-income levels per capita and drive the population to demand for an improvement in environmental quality in line with the Environmental Kuznerts Curve theory.

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ACRONYMS AND ABBREVIATIONS

CBOs	Community Based Organizations
CDO	Community Development Officer
CSOs	Civil Society Organizations
DEC	District Environment Committee
DEO	District Environment Officer
DNRO	District Natural Resources Officer
DPSIR	Driving Force-Pressure-State-Impact-Response)
EA	Environmental Alert
EBA	Ecosystem Based Adaptation
EIA	Environmental Impact Assessment
ENR	Environment and Natural Resource
FGDs	Focus Group Discussions
FY	Financial Year
GIS	Geographic Information Systems
GoU	Government of Uganda
GPS	Global Positioning System
HGM	Hydro-geomorphic
IPCC	Intergovernmental Panel on Climate Change
KCCA	Kampala Capital City Authority
LEC	Local Environment Committee
LC	Local Council
LG	Local Government

MWE	Ministry of Water and Environment
NDVI	Normalized Difference Vegetation Index
NEA	National Environment Act
NEMA	National Environmental Management Authority (Uganda)
NGOs	Non-Governmental Organizations
NIR	Near-infrared
NWP	National Wetland Program
NWSC	National Water and Sewerage Cooperation (Uganda)
OECD	Organisation for Economic Co-operation and Development
RS	Remote Sensing
SC	Sub County
SDGs	Sustainable Development Goals
SOER	State of Environment Report
SPR	Sector Performance Report of Water and Environment Sector
SPSS	Statistical Package for the Social Sciences
UBOS	Uganda Bureau of Statistics
UCU	Ugana Christian University
UGX	Uganda Shillings
UIA	Uganda Investment Authority
UNCST	Uganda National Council for Science and Technology
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reductio**n**
VBN	Value Belief Norm Theory
WET	Wetland Evaluation Techniques
WID	Wetlands Inspection Division
WMD	Wetlands Management Department
EPPU	Environmental Protection Police Unit
MEO	Municipal Environment Officer
NFA	National Forestry Authority
UEEF	Uganda Environment Education Foundation
UNDP	United Nations Development Program
FAO	Food and Agriculture Organization of UN
ICRAF	International Centre for Research in Agroforestry
CITES	Convention on International Trade in Endangered Species

UN	United Nations

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Globally, wetlands have important values both to the human beings and to the ecosystem. Wetlands are useful in ground water recharge and discharge, flood control, sedimentation or nutrient and toxicant retention, biomass export, recreation or tourism, storm prevention or wind break, micro climate stabilization and water transport (Dugan 1990; Apunyo 2006). In addition, they are a source of various forms of resources including forest resources, wildlife, fisheries, forage, agriculture, and water supply. Wetlands also provide essential habitat for species of birds and mammals due to their temporal and spatial variability. They are rich in endemic, rare and endangered species. For example, more than half of Europe's most endangered birds depend on wetlands (Beopoulous 1996). In Belgium, 97% of the 306 plants classified as rare, vulnerable, endangered or already extinct are wetland species. Further, they are a source of biological diversity and a source of culture or heritage.

Wetlands are ecosystems that occupy about 6% of the world's land surface (Mitsch and Gosselink, 1997). They comprise both land ecosystems that are strongly influenced by water and aquatic ecosystems with special characteristics due to shallowness and proximity to land. Although various different classifications of wetlands exist, a useful approach is one provided by Ramsar 1971 Convention on wetlands. It divides wetlands into three main categories of wetland habitats namely: marine or coastal wetlands, inland wetlands and man-made wetlands. Wetlands are characterised by "areas of marsh, fen, peat land or water whether natural or artificial, permanent or seasonal with water that is static or flowing, fresh, blackish or salty, including areas of marine water, the depth of which at low tide does not exceed six metres" (Ramsar 1971, p. 7).

Despite the multiple values wetlands provide, wetland degradation has been a severe environmental problem since the 1960s. It is against this background that nations met for a Ramsar Convention in Iran in 1971 to address concerns regarding wetlands and their degradation (Ramsar Convention Secretariat, 2007). Wetland degradation is becoming a major environmental problem in the world, moreover, with unsustainable utilisation of limited natural resources, population increase, desertification, soil erosion and decline in agricultural land productivity (Reed & Stringer 2016). In the 20th century, there was an estimated global decline in wetlands of 64-71%, both due to natural and human factors (Sidle et al. 2013). Degradation and loss of wetlands has deprived many human communities of important ecosystem services (Gardner et al. 2015). Wetland soils are formed under special chemical conditions of a waterlogged environment and tend to turn acidic under drained conditions. Thus, it is quite common for drained or severely degraded wetlands to become unsuitable for crop production or even for grazing.

Drainage and other forms of disturbance associated with agriculture are widely identified as the main contributor to wetland loss. Williams (1991) has suggested that globally, 160 600 km2 of wetlands had been drained by 1995, primarily for agriculture and food production. For instance, it has been, estimated that about 90% of New Zealand's former wetlands have been absorbed by arable, pastoral and horticultural developments (NWASCO 1982). The continuation of this trend means that the world will face a very serious struggle to meet the global goals on water and sanitation, food security, climate change action, life on land and affordable and clean energy (FAO 2015).

Outside Western Europe and North America there is very little information available or attempt made to calculate wetland loss on a systematic basis. The loss of wetlands worldwide has been estimated at 50% of those that existed in 1900, a figure that includes inland wetlands and possibly mangroves, but not large estuaries and marine wetlands such as reefs and seagrasses. Much of this loss occurred in the northern temperate zone during the first half of 20^{th} century. However, since the 1950s tropical and sub-tropical wetlands, particularly swamp forests and mangroves, have increasingly been lost (Global review of wetland resources and priorities for wetland inventory, Summary Report). In Africa, Hamilton 1998, notes that some wetland areas are experiencing immense pressure from land use activities, the most important being drainage for agriculture and settlement, excessive exploitation by local communities and improperly planned development activities.

In East Africa, Stevenson and Frazier (1999) estimate wetlands to cover an area of approx. 0.17million km^2 in the east African countries of Kenya, Rwanda, Uganda and Tanzania, with still a relatively small share being used for food production. Current upland agricultural use intensification in these countries due to demographic growth, climate change and globalization effects are leading to an over-exploitation of the resource base, followed by an intensification of agricultural wetland use. It is estimated that since 1980, more than 80% of the wetlands in east African countries have been lost as a result of agricultural expansion schemes, industrial development and urbanization (GNF 2002). In Kenya, drainage and conversion to arable cropping continue to degrade wetlands. By 1990, when Kenya ratified the Ramsar convention, most of the country's wetlands had been degraded. Drainage, land reclamation, overgrazing, eutrophication of inland waters caused by agricultural pollution are among the impacts of agriculture on Kenya's wetlands (Mironga 2005). Rwanda has 915 wetlands, which make up close to 10% of the country's surface area. Of these, only 38 wetlands are protected, meaning that no activities like agriculture and tourism are allowed to be carried out in them. The remaining marshlands are used for income-generating activities and have seen massive degradation from sand and clay mining, settlements, agriculture and recreation developments.

In Uganda, wetlands are defined as areas where plants and animals have become adapted to temporary or permanent flooding (NWP 1994). It includes permanently flooded areas with papyrus or grass swamps, swamp forests or high-altitude mountain bogs, as well as seasonal floodplains and grasslands. While all wetlands are characterized by impeded drainage, the length of their flooding period, depth of water, soil fertility, and other environmental factors vary with different wetland types. Wetlands are home to distinctive plant and animal communities that are well adapted to the presence of water and flooding regimes (MNR 1995). In Uganda, wetlands have declined from an estimated 13% of the total land area in 1994 to 10.9% in 2008 (Nsubuga et al. 2014). Out of a population of more than 40 million, 80% of Ugandans are involved in agriculture and 70% rely on subsistence farming and are heavily dependent on wetlands (UBOS 2016). The benefits obtained from wetlands in Uganda range from water and food supply to materials for construction and handicrafts (Apunyo 2006). The non-use values are the regulating services like flood control, climate modification, ground recharge, wastewater treatment and biodiversity maintenance (MEA 2005). These values act as the source of livelihood for the population. As a result of the increased use of wetland areas, there has been an increase in the frequency of vegetation clearance, draining and diversion of water flow, crop cultivation, overgrazing, sand mining and exposing the soil surface to erosion (MWE 2013).

In Uganda, the value of most tangible ecosystem services is well recognized by the wetland users. However, the value of most of the non-tangible ecosystem services is not fully recognized by most wetland users (Kakuru 2014). The lack of knowledge about the non-tangible ecosystem is driving continuous degradation of wetlands in Uganda. The degradation of the wetland undermines the capacity of the wetland to sustainably provide the ecosystem services to the people. The major drivers of wetland degradation in Uganda are socio-economic and political in nature. The government of Uganda has been pushing for a rapid expansion of economic activities to increase economic growth and create jobs for its youthful population. As a result, urbanization and industrialization sector has seen exponential growth, coupled with high population pressure and low enforcement of the wetland policies, which has caused extensive degradation of wetlands. Uganda population currently stands at approximately 41 million people with a growth rate of 3.03% (UBOS 2016) and urbanization rate stands at 5.43% per annum (one of the highest in the world). Consequently, the wetlands have declined from an estimated 13% of the total land area in 1994 to 10.9% in 2008 and to 8.9% in 2015 (MWE 2017). Wetland loss and degradation undermines the capacity of wetlands to provide valuable ecosystem services to humanity (Wasswa 2013).

The high rate of wetland degradation threaten the roles of wetlands in for example water quality regulation and providing other ecosystem services. For long, wetlands have been known for supporting

the life of a number of animal and bird species (Kotze 2005). However, the unwise use of the wetlands can negatively affect the health of the wetland, which at the end affect the quality of the services provided by the wetlands and the continuity of the wetlands to provide the services (Wassa et al 2018).

1.2 Problem statement

Namanve wetland, one of the main wetlands in Mukono district, has experienced land cover changes in the recent past. A transect walk across the wetland system reveals a lot of human induced activities which signify massive encroachment on the wetland. The most visible activities include industrial establishments, settlements, brick making, sand mining and farming. There is a significant reduction in the vegetation cover, and the wetland now experiences more visible instances of flooding than before during heavy rains. All these activities put a lot of pressure on the wetland system affecting its ability to continuously provide ecosystem services.

Namanve wetland is one of the wetlands that acts as a pollution buffer for Lake Victoria and is a flood attenuation zone for the surrounding areas. Draining of wetlands is associated with the significant public health risks such as toxic food contaminants (Nasinyama et al 2010) as well as infectious diseases (Horwitz et al 2012) resulting from contamination of water sources. A healthy wetland is able to provide the necessary ecosystem services to the people and also promote conservation of the biodiversity. Successful use and management of wetland ecosystems can be achieved if the relationship between people, wetlands and human institutions is understood by wetland users, planners and policy makers (Shine and de Klemm 1999).

Efforts at National and Local Government levels for curtailing wetland degradation in the country seem to be insufficient. The Annual Perfomance Report 2016 for Ministry of Water and Environment 2016 indicates that a total number of 1500 km of boundary lines for major urban critical wetlands have been surveyed and demarcated, 4000 ha of degraded wetlands restored, there are apparently strong legislative and institutional framework in place and an improvement in environment and natural resource funding. Yet inspite of all these efforts, wetland degradation still persists.

Wetland health mainly covers three components which include the hydrology, vegetation and geomorphology (Macfarlane et al 2009). Most studies have focused on the spatial change in the wetland area. Isunju (2016) looked at spatio-temporal analysis of encroachment on wetlands focusing on hazards, vulnalability and adaptations in Kampala city. While Businge (2017) studied the drivers of wetland degradation in western Uganda and compared the policies related to wetland management to that of Iceland, the information which integrates the spatial change, the health of the wetland and the

governance structures in Uganda is lacking to the best of my knowledge. Hence, this study shall provide the necessary spatial, health and governance data on the wetland under investigation using a combination of Geographical Information System (GIS), Wetland Evaluation Techniques (WET-health) and sample survey tools. The information obtained shall be valuable in catchment-scale decision making.

1.3 Research Objectives

1.3.1 General Objective of the Study

The general objective of the study was to assess the spatio-temporal impact of land cover changes on the Namanve wetland health and counter management strategies in Mukono district.

1.3.2 Specific Objectives

1.To characterise land cover changes in namanve wetland from 1996 to 2016.

2. To determine the effects of land cover changes on Namanve wetland health, using the WET-Health assessment tool.

3. To assess the contributions of formal and informal institutional arrangements in managing land cover changes in the wetlands in Mukono district.

1.4 Research questions

1. To what extent has the Namanve wetland cover changed from 1996 till 2016?

2. Which human activities are influencing the size of Namanve wetland system in Mukono district?

3. What are the impacts of land cover changes on Namanve wetland's vegetation, hydrology and geomorphology?

4. What is the percentage contribution of each of the selected human activities to the Namanve wetland cover change?

5. What has been the role of the state and non-state actors in the sustainable management of wetland resources in the country?

1.5 Originality and contribution to new knowledge

To define an original contribution to knowledge in the context of academic research studies is complicated. In one sense, it can be seen as something which someone else has not done before and requires a large amount of innovation and commitment from the researcher. Gall et al. (1996:47) noted that "the imagination and insight that goes into defining the research problem usually determines the ultimate value of a research study more than any other factor". Madsen (1983:25) however, offers the following insights to term originality: ''Original" means "the potential to do at least one of the following: uncover new facts or principles, suggest relationships that were previously unrecognized,

challenge existing truths or assumptions, afford new insights into little-understood phenomena, or suggest new interpretations of known facts that can alter man's perception of the world around him."

Against this background, the area of this research study is not new in the context of originality, however the specific research study area and some specific objectives such as assessment of Namanve land cover change and wetland health using WET-Health tool is considered original to the best of my knowledge.

It is therefore expected that the findings and recommendations of this research study will contribute greatly to the new knowledge for wetland management for Uganda in general and for Mukono district in particular.

1.6 Significance of the Study

The study is expected to highlight the land cover changes that have taken place in Namanve wetland system over a period of 20 years focusing on the health, vegetation and geomorphologic characteristics of wetland and examine whether the existing management practices for sustainable wetland conservation are adequate or lacking. These changes have come as a result of many factors both man-made and natural that this study identified. The study also identified the associated impacts of land use changes on Namanve wetland and eventually suggest the most appropriate remedies for sustainable utilization of wetland resources not only in Mukono district but the country at large.

Then, the role of state and non-state actors such as Non-governmental Organizations, Civil Society Organisations, Private sector, Community based organisations and church/cultural based foundations in promotion of sustainable wetland management practices in the country shall be examined with a particular focus on Mukono district. This information shall be valuable in evaluating the contribution of these actors, identifying the challenges they face and identify common grounds upon which the state institutions should be able to forge alliance for sound management of wetland resources

The information generated can help inform policy makers how land cover changes over time affect wetland health and identify the causes of wetland degradation. Integrated wetland assessment can also raise public awareness of the wetlands condition and guide policy makers to make rational and sustainable policies and strategies to protect and restore the health of the wetlands.

1.7 The scope of the study

Geographically, the study was carried out in Mukono district focussing on Namanve wetland system which traverses the five sub counties, twelve parishes and twenty-five villages. The period of spatio-temporal analysis is between 1996-2016 which the researcher considers sufficient to generate the required information but also is subject to availability of data. Conceptually, a DPSIR (Driving Forces-

Pressures-States-Impacts-Responses) framework was adopted where characterisation of land cover types, impacts of land cover changes and counter management responses are key ingredients of this study.

1.8 Theoretical frame work

The DPSIR is one of the integrated environment system assessment frameworks introduced by OECD (Organization for Economic Cooperation and Development) in 1993.

Wetlands when sustainably managed can sustain the benefits derived from the ecosystem services by the community. Wetlands provide different ecosystem services, both use value (papyrus, water, wood, fish etc) and non-use value (flood control, water (waste) treatment, climate regulation, carbon storage, nutrient cycling etc). When high **Pressure** is put on the wetlands as a result of **Drivers** for example population growth, industrial growth and poverty, the ability of the wetlands to provide the services to the people reduces. Therefore, the wetland health is negatively affected which in this case result **State** into poor water storage, pollution and poor water/wastewater treatment. Unhealthy wetland cannot store running rainy water hence causing flooding, which affects the health of the people. The cost of treating the water from water sources also increases and health hazards **Impacts**. In response, the responsible actors can develop management strategies to guide the sustainable utilization of wetland resources.

The management strategies may include: - developing of policies to guide the sustainable use of the wetlands. It's postulated that during the implementation of the policies, the different actors need to have coordinated efforts for the policies to have positive impacts. Therefore, if a wetland is considered to be a system, concept described under this section can be depicted by DPSIR conceptual framework as illustrated in figure 1 below (Namaalwa 2012). According to Marzieh (2014), the DPSIR provides an easy way to present difficult concepts to different stakeholders. The framework helps the stakeholders to easily understand the relationship between complex problems in the environmental system. Therefore, they are able to develop tailor-made solutions for each component of the framework (Kristensen 2004).

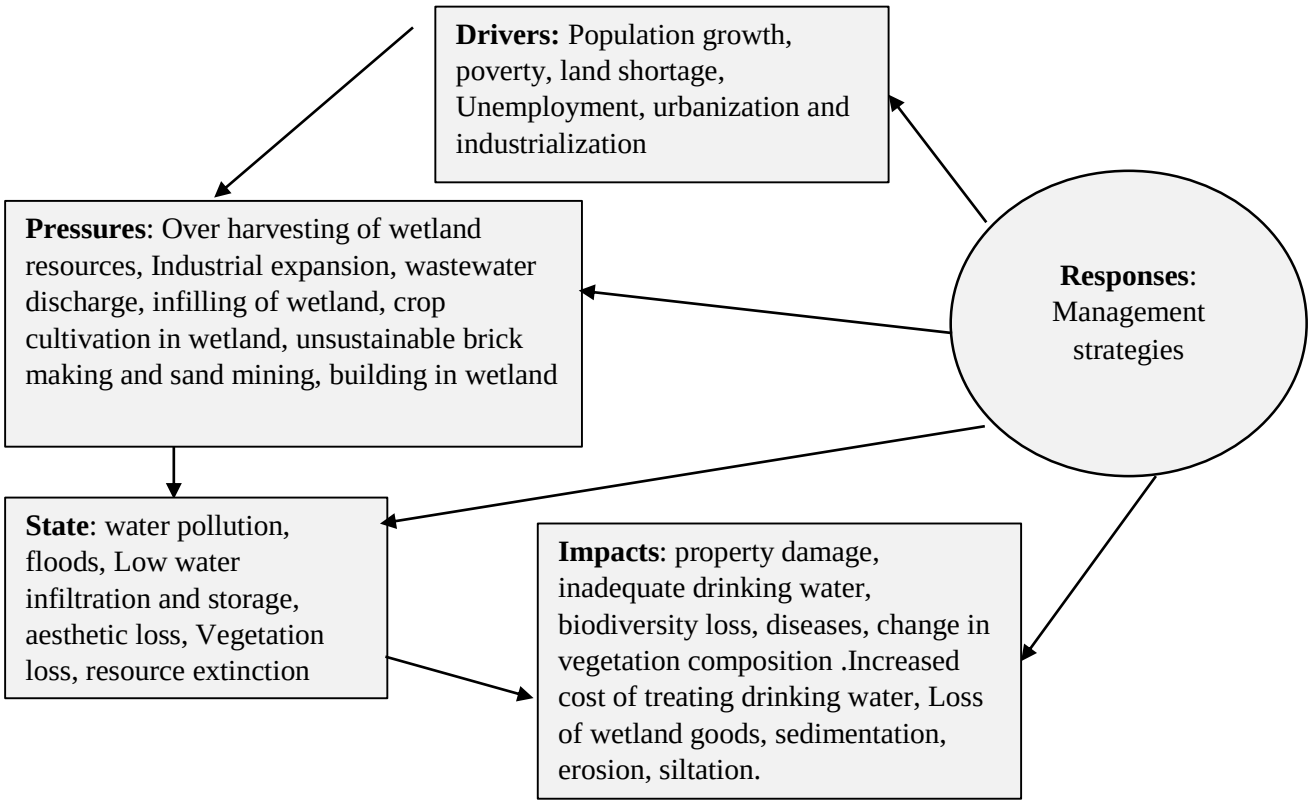

Figure 1: Conceptual Framework (DPSIR) for wetland management (Adapted from the OECD 1993)

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