IMPACTS OF LAND USE ACTIVITIES ON MARURA WETLANDS; UASIN GISHU COUNTY, KENYA

BY

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DECLARATION

Declaration by the student

This research thesis is my original work and has never been submitted in any institution for an award of degree in any university.

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Declaration by the Supervisors

This research Thesis has been submitted for examination with our approval as the University Supervisors.

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ABSTRACT

The study sought to investigate the impact of land use activities on Marura wetland and was guided by the following specific objectives; to establish the main land use activities around Marura wetland, to assess the impact of anthropogenic activities on wetlands and to determine the causes of wetlands degradation. Secondary sources of data were used in mapping the effects of anthropogenic activities through GIS and remote sensing techniques. Primary data was collected using household questionnaires and observation on the main landuse activities while. Purposive sampling method was used and collected data were analyzed using SPSS and Excel. The analyzed data was presented in tables, charts, graphs and narratives. The study indicates that 193(98%) of the respondents identified the most important aspect of the wetlands as a source of water in the community while Agriculture as the major cause of degradation to Marura wetland. This is because people have encroached inside the wetlands increasing the loosening of the soils and causing soil erosion and reduction in the water table. The findings of this study is of great significance to the community, NEMA and the County Government of Uasin Gishu as it will help in coming up with the best landuse practices for sustainable utilization of wetlands. The study recommends participatory management plan be developed and implemented to curb exploitation of the wetlands resources and coming up with environmentally friendly landuse practices which will sustain the marura wetlands for posterity.

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DEFINITION OF KEY TERMS

Anthropogenic: In this study, this term is used to mean the human impact on the environment

Causes: This term will be used in this study to describe the genesis of existing loss of value by the wetlands

Degradation: This refers to the loss of value by the wetlands

Land Use: Is used in this study to describe the act of utilizing the ground closer to wetlands

Wetland: This term is used in this study to define the ecological site that exhibits watery conditions

LIST OF ACRONYMS

CEC: County Executive Committee

NACOSTI: National Commission for Science, Technology Innovation

NEMA: National Environmental Management Authority

PAH: Polynuclear Aromatic Hydrocarbon

SLC- Scan Line Corrector

SPSS: Statistical Package for Social Sciences

TEEB: The Economics of Ecosystems and Biodiversity

UN: United Nations

UNEP: United Nations Environmental Program

UOE: University of Eldoret

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The basic human life-support systems of the biological environment have always been characterized by change, an inevitable consequence of all human land use throughout history (Mitsch and Gosselink, 2007). Seemingly "natural" or pristine ecosystems have been altered significantly by humans at some point in the past (Miller, Wardrop, Mahaney and Brooks, 2006). The generally low human populations, practice of sustainable traditional agriculture, fishing, and animal husbandry, as well as limitation of land use to a relatively smaller segment of the population using simple tools on smaller land areas, in the past, ensured the sustenance of soil fertility without the use of agro-chemicals. Biodiversity conservation is achieved through environment-friendly traditional human cultural practices and beliefs (Mitsch *et al*, 2007). This in turn foster a close and mutually supportive relationship between humans and biodiversity for tens of thousands of years.

In recent times, biodiversity has become easy target for humans over-exploitation due to burgeoning human populations and the quest for a "better life" through improvements in science and technology. Biodiversity, therefore, is being exploited at much faster rates than ever before with negative implications for sustainable human livelihood (Miller, *et al*, 2006). According to Wilson (1992), biodiversity is facing a decline of crisis proportions, which could ultimately lead to mass extinctions in the very near future.

Wetlands occupy approximately 6 per cent of the Earth's surface area (Ramsar, 2006). However, the wetland provisioning services have seriously degraded the integrity of these

wetlands (Millennium Ecosystem Assessment 2005). Wetlands can remove 90 to 100% of (Nitrogen Oxide) NO_3 that enters the ecosystem as well as 3.8 kg/ha/yr of P and act as sinks for phosphorus contained in agricultural runoff (LaPaix, Freedman and Patriquin, 2009). Not only does the vegetation in these systems affect the fate of these excess nutrients, but excess nutrients can also affect the plant community structure (Miller. *et al.* 2006). The introduction of nutrients into a natural system can limit the productivity of some species while enhancing the productivity of others. Nutrient enrichment can change species composition and reduce the species diversity of wetlands (Crewe and Timmermans, 2005).

Wetlands have faced destruction over the years and if true is not checked most may be completely degraded. The international community realized this outcry and the effects it would have on humans and, therefore, converged in Iran to come up with Ramsar Convention on wetlands of international importance (Ramsar, 2006). Ramsar Convention highlights major conservation measures to be undertaken to protect wetlands through identifying wetlands of international importance. Despite this treaty there has been continued destruction of the wetlands especially through encroachment by agricultural activities, human settlements and commercial activities. The effects are more in urban areas due to the rapid urbanization that was estimated at an annual growth rate of 1.6 % (UN, 2009). The continued urbanization has increased the ecological footprint of the major world cities far beyond their actual geographical sizes hence complicating their ability to maintain their wetlands. Dougan and Associates (2009) in their study on wetland integrity in the Credit River Watershed of Ontario Canada reported that land use and climate change, nutrient and contaminant loading and introduction of non-native stressors were the main stressors of the wetland integrity.

According to UN (2009), in many African countries including Uganda, South Africa, Congo, and Ghana. Wetlands have been drained for agricultural activities due to their fertile soils. In Ghana, increasing evidence indicates that the rate of environmental degradation has increased in recent times with previously rich forests being converted to savanna woodlands and existing savanna woodlands converted into near desert (Adupong, Nortey and Asiedu, 2013). It has been estimated that Ghana's high forest area of 8.2 million hectares at the turn of last century had dwindled to about 1.7 million hectares by the mid-1980s and about one million hectares by the mid-1990s (Adupong, *et al*, 2013).

Wetlands are among the most important ecosystems in Kenya and are vital for the achievement of Vision 2030 (Nyunja, Ochola, Pengra and Ochieng, 2012). The exploitation of wetlands for sustaining livelihoods compounded by climate change have drastically strained wetlands in Kenya. Article 10 (2) (d) of the 2010 Constitution of Kenya as well as the National Land Policy and the Draft Environment Policy of 2013 and the Environmental Management and Coordination Act of 1999 acknowledge the importance of conserving the environment and by extension wetlands. In addition, the National Wetlands Conservation and Management Policy of 2013 fulfills Kenya's obligations under the Ramsar Convention and provides the framework for tackling wetland threats. However, many wetlands in Kenya and by extension Eldoret have continued to experience an array of pressures and threats emanating from both the natural events and the anthropogenic activities as 80% of wetlands occur on lands that are privately or communally owned and without any serious conservation measures (Nyunja *et al*, 2012). Eldoret is experiencing rapid urbanization that does not resonate to

infrastructural development and environmental conservation. It is against this background that the researcher sought to find out impacts of land use activities on Marura wetlands in Eldoret.

1.2 Problem Statement

Anthropogenic activities around Marura wetland have had devastating impacts on its integrity and status leading to its degradation. A number of emerging land uses has penetrated the region adjacent to Marura wetland including housing developments, floriculture, aquaculture, and waste treatment plant and dam constructions. These developments have had diverse effects on previously flourishing ecosystem. Marura wetland has also been shrinking both in size and biodiversity richness (Njagi, 2005). The section of Marura wetland between Marura Bridge on Iten Road and Kaprobu in the North are the stretches facing a serious pull factors from all emerging environmental and planning realms. The stretch is characterized by a large Agricultural farm, uprising and fast growing residential on the West side and University with a growing population along the western banks of the Wetland. This has posed varied challenges and pressure to the swamp and it was, therefore, imperative that a study be conducted to analyze the socio-economic activities and their impact on the wellness and coexistence of this wetland to establish mechanisms that will abate these impacts.

Thus the study therefore set up to evaluate the effects of various land use activities on Marura wetlands so as to recommend various measures which need to be undertaken to ensure that Marura regains its place in the socioeconomic development of UasinGishu county and Kenya at large.

1.3 Overall objective of the Study

The overall objective of the study was to evaluate the impact of land use activities on marura wetland in Uasin Gishu Kenya.

1.4 Objectives of the Study

i. To establish the changes in land use activities around Marura wetland between 1985 and 2015.
ii. To determine the goods and services provided by Marura wetland to the local community.
iii. To document the anthropogenic activities along Marura wetlands
iv. To investigate the relationship between land use activities/anthropogenic activities and the integrity of Marura wetland.

1.5 Research Questions

i. How has land use activities around Marura wetland changed between 1985 and 2015?
ii. What goods and services does the local community get from Marura wetland?
iii. What are the anthropogenic activities along Marura wetlands?
iv. What is the relationship between land use activities/anthropogenic activities and the integrity of Marura wetland?

1.6 Justification of the Study

Sustainability and management of wetlands are fundamental as wetlands provide goods and services important for the socio-economic development of the local community. Degradation of the wetlands leads to declined basic human life-support systems of the biological environment with the inevitable consequence of all human land use.

Uncontrolled land use and other anthropogenic activities have been found by previous scholars to adversely affect the wetlands. However, no scholar has attempted to find out the changes in land use activities around Marura wetland and their progressive relationship with the degradation of the wetland. This study therefore is justified in looking at this changes so as to provide information to be used in coming up with management measures of land use activities on Marura wetlands so as to recommend interventions to salvage the wetland.

1.7 Significance of the Study

This study will be of importance to various stakeholders in Kenya in some ways or others:

Findings from this study will be of great significance to NEMA and the County Government of Uasin Gishu by proposing possible recommendations on the best possible solutions to the land use activities effects on wetlands. More so, findings from this study will significantly help households living along the wetland by proposing possible alternatives for them to avoid activities that cause land degradation.

The findings of this study will also be used by scholars who will use the knowledge as the basis for further study in the field.

1.8 Scope and Delimitation

v. This study was conducted between the months of April 2015 and Sep 2015 on the assessment of the impact of land use activities on Marura wetlands in Eldoret and its environs. The study took a cross sectional survey approach and targeted Marura wetland within Eldoret. The study area stretches between Koilel and Kaprobu Bridge along Eldoret- Ziwa road. The study area is specifically picked owing to its proximity

to University of Eldoret and deemed to experience more pressure from settlement, University, Equator flowers on the Eastern side and small scale farms down south on the swamp at Mti Moja and Kaprobu. The study was limited to four objectives; To establish the changes in land use activities around Marura wetland between 1985 and 2015; To determine the goods and services provided by Marura wetland to the local community. To document the anthropogenic activities along Marura wetlands and to investigate the relationship between land use activities/anthropogenic activities and the integrity of Marura wetland.

1.9 Limitation of this Study

The following are the limitations of this study

i) The study concentrated in Marura wetland within Eldoret town and its environs and did not study any other wetland not defined by the study scope.

ii) The study only dwelt on the assessment of the impacts of land use on wetlands.

CHAPTER TWO

LITERATURE REVIEW

2.1 Changes in Land Use Activities along Marura Wetlands between 1985 and 2015

Land use evaluation involves relating land mapping units to specified types of land use. The types of use considered are limited to those which appear to be relevant under general physical, economic and social conditions prevailing in an area. These kinds of land use serve as the subject of land evaluation. They may consist of major kinds of land use or land utilization types (FAO, 2015).

The geography of Kenya is diverse with a coastline on the Indian Ocean. The coastline contains swamps of East African mangroves, inland are broad plains and numerous hills while Central and Western Kenya is characterized by the Kenyan Rift Valley home to two of Africa's highest mountains, Mount Kenya, and Mount Elgon (Nyunja *et al*, 2012).The Kakamega Forest in western Kenya is arelic of an East African rainforest. Much larger is Mau Forest, the largest forest complex in East Africa 9.48% of the land is arable (Nyunja *et al*, 2012). Major kind of land use is a major subdivision of rural land use, such asrain-fedagriculture, irrigated agriculture, grassland, forestry, or recreation. Major kinds of land use are usually considered in land evaluation studies of a qualitative or reconnaissance nature.

A land utilization type is a kind of land use described or defined in a degree of detail greater than that of a major kind of land use. In detailed or quantitative land evaluation studies, the kinds of land use considered will usually consist of land utilization types. They are described with as much detail and precision as the purpose requires. Thus land

utilization types are not a categorical level in a classification of land use but refer to any defined use below the level of the major kind of land use.A land utilization typo consists of a set of technical specifications in a given physical, economic and social setting. This may be the current environment or a future betting modified by major land improvement e.g. drainage scheme. Attributes of land utilization types include data or assumptions on: Produce, including goods (e.g. crops, livestock timber), services (e.g. recreational facilities) or other benefits (e.g. wildlife conservation); Market orientation, including whether towards subsistence or commercial production; Capital intensity; Labour intensity; Power sources (e.g. man's labour, draught animals machinery using fuels); Technical knowledge and attitudes of land users; Technology employed (e.g. implements and machinery, livestock breeds, fertilizers, farm transport, methods of timber felling); Infrastructure requirements (e.g. sawmills, tat factories, agricultural advisory services); Size and configuration of land holdings, including whether consolidated or fragmented; Land tenure, the legal or customary manner in which rights to land are held, by individuals or groups; Income levels, expressed per capita, per unit of production (e.g. farm) or per unit area (Beek, 2009).

Management practices on different areas within one land utilization type are not necessarily the same. For example, the land utilization type may consist of mixed farming, with part of the land under arable use and part allocated to grazing. Such differences may arise from variation in the land, from the requirements of the management system, or both (FAO, 2015).

Some examples of land utilization types are: Rain-fed annual cropping based on groundnuts with subsistence maize, by smallholders with low capital resources, using farm implements, with high labour intensity, on freehold farms of 5-10ha; Farming in respect of production, capital, labour, power and technology, but farms of 200-500ha operated on a communal basis; Commercial wheat production on large freehold farms, with high capital and low labour intensity, and a high level of mechanization and inputs; Extensive cattle ranching, with medium levels of capital and labour intensity, with land held and central services operated by a governmental agency; Softwood plantations operated by a government Department of Forestry, with high capital intensity, low labour intensity, and advanced technology; A national park for recreation and tourism (Kostrowicki, 2011).

2.1.1 Remote sensing in land use and Land Cover

Remote sensing has been widely used in studies and activities related to land use. Muzein (2006) noted that this application especially the use of panchromatic, medium scale a rapid photograph in mapping land use has been accepted practice since the 1950s. Allan, (1990) added that this historical application stemmed from the development of the techniques for the purpose of military reconnaissance in 1915-1918. The technique has been used in assessing a rapidly changing agricultural area (Allan, 1990).

Muzein (2006) reported that the sequential serial photograph interpretation is potentially a powerful method of evaluating environmental change subject to satisfactory interpretation it can generate accurate land use statistic. Land use/ land cover (LULC) changes play a major role in the study of global change. Land use (LULC) and human

resulted in deforestation blood resting loss, global warming and increase in natural disaster flooding.

Therefore, available data on LULC changes can provide critical impact in decision asking of environmental management and planning the future (Turner, Spector, Gardiner, Fladeland, Sterling and Steininger, 2003). The growing population and increasing socio economic necessities creates a pressure or land use land core. This pressure results in unplanned and uncontrolled changes in LULC. The LULC alterations are generally caused by mismanagement of agricultural urban range and forest lands which led to severe environmental problems such as land slide floods etc (USGS, UNEP and UNOOSA. 2004).

Remote sensing and geographic information systems 9 GIS) are powerful tools to derive accurate and timely information on the spatial distribution of land use land use / land cover changes over large areas (Muzein, 2006). The aim of change detection process is to recognize LULC in digital process is to recognize LULC in digital images that change features of interest between two or more dates (Muzein, 2006).

2.2 The goods and services provided by wetlands to the local community

As a nation, the public, politicians andadministrators view land as a sovereign entity whose boundaries reflect a social, cultural and political identity.

To development agencies, land providesgoods and services required for people'swelfare and prosperity (Cityfarmer, 2015). Conservationist technically defined land as a fragile, ecological entity resulting from the mutual working of non living and livingthings on the

earth's surface. These perceptions roughlytranslate into different, and often competing, interests in land in Kenya. Some common features in the definitions indirectly suggest that land is an area of the earth’s surface embracing the biosphere, the atmosphere, and the lithosphere.

Wakhungu (2013) observed that wetland uses include cultural sites, fishing, forestry, energy. Of the total land cover, about 2.4% is under indigenous and exotic forests. About 12% of the land has high rainfall supporting the production of tea, coffee, pyrethrum, horticulture and floriculture, and food crops such as maize, wheat, potatoes, pulses, and dairy farming. The semi-arid area covering about 32% of total land has average rainfall and supports mixed crop and livestock rearing. Irrigated flower farming has in the recent past emerged as a major type of land use alongside agro-pastoralism. Over 50% of the total and cover is arid with lowland erratic rainfall (Mitsch *et al*, 2007). The expansive land was used for extensive livestock production under nomadic systems. Rivers are the largest source of hydropower upstream while the lower parts of the large rivers have made irrigated farming possible. The expansive savannahs and grasslands are home to livestock production and wildlife conservation. They are now major focus for innovations in dry land farming.

2.3 Anthropogenic Activities along Wetlands

Bushfires as natural phenomena are beneficial to both the biotic andabiotic component of ecosystems. However, indiscriminate and repeated anthropogenic bushfires impact negatively on such ecosystems, and, therefore, need to be checked. The high incidence of deliberately set bushfires in the Muni Pomadze wetland could be explained by the fact

that most of the human activities on the wetland required the use of fire as a short-cut to achieving the desired results (e.g. hunting and farming). Another reason for the rampant bushfiresis the inability of the fire setters to control the fires by using more efficient methods (e.g. creation of fire barriers). Often, the fire setters use less effective materials like tree branches and essentially abandon the fires to burn out of control (Afolayan, 2008).

Unfortunately, bushfire setters do not often take into consideration the direct (killing through burning) andindirect (exposing vulnerable animals to predationand clearing vegetation) destructive effects on wildlife (Keddy, 2010). They rather consider anthropogenic bushfires as beneficial in several ways: driving away dangerous animals like snakes, which shelter in dense vegetation, enhanced hunting efficiency in shortened grasses and attracting game animals after burning, destruction of unpalatable grassand stimulating the sprouting of new and more palatable grass for grazing mammals at the beginning of the wet season (Mitsch and Gosselink, 2000).

Because bush-meat prices tend to be higher than those of the traditional sources of protein (goat, sheep, poultry, etc.), and demand is high (Butchart, Dieme-Amting, Gitay, Raaymakers and Taylor, 2005). Commercial bush-meat hunting has been a major economic activity in the many wetlands, leading to an influx of migrant hunters from nearby settlements to hunt the already over-exploited bush-meat animals. The fewer numbers of older hunters could be a result of the current scarcity of economically-profitable game largely due to habitat destruction, which has tended to force them to retire early from the profession because of their inability to travel longer and longer

distances in search of bigger and economically more profitable game. Unfortunately, the younger hunters, being more prone to disregarding the need for sustainability of the hunting industry, resort to the use of illegal hunting methods (e.g. group hunting, setting bushfires, using chemical poisons, etc.) in flagrant disregard of Wildlife Conservation Regulations (Butchart, *et al*, 2005).

Widespread rural poverty, illiteracy, and hunger have compelled rural populations to exploit natural resources unsustainably for survival (Keddy, 2010). Such populations simply could ill-afford to preserve wildlife for purely aesthetic, cultural or educational reasons. This appears to be the case with the inhabitants of the study area that could only be expected to appreciate wildlife through education and awareness programs, which stress the importance of biodiversity conservation and its role in ultimately increasing food supply.

Fuel wood provides the main energy source for both rural and urban households throughout Africa, with estimates of about 50% of total energy consumption (Thomas, Kariuki, Magero, and Schenk, 2016). Fuel wood plays an important role in human activities like fish smoking and charcoal production. It is apparent that overexploitation of fuel wood has resulted in a reduction in size of fuel wood harvested, and the use of less-preferred materials. The situation has assumed such alarming proportions that even a tree species like *Milletia spp*., which was, previously left intact, because of its soil fertility rejuvenating qualities, is now being harvested for fuel wood (Thomas, *et al*, 2016).

TEEB, (2010) concluded that there is a large proportion of the population who do not consider farming activities as threats to biodiversity and environment, as well as a lack of awareness of the direct (source of meat, medicine, etc.) and indirect (pollinators, seed dispersers, etc.) uses of biodiversity to human populations. They prefer a rather low priority given to wildlife or environmental awareness among the wetland community. It appears that farming is undertaken without due consideration to sustainable land use practices. Large tracts of land are cleared for farming and infrastructural development at the expense of valuable wildlife habitat (Thomas, *et al*, 2016). The important roles of wildlife in the ecosystem food web as pollinators, predators, seed dispersers or prey species of other animals does not seem to be appreciated by a majority of the local people. An appreciation of such indirect values of wildlife is important to prevent destruction of wildlife habitat through farming and other human activities (Keddy, 2010).

2.4 Relationship between land use/anthropogenic activities and integrity of wetlands

The three primary inventory techniques currently used to map wetland ecosystems are onsite evaluations, aerial photo interpretation, and digital image processing. Methods of wetland delineation require presence of three parameters hydric soils, wetlands hydrology and hydrophytic vegetation (Baker *et al.,* 2006).

For scientific purposes and as a means of evaluating methods of delineating wetland boundaries the NRC, (1995) defines wetlands as an ecosystem that depends on constant or recurrent shallow inundation or saturation at or near the surface of the substrate. According to Ramsar, Wetlands are among the most diverse and productive ecosystems.

They provide essential services and supply all our fresh water. However, they continue to be degraded and converted to other uses.

The Convention uses a broad definition of wetlands. It includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peat lands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical and biological features reflective of recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils, and hydrophytic vegetation. These features will be present except where specific physicochemical, biotic or anthropogenic factors have removed them or prevented their development (NRC, 1995).

Accurate wetland mapping is an important tool for understanding wetland function and monitoring wetland response to natural and anthropogenic actions. Wetlands are often damaged or overwhelmed through increased surface flows in urban or suburban areas with high densities of impervious surfaces. Wetland mapping is used to evaluate land use decisions and monitor the effectiveness of mitigation efforts. Landscape scale mapping of these scarce habitats facilitates understanding of floral and faunal population dynamics (Semilitsch & Bodie, 2008).

The susceptibility of wetlands to human activities and human dependence on the ecological contributions of wetlands illustrate the importance of mapping wetlands

resources. Furthermore, establishing the role of wetlands in increasingly urban landscape requires an understanding of wetland density and distribution. Wetlands and riparian zones provide a variety of ecological services that contribute to ecosystem functions at local, watershed and regional scales. The shape, size and distribution of wetland and riparian zones are largely determined by geologic, topography and hydrologic conditions. The ecological contributions of wetlands and riparian zones, if factored into land value, suggest that these ecosystems are more economically and ecologically valuable than most other land cover types. Therefore, there is need to regulate utilization/exploitation levels of wetlands to balance the livelihoods aspect and sustainable management of urban wetlands (Mitsch & Gosselink, 2000).

Land use mapping is the process of assessing land for the specific kinds of use. The basic feature of the process is the comparison of the requirements of land use with the resources offered by the land. Fundamental to the assessment process, is the fact that different kinds of use have differing requirements. Land suitability mapping requires information from three main sources: land, land-use and socio-economics. This is because considerations of economic, social consequences for the people concerned and consequences beneficial or adverse for the environment have to be taken into account. Successful land assessment is a necessarily multi-disciplinary process and therefore, the use of a standardized framework is essential to ensure logical, and quantitative analysis of the suitability of the land for a wide range of possible land uses (Dent and Young 2011).

Suitability mapping does not involve the determination of land use changes or proposals but rather provides information on which decisions on land use interventions can be made

(Dent *et al*, 2011). To be useful in this role, the products of suitability mapping should provide information on two or more potential alternatives for use for each area of land including the consequences, beneficial and/or adverse of each.

According to Lam (2008), the basic principles that are fundamental to the methods used in land use mapping are: Land suitability is assessed and classified with respect to specified kinds of use. This principle gives recognition to the fact that different land uses have different requirements. The concept of land suitability is only meaningful in terms of specific kinds of land use, each with their own requirements, e.g. for soil moisture and rooting depth among others. The qualities of each type of land, such as moisture availability or liability to flooding, are compared with the requirements of each use. Thus, the land itself and the land use are equally fundamental to land suitability assessment. Assessment requires a comparison of the benefits obtained and the inputs needed on different types of land. Suitability for each use is assessed by comparing the required inputs, such as labour, fertilizers or road construction, with the goods produced or other benefits obtained.

A multidisciplinary approach is required. The process requires contributions from the fields of natural science, appropriate land use technologies, economics and sociology. In particular, suitability assessment always incorporates economic considerations to a greater or lesser extent (Lam, 2008). The comparison of benefits and inputs in economic terms plays a major part in the determination of suitability.

Evaluation is made in terms relevant to the physical, economic and social context of the area concerned. The assumptions underlying suitability evaluation differ from one country to another and, to some extent, between different areas of the same country. Many of these factors are often implicitly assumed; to avoid misunderstanding and to assist in comparisons between different areas, such assumptions should be explicitly stated (Anderson, 2017).

Suitability refers to use on a sustained basis (Miller, *et al,* 2006). The aspect of environmental degradation is taken into account when assessing suitability. There might, for example, be forms of land use which appear to be highly profitable in the short run but are likely to lead to soil erosion, progressive pasturedegradation, or adverse changes in river regimes downstream. Such consequences would outweigh the short-term profitability and hence such land is classified as not suitable for such purposes. Suitability assessment involves comparison of more than a single kind of use (Miller, *et al*, 2006). This comparison could be, for example, between agriculture and forestry, between two or more different farming systems, or between individual crops. Often it includes comparing the existing uses with possible changes, either to new kinds of use or modifications to the existing uses.

Wetlands form as a result of certain hydrologic conditions which cause the water table to saturate or inundate the soil for a certain amount of time each year (Mitsch *et al*, 2000). The frequent or prolonged presence of water at or near the soil (hydrology) is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands can be identified by

the presence of those plants (hydrophytes) that are adapted to life in the soils that form under flooded or saturated conditions (hydric soils) characteristic of all wetlands. Thus alteration of wetland hydrology can change the soil chemistry and the plant and animal community. Alteration which reduces or increases the natural amount of water entering a wetland or the period of saturation and inundation can, in time, cause the ecosystem to change to an upland system or, conversely, to a riverine or lacustrine system. This alteration can be natural, such as through the succession process of stream impoundment by beavers or climate change (Mitsch *et al*, 2000).

Wetland loss and degradation through hydrologic alteration by man has occurred historically through such actions as: drainage, dredging, stream channelization, ditching, levees, deposition of fill material, stream diversion, ground water withdrawal, and impoundment (Miller, *et al*, 2006).

Roads and bridges are frequently constructed across wetlands since wetlands have low land value. It is often considered to be more cost effective to build roads or bridges across wetlands than around them. Roads can impound a wetland, even if culverts are used. Such inadvertent impoundment and hydrologic alteration can change the functions of the wetland (Winter, 2008). Road and bridge construction activities can increase sediment loading to wetlands. Roads can also disrupt habitat continuity, driving out more sensitive, interior species, and providing habitat for harder opportunistic edge and non-native species. Roads can impede movement of certain species or result in increased mortality for animals crossing them. Borrow pits (used to provide fill for road construction) that are

adjacent to wetlands can degrade water quality through sedimentation and increase turbidity in the wetland (Winter 2008).

The maintenance and use of roads contribute many chemicals into the surrounding wetlands. Rock salt used for deicing roads can damage or kill vegetation and aquatic life. Herbicides, soil stabilizers, and dust palliatives used along roadways can damage wetland plants and the chemicals may concentrate in aquatic life or cause mortality. Runoff from bridges can increase loadings of hydrocarbons, heavy metals, toxic substances, and deicing chemicals directly into wetlands. Bridge maintenance may contribute lead, rust (iron), and the chemicals from paint, solvents, abrasives, and cleaners directly into wetlands below (TEEB, 2010).

Sanitary Landfills can also pose an ecological risk to wetlands. Landfill construction may alter the hydrology of nearby wetlands. Leachate from solid waste landfills often has high biological oxygen demand, and ammonium, iron, and manganese in concentrations that are toxic to plant and animal life. Sanitary landfills may receive household hazardous waste and some hazardous waste from small quantity operators, as well as sewage sludge and industrial waste (Anderson, 2017). Although regulated, these facilities may not always be properly located, designed, or managed, in which case some surface water contamination may occur. Researchers who conducted a study of the proximity of 1,153 sanitary landfills to wetlands in 11 states, found that 98 percent of the sanitary landfills were 1 mile or less from a wetland, and 72 percent were 1/4 mile or less from a wetland (Anderson, 2017).

Adverse effects of industry on wetlands can include: reduction of wetland acreage, alteration of wetland hydrology due to industrial water intake and discharge, water temperature increases, point and nonpoint source pollutant inputs, pH changes as a result of discharges, and atmospheric deposition (Zedler, *et al*, 2005). Saline water discharges, hydrocarbon contamination, and radionuclide accumulation from oil and gas production can significantly degrade coastal wetlands. Most petroleum hydrocarbon inputs into coastal wetlands are either from coastal oil industry activities, from oil spills at sea, from runoff, or from upstream releases. Oil can alter reproduction, growth, and behavior of wetland organisms, and can result in mortality. Plants suffocate when oil blocks their stomata.

Polynuclear aromatic hydrocarbons (PAHs) are extremely toxic compounds that can enter estuarine wetlands through industrial effluent and atmospheric deposition (Zedler, *et al*, 2005). PAHs concentrate in sediments and thus contaminate benthic organisms. Fish contaminated with PAHs exhibit external abnormalities, such as fin loss and dermal lesions.

Wetlands provide critical habitat for waterfowl populations. The drainage of U.S. and Canadian prairie potholes for agricultural production has been linked to a concomitant 50% - 80% decline in waterfowl populations since 1955 (TEEB, 2010). Since the Swamp buster legislation was promulgated, the waterfowl population has begun to increase. Swamp buster rendered drainage of prairie potholes costly and encouraged farmers to allow prior converted wetlands to revert to their previous natural wetland state and to construct farm ponds or restore marshes. Duck populations in 1994 increased by 24%

over 1993 populations, and were the highest since 1980, when duck populations had plunged to a low (TEEB, 2010).

Grazing livestock can degrade wetlands that they use as a food and water source. Urea and manure can result in high nutrient inputs. Cattle traffic may cause dens and tunnels to collapse. Overgrazing of riparian areas by livestock reduces streamside vegetation, preventing runoff filtration, increasing stream temperatures, and eliminating food and cover for fish and wildlife. As vegetation is reduced, stream banks can be destroyed by sloughing and erosion. Stream bank destabilization and erosion then cause downstream sedimentation. Sedimentation reduces stream and lake capacity, resulting in decreased water supply, irrigation water, flood control, hydropower production, water quality, and impairment of aquatic life and wetland habitat (Mitsch *et al,* 2000).

The major cause of wetland loss around the world continues to be conversion to agricultural use. When wetlands are converted to agricultural land, large quantities of CO_2 (carbon) and N_2O (nitrous oxide) are released. Land use therefore plays a major role in climate change at global, regional and local scales. The combination of climate and land use changes may have profound effects on habitability of the planet in more significant ways than either acting alone and are likely to affect natural ecosystems in complex ways. While land use change is often a driver of environmental and climatic changes, a changing climate can in turn affect land use and land cover. Climate variability alters land use practices differently in different parts of the world, highlighting differences in societal vulnerability and resilience (Mitch *et al,* 2000).

Many wetland losses, the world over, are direct result of economic activities engaged in by man. These activities range from agriculture, construction, water diversion and a host of others. It is estimated that around 5 percent of agricultural land globally is irrigated, with South Asia (35%), Southeast Asia (15%) and East Asia (7%) showing a high dependency on irrigation. China and India have 39 percent of the global irrigated areaand Western Europe and United States have 13 percent, while sub-Saharan Africa and Oceania have less than 1 percent of their agricultural land irrigated (Pilot, 2000). Irrigation accounts for approximately 70 % of the water withdrawn from freshwater systems for human use. Only 30 –60 % is subsequently used downstream, making irrigation the largest net user of freshwater. Estimates alsoshow that the share of cropland that is irrigated has grown by 72 % from 1996. (Reid *et al,* 2005) reported that the degradation and loss of inland wetlands and species hasbeen driven by infrastructure development (such as dams, dykes, and levees), land conversion, water withdrawals,pollution, overharvesting, and the introduction of invasive alien species.

While there had been studies on wetland loss in places such Louisiana, USA, one cannot categorically say that such studies had been conducted on wetland loss in Lagos Metropolis however all the factors contributing to wetland losses are highly noticeable in the metropolis. In USA, Wetland losses in the lower Mississippi delta have been the subject of intensive investigations ever since the magnitude of wetland loss problem and its potential economic and social impacts were first recognized (Reid *et al,* 2005).

Literally hundreds of reports have been written about the complex physical and biogeochemical processes and their interdependencies that are responsible for wetland

loss. Despite the multitude of prior studies, there still are controversies and unanswered questions regarding the primary importance of natural versus induced environmental changes that have caused the most recent dramatic losses inwetlands. The primary causes of wetland loss in Lagos Metropolis could be identified with perennial flooding usually associated with the release of water from dams along the course of Ogun/Osun Rivers and Benin/Owena Rivers; the two river basins that drain the whole South-Western landscape (Adupong, *et al*, 2013).

Degradation of coastal wetlands through land development and water management reduces the capacity of wetlands to provide significant ecosystem services that reduce the risks of living and working in coastal landscapes. Human activities intended to reduce damage to life and properties from climate extremes have unintentionally increased the vulnerability of coastal areas to climate change by altering the natural hydrologic functions of wetlands. Disturbances that directly change the structure of wetlands can be so severe that the wetland is destroyed. Fillingor draining a wetland can so alter the water regime that the land can no longer support the wetland vegetation and maintain hydric soils (Bierkens and van Beek, 2009).

Water withdrawals for irrigation in some cases can act to exacerbate the effects of other stressors on the wetlandecosystems, resulting in effects that exceed those that would be expected from dewatering alone (Bierkens *et al*, 2009). One of these stresses is the increasing pollution of the lake by organic materials. This, inconjunction with dewatering for irrigation, has resulted in the increasing eutrophication of the lake and changes inthe aquatic biota toward an assemblage more characteristic of nutrient rich systems. Wildlife

responses to theimplementation of irrigation schemes can, in turn, result in stress to wetlands. Water withdrawal was alsoidentified as a source of stress around Lake Kus. There is no known mechanically operated irrigation activity pastor present in Lagos Metropolis. The major pressure is wetland reclamation and conversion to developmentpurposes.

Watering of rivers result in the loss of prime grazing habitat for wildlife (Adupong, *et al*, 2013). Populations of some ungulates such as reedbuck and kob have been lost or severely reduced. Elephants have been displaced from their traditional areas, resulting in damage to wetland habitats and more frequent interactions with humans. Zedler, et al, (2005) identifies the direct effects of livestock grazing on wetland ecosystem to include: Consumption of plant biomass; Trampling of plants, including below-ground parts and soil; Nutrient inputs and bacterial contamination from dung and urine; Introduction and dispersal of seeds and other propagates.

In the same vein, Ndungu (2013), in a study conducted In Nairobi River in Kenya, points out that drainage and other forms of disturbance associated with agriculture are the main contributors to wetland loss. Crewe and Timmermans, (2005) state that globally, wetlands have drained, primarily for agriculture and food production. Wetlands are exploited more during the dry months. Households take advantage of the wetlands' moist conditions to grow a variety of vegetables and root crops for sale or for own consumption. These wetland ecosystems provide many tangible and intangible benefits on a sustainable basis not only to the urban society but also to the associated dependent ecosystems. Wetland areas on the fringes of river channels in a city are looked upon as a

precious property resource with different potential land uses such as agriculture, site for human settlements, industries, civic construction and waste dumping sites, to mention just a few. All the literature sited above shows that economic activities such as grazing and draining wetlands for agricultural purposes have great effect on wetland ecosystems. Kenyan wetlands have been variously affected by conversion to developmental uses such as residential and commercial purposes.

2.5 Knowledge Gap

An analysis of above literature indicates that previous scholars have carried out studies on various aspects of land use and anthropogenic activities and their effects on wetland across the world. Njagi (2005) carried out a study on the effects of land use activities on Chepkoilel River. However, previous studies have not been able to establish the relationship between land use/anthropogenic activities and integrity of wetlands and that is why this study will seek to fill this gap by establishing the goods and services from Marura wetlands and then evaluate the various land use/anthropogenic activities along Marura wetlands and how they have changed in the last 30 years.

2.6 Theoretical framework

The study modified Tragedy of the Commons theory to suit this study. Since the theory started in 1968 by Garrett Hardin,it has been used in attempt to explain disasters such as deforestation, overexploitation of fisheries resources, soil erosion, wetland resources and overgrazing of rangelands (Hardin 1968). According to the model, for a tragedy to occur, three conditions must be fulfilled. Firstly the resource must be owned in common by a group of people (common property and must be open to any user (open access)). Secondly, the user must be selfish. Individuals pose self-interest as opposed to collective

good and thirdly the resource must be used so intensively that the rate of exploitation exceeds the natural rate of replenishment of the resource (Hardin 1968). According to Hardin's model, such resources held in common are doom to over-exploitation since each resource use places immediate self-interest above community interest. This way, the model makes a critical assumption that resource users are individualistic and unable to cooperate towards the greater community interest. Thus, they eventually become both villain and victims of resource depletion.

Lloyd(1968) identified the problem of "externalities" people are unlikely to retain their behavior when the immediate benefits of their actions are theirs but the costs are passed onto society as a whole or others, and any benefit that may occur from an individual's effort to conserve are indiscernible". The tragedy of the commons proposes the freedom in the utilization of a common property resources results in a tragedy that brings ruin to all as each's consequences of overexploiting the resources. The theory is concerned with the utilization of common property resource and its depletion over time in which those involved know that a disaster is coming but are unable to do anything about it (Arnold, 1998). Marura is a common resource and, therefore, common property regime is inimical to the sustainable management of resources as it leads to overuse of the resources.

In these illustrations, degradation can be achieved by studying the anthropogenic activities within the study site and the change in spatial extent of the swamp by using satellite images. This is arrived at based on Hardin's study on 'tragedy of the commons'- that humans deplete commonly shared resources faster than individually or privately managed resources. This is also affected by some factors called the intervening factors

which are the prime causes of swamp size decrease or increase. The will be a future prediction on swamp size and provide a mitigation measures based on observation and findings from the research to enhance environmental sustainability of the swamp.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Research Design

The study employed a cross-sectional research design. According to Cooper and Schindler (2008), cross-sectional study (also known as a cross-sectional analysis, transversal study, prevalence study) is a type of observational study that involves the analysis of data collected from a population, or a representative subset, at one specific point in time. This was an appropriate research design for this study as it aims at producing accurate information desired to be collected at that particular time.

The use of cross sectional research design was employed on data collected from the users of the Wetlands. The Wetlands key users data was collected using questionnaires and then the data for each group at a specific time (2015) after which analysis was done for the representative groups.

3.2 Target Population

According to Mugenda (1999), target population is a population to which a researcher would like to generalize the result of the study. The population for the study was drawn from the population living within the catchment of the swamp area, which covers 210 km^2. This included residents engaging in various activities within the swamp. It also targeted key informants made up of the Uasin Gishu County executive in charge of the Ministry of Environment, water and natural resources representative from NEMA. In total, the target population for this study was 21, 831 as per population census of 2009.

3.3 Sample Size and Sampling Technique

The sample sizes were obtained using Yamane's formulae;

$$n = \frac{N}{[1 + Ne^2]}$$

$$n = [1 + Ne^2]$$

Source: *Yamane (1967)*

Where n= Sample size, N=Population size, E=Sampling error (usually 0.10), ***N***- were obtained from Central Bureau of statistics 2010 records.

Table 3.1: Sample size calculation

Location	**Population Size (Number of Households)**	**Sample size using Yamane's Formula**
Upper zone		$n=N/(1+Ne^2)$
Kaptagat	2227	$n=(5443/1+5443\times0.1^2)$
Tembelio	1282	n=5443/55.43=98.195
Mid Zone		98.195
Elgeyo Border	855	
Sergoit	1079	
Total	5443	
Lower Zone		
Chepkoilel/Kimumu/Chepkoilel	10945	$n=10945/(1+10945\times0.1^2)$ n=10945/110.45=99.09 n=99.09
Total Population		197.85 ≈ 198 Respondents

Source: *Author,* 2018

The study adopted purposeful sampling method to select the CEC in charge of Environment, Water and natural resources and one NEMA official. Stratified random sampling was used to sample out all the 198 households living along the wetland. The total sample size was therefore was 200 respondents. The study area was purposefully stratified depending on the type and intensity of human activity along the wetland.

3.4 Data Collection

3.4.1 Household data collection

As a method of data collection, structured questionnaires involve asking rather than observing the respondents. The use of questionnaires enabled the interviewee to gather data over a large sample spread within the wetland. The researcher developed structured questionnaires to gather information form the local community on the products and services they receive from Marura wetland as well as their use of the land along Marura wetland.

The questionnaire asked the key questions on wetland change over last 30 years if there were any observable changes, the attitudes of the respondents, the main anthropogenic activities in the wetlands their impacts and relationships of anthropogenic activities to swamp size.

3.4.2 Land use data collection

A geographic information system (GIS) is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. The research used GIS monitoring to gather data on the effect of land use mapping on wetlands. This requires the mapping of all the major land uses adjacent to Marura

wetland. Changes in land use data was obtained from classification of satellite images from 1985 to 2015.

The images were obtained from Landsat satellite images Image courtesy of the U.S. Geological Survey covering path 169 row 069. The images were obtained for the Months of January from 2015 with a span of 10 years. January images were also selected due to low cloud in the atmosphere- less than 10% cover. The images were analyzed to find out the land use changes per pixel with the output being a raster re-class of images showing land use change between a period of 10 years and a final image showing input of the last 10 years.

The second data set was land use types collected for purposes image classification for the current land use and land cover types along Marura wetland. The Google earth image was downloaded and using features with known coordinates, the image was geo-referenced. A combination of visual image interpretation techniques and field work was used to delineate all the major land uses around the wetland.

The images were then processed using multivariate analysis unsupervised classification tool to create four land use types that included Wetland, Agricultural Farm, Grasslands and Settlement. The unsupervised classified image was then reclassified using raster reclass to control outliers and unfit land uses. The reclassified image was then exported to ERDAS imagine 2014 to create land use change images. Zonal change, image difference tool was used to compute the image difference between 10 years. The difference between

1985 and 1995, 1995 and 2006, 2006 and 2015 were computed. A final range of difference was computed between 2005 and 1985.

The area of the land uses was calculated based on number of pixels per count. This was based on the images metadata indicating the size of the scene was 30 by 30 m for each pixel. The total pixels indicating a particular scene were then multiplied by area of one pixel.

3.5 Data Analysis

Land use types were obtained through visual image interpretation. After identifying representative land use types in the field by comparing and marking the georeferenced image with ground data,major land use/ land cover types were identified through visual inspection and representative types were picked with a minimum of 6 sampling points and coordinates read for each of the sites. For each land use, ArcGIS software was used to delineate the image into appropriate land use types using multivariate analysis unsupervised classification tool to generate a map showing this land covers types.

The images prepared by using ArcGis were grounds filled with voids. A combination of band 4, 3, 2 on Landsat MSS, TM, TM+ and ETM for ETM+ obtained and captured by Landsat 8 the band 5, 4, 3 were used in preparation of a false colour image. This is because band 5 in Landsat 8 is the NIR band while Band 1 is ocean coastline sensor. The images were then clipped on the area of study. The clipping were done after creation of colour composite for all the years.

Collected data was tabulated and analyzed for descriptive statistics with the help of SPSS version 20 for windows was used to analyze qualitative data obtained from questionnaires in the field including regression analysis and correlational analysis and GIS. The collected data was however analyzed separately as the data was collected using different instruments for each objective. The means and mean percentages were determined to help make valid conclusions and probable recommendations. The analyzed data was presented in tables, charts, graphs and narratives

3.6 Ethical Considerations

Data collection is a sensitive issue as it borders on invading people's private lives, ethical consideration are therefore of paramount importance in research (China and Oteng'i, 2007). Clearance to collect data was obtained from the Ministry of education, University of Eldoret and Uasin Gishu County.

CHAPTER FOUR

RESULTS

4.1 Introduction

The study presents the findings on the background of the respondents in terms of age gender, marital status, education level primary occupation, income level; period lived in Marura and size of land.

4.2 Geographical Description of the research Area

The Marura wetland in Eldoret is a major wetland running South - North a few kilometers North of Eldoret. It is a permanent, riverine wetland with a high length to width ratio, about 10 km long and about 700 m wide at the widest point. The wetland sits in a shallow trough-like valley that lies at an elevation between 2110m and 2140m above sea level. Marura wetland covers a total area of 18 km in length rising from 2340 m above mean sea level at Kaptagat forest on GPS location $35^0$45"8' E $0^0$52" 8' N to South East to 1408 m Above Mean sea Level at the end of the swamp North at GPS location $35^0$05"9 'E and $0^0$63" 2' N.

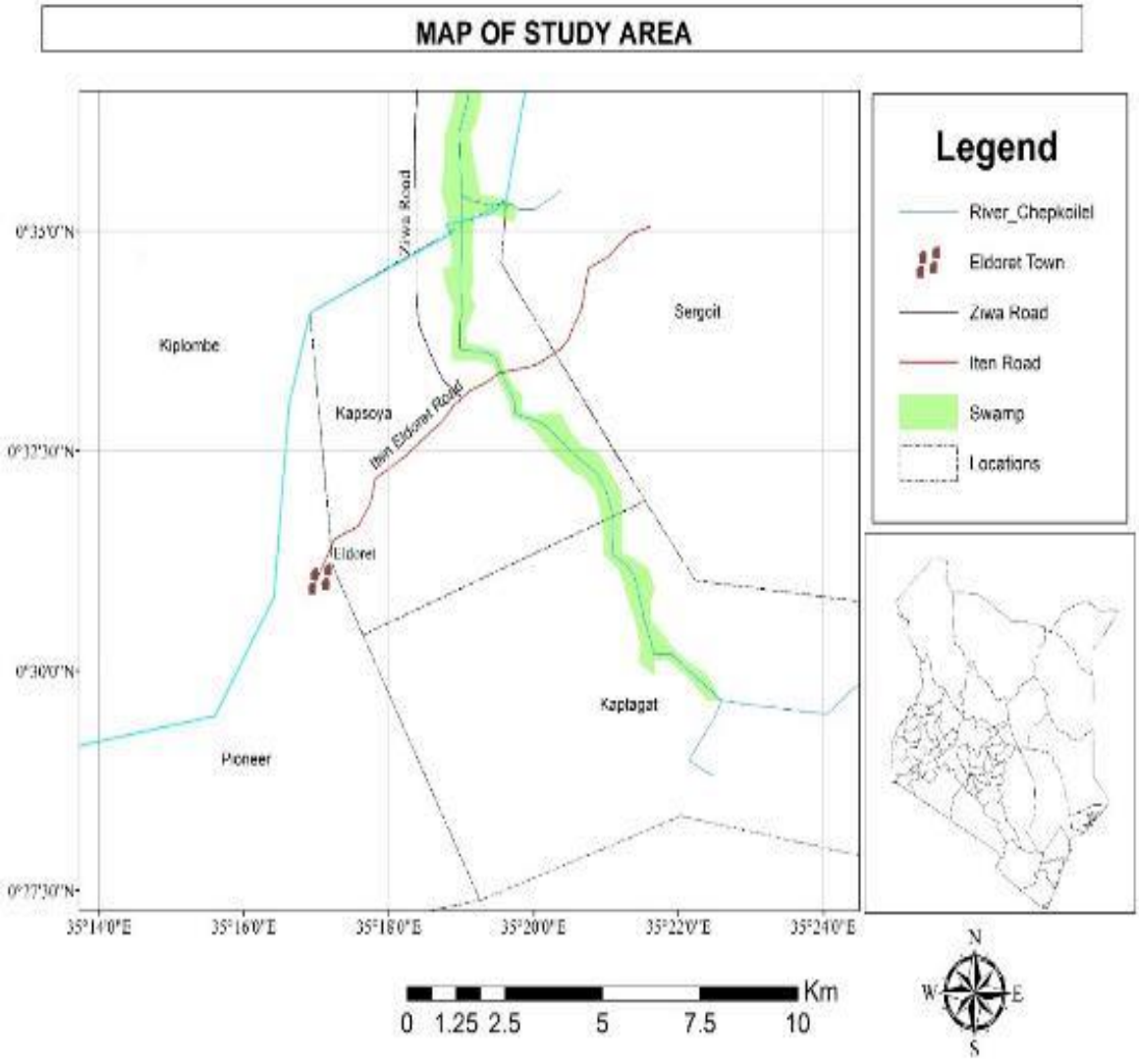


Figure 4.1: Map of study area

Source: *Google Maps* (2018)

4.3 Age of the Respondents

The study of the respondents and presented the findings as shown on Figure 4.1

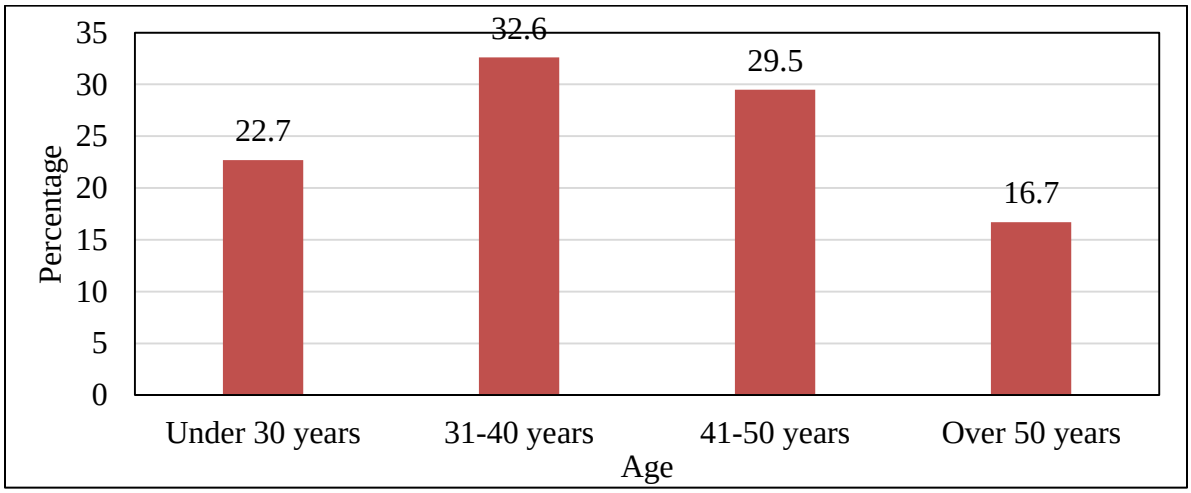


Figure 4.2: Age of the Respondents

Source*: Author's Data, (2018)*

The study indicates that 43 (22.7%) were under 30 years, 62 (32.6%) were aged between 31-40 years, 56 (29.5%) were aged between 41-50 years while 32 (16.7%) were aged over 50 years. Majority of the respondents were aged between 31-40 years. The purpose of establishing the ages was to ensure that the study collects information from respondents of diverse ages to satisfy the quality of the study.

4.4 Gender of the Respondents

There were 82(62.5%) male respondents and 50(37.5%) female respondents. The purpose of checking the gender of the respondents was to ensure that there was no bias in terms of gender on the information given.

4.5 Marital Status of the Respondents

The informants interviewed 169 (87.5%) were married, 21 (10.7%) were single while three where widowed. There were no divorced or others in this category. Majority of the respondents were married. The reasons for the marital status were to establish balance in information needed for the study in terms of marital status.

4.6 Education Level of the Respondents

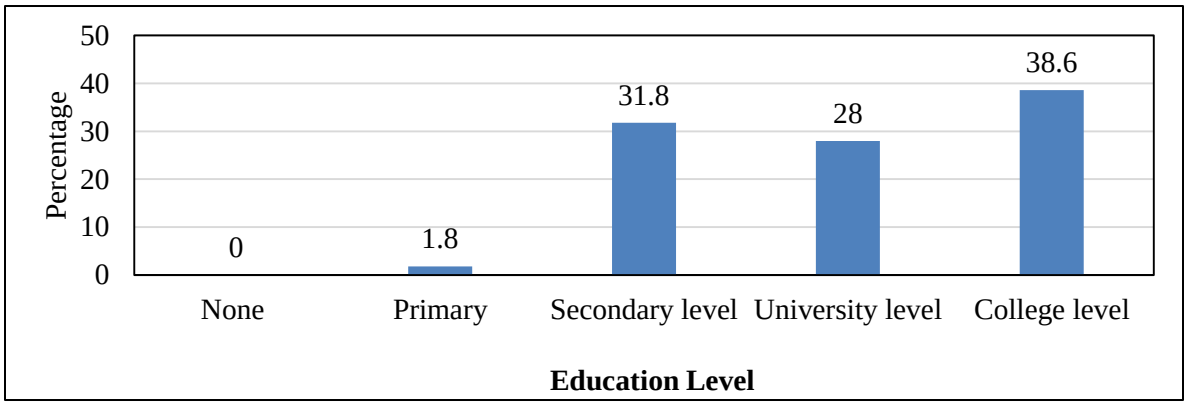


Figure 4.3: Level of education of the Respondents

Source*: Author's Data, (2018)*

There were no respondents who had not gone to school. Three (1.8%) had attained primary level, 61 (31.8%) secondary level, 54 (28%) were of the respondents were of university level while75 (38.6%) of the respondents were of college. Majority of the respondents were of college level of education. It was important to establish the academic qualifications of the respondents to achieve the quality and the validity of the study.

4.7 Occupation of the Respondents

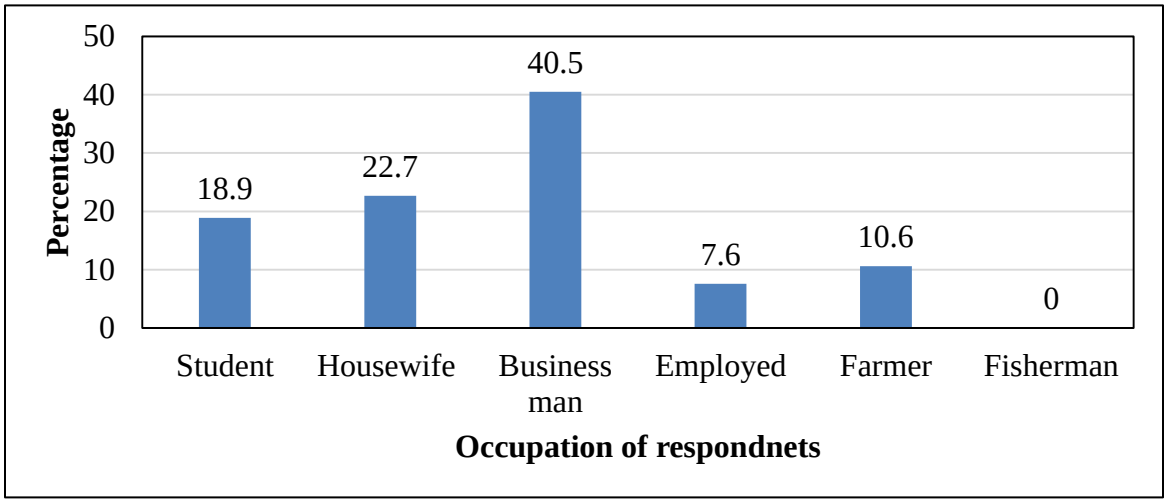


Figure 4.4: Occupation of the Respondents in study area

Source*: Author's Data, (2018)*

The study shows 36 (18.9%) of the respondents were students, 44 (22.7%) of the respondents were housewives, 78 (40.5%) of the respondents were businesspersons, 15 (7.6%) were employed while 20 (10.6%) were farmers. There were no fishermen. Majority of the respondents had experiences of between 4-7 years. The purpose of determining the occupation of the respondents was to ensure that the study collects information from different respondents with different occupation. This was to ensure there is no bias in terms of occupation.

4.8 Average Monthly Income of the Respondents

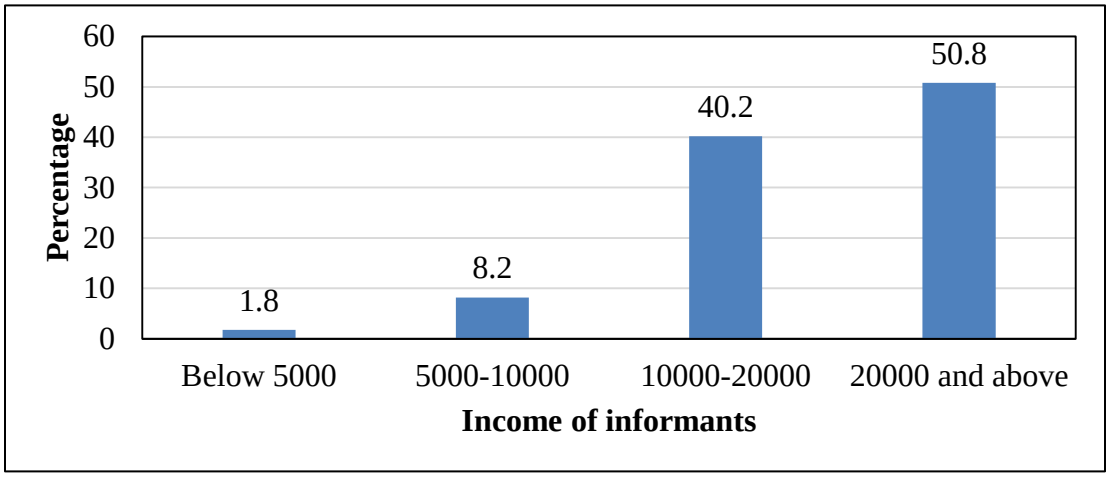


Figure 4.5: Income of the Respondents in Marura swamp

Source*: Author's Data, (2018)*

The study shows that three (1.8%) earned incomes of below 5,000, 16 (8.2%) earned income of 5,000-10,000 shillings, 78 (40.2%) earned incomes of 10,000-20,000 while 96 (50.8%) earned incomes of 20,000 and above. Majority of the respondents earned income of 20,000 and above. The study collected data about income of the respondents so as to establish the extent to which the residents along Marura wetland benefited economically from the wetland apart from their normal salary.

4.9 Length of Stay in the Study Area

From the study, 78 (40.2%) had lived there for a period below 5 years, 73 (37.9%) had been there for 6-10 years, 34 (17.4%) had lived there for between 11-20 years, 8 (5.5%) had lived in Marura for between 21-30 years while there were no respondents who had lived there for above 30 years. Majority of the respondents had lived in Marura for below 5 years. The purpose of determining the period the respondents have lived in Marura was

to ensure that the study collects information from different informants on the duration of their stay in the area; this was to ensure there is no bias in terms of period of living.

4.10 Size of Land owned by respondents in Marura

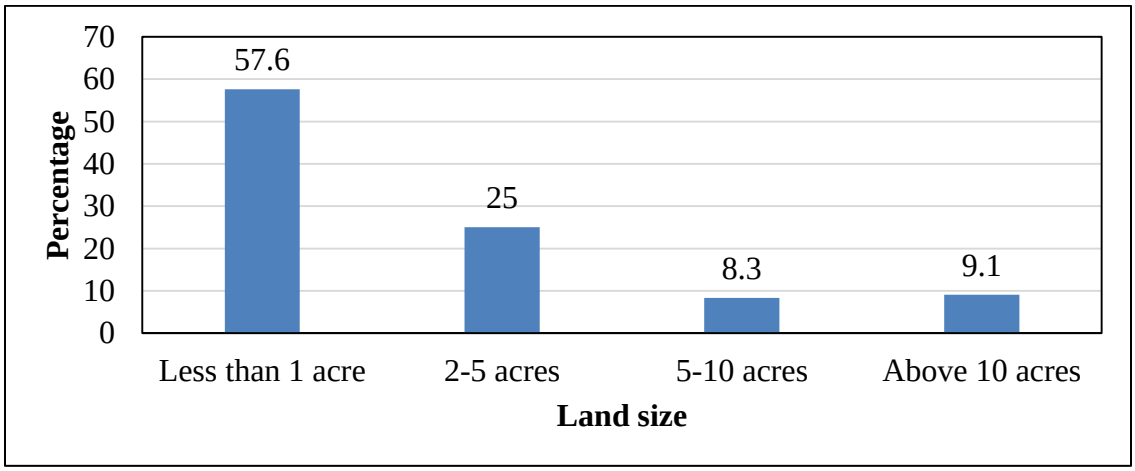


Figure 4.6: Size of Land owned by respondents in Marura

Source*: Author's Data, (2018)*

Survey findings indicate that 111 (57.6%) had less than one acre, 48 (25%) had 2-5 acres, 16 (8.3%) had 5-10 acres while 18 (9.1%) had above 10 acres. It was important to assess the sizes of land of the respondents so as to get a clear view of the land use in the area to enrich the study.

4.11 Membership in a Conservation Group

Seventy-five (39.1%) respondents reported that they belonged to conservation group while 118 (62.9%) did not belong to any group. Majority of the respondents did not belong to any conservation group. This could be as a result of fewer conservation groups

in the region with most of them that currently exist being inactive and sleeping on job resulting to people not willing to join them.

4.12 Goods Obtained from Marura Wetlands

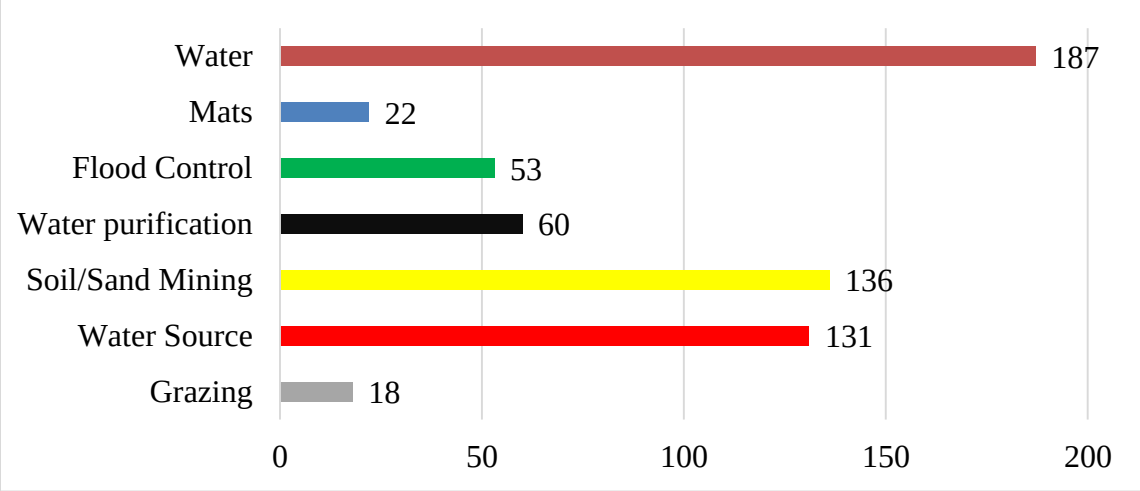


Figure 4.7: Goods Obtained from Marura Wetlands

Source*: Author's Data, (2018)*

The findings show that water is the most essential good the local community obtain from Marura wetland at 97%. The locals also get papyrus reeds (70.5%), bricks (68.2%), brooms (31.1%), firewood (27.3%) and fewer medicines from the wetlands (9.1%).

4.12 Perceived importance of Marura Wetland

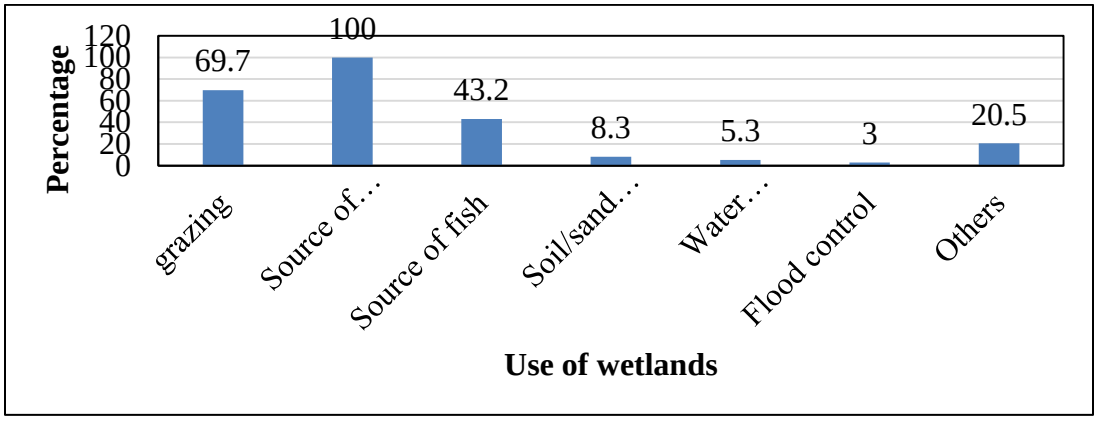


Figure 4.8: Perceived Importance of Marura Wetland

Source*: Author's Data, (2018)*

The study indicates that 193 (100%) of the respondents were of the opinion that the most important aspect of the wetlands in the community is that it is the water source. This could be because of the fact that most communities living near wetlands depend on them for water source and also water their animals from the wetland. The researcher sought to find out from the respondents how they had come to understand the importance of Marura wetlands. Table 4.1 below presents the findings.

Table 4.1 Source of Information on the Importance of Marura Wetland

Source	Frequency	Percentage
Radio	145	74.2
Newspaper	16	8.3
Chief's Baraza	6	3.2
Wetland day celebration	2	0.75
TV stations	14	7.5
Others	10	5.3
Total	**193**	**100**

Source: Author's Data, (2018)

4.13 Attitude of the Respondents towards Environmental Integrity

Table 4.2 Attitude of the Respondents towards Environmental Integrity

KEY; F- frequency %- percentage 5-strongly agree, 4-agree, 3-undecided, 2-disagree, 1-strongly disagree, T-total

ITEM		5	4	3	2	1
We are approaching the limit of the number of people that Marura wetlands area can support.	%	25	54.8	7.1	7.1	8.9
Humans have the right to modify the natural environment to suit their need.	%	26.8	39.3	14.3	5.4	14.3
When humans interfere with nature, it often produces disastrous consequences	%	23.2	39.3	12.5	14.3	11.7
Local communities are severely abusing the wetlands	%	30.4	26.8	14.3	12.5	16.1
The earth has plenty natural resources if we just learn how to develop them.	%	17.9	44.6	7.1	14.3	16
Plants and animals have as much rights as human beings to exist	%	17.9	44.6	7.1	14.3	16

Source: Author's Data, (2018)

The study indicates that 80% of the respondents were of the opinion that they are approaching the limit of the number of people that Marura wetlands area can support. 76% stated that humans have the right to modify the natural environment to suit their need. 74% were of both opinions that local communities are severely abusing the wetlands and that when humans interfere with nature, it often produces disastrous consequences. The other 70% were also of both opinions that the earth has plenty natural

resources if we just learn how to develop them and that plants and animals have as much rights as human beings to exist.

4.14 Change in Land Use around Marura Wetland from 1985 to 2015

The changes in the use of Marura wetland was recorded on 10 years interval.

4.14.1 Uses of Marura Wetland between 1985 and 2015

It was observed that from 1985 to 1995 there was varied rate of anthropogenic activities in the study areas respectively. The chart below shows the trend of anthropogenic activities in the wetland from 1985 to 2015. It is observed that settlement has increased from 4% in 1995 to a high of 86% in 2015, on all the land use activities the most increased land use was wetland area with a change of 24%.

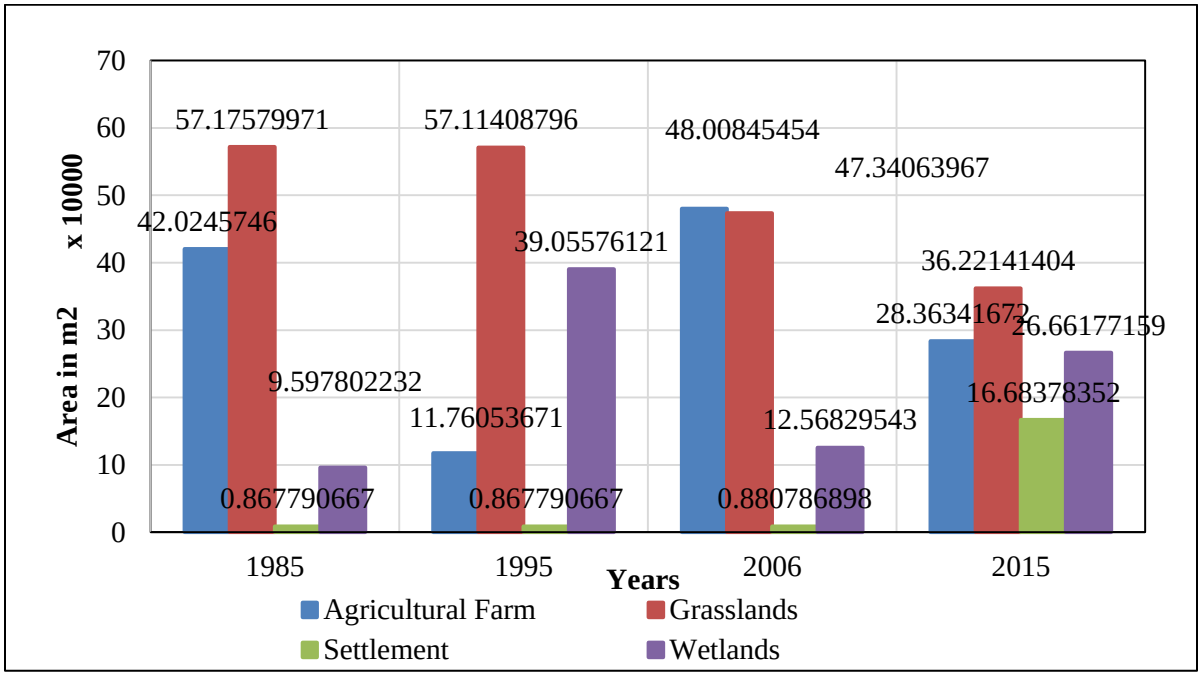
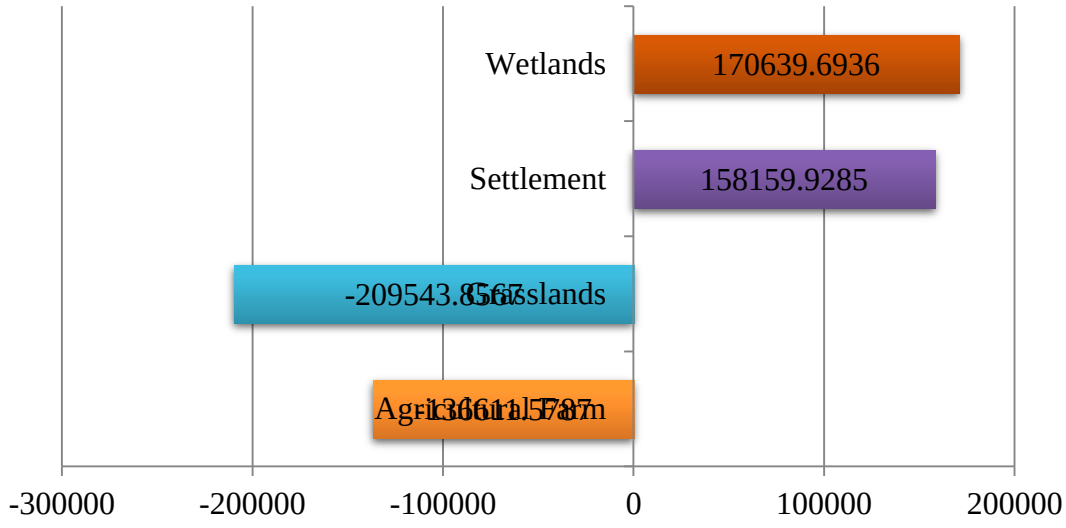


Figure 4.9: Uses of Marura Wetland between 1985 and 2015
Source*: Author's Data, (2018)*

4.14.2: Change in the Land Use Cover along Marura Wetland between 1985 and 2015



- (neg)- Represents a decrease in land size and + (pos) -Represents an increase in land size

Figure 4.10: Change in the Land Use Cover along Marura Wetland between 1985 and 2015

Source*: Author's Data, (2018)*

The negative values in the chart above indicates reduced land use activities from 1985 to 2015, it is observed that grassland has been on the decline from 1985 losing 208,926.7m^2 equivalent to 31% of total land cover in the study area.

4.14.3: Land Use/cover Area in m^2 between 1985 and 2015

Table 4.3 Land Use/cover Area in m^2 between 1985 and 2015

Land use	1985	1995	2006	2015
Agricultural Farm	420245.746	571757.9971	8677.906665	95978.02232
Grasslands	117605.3671	571140.8796	8677.906665	390557.6121
Settlement	480084.5454	473406.3967	8807.868984	125682.9543
Wetlands	283634.1672	362214.1404	166837.8352	266617.7159
TOTAL Area m^2	1301569.826	1978519.414	193001.5175	878836.3046

Source*: Author's Data, (2018)*

Land use change in Km^2 showed no much change between 1985 and 2006 while an increased change was noted between 2006 and 2015; this was due to increased green surface in the areas in 2015.

4.14.4: Overall Land use change in Km^2

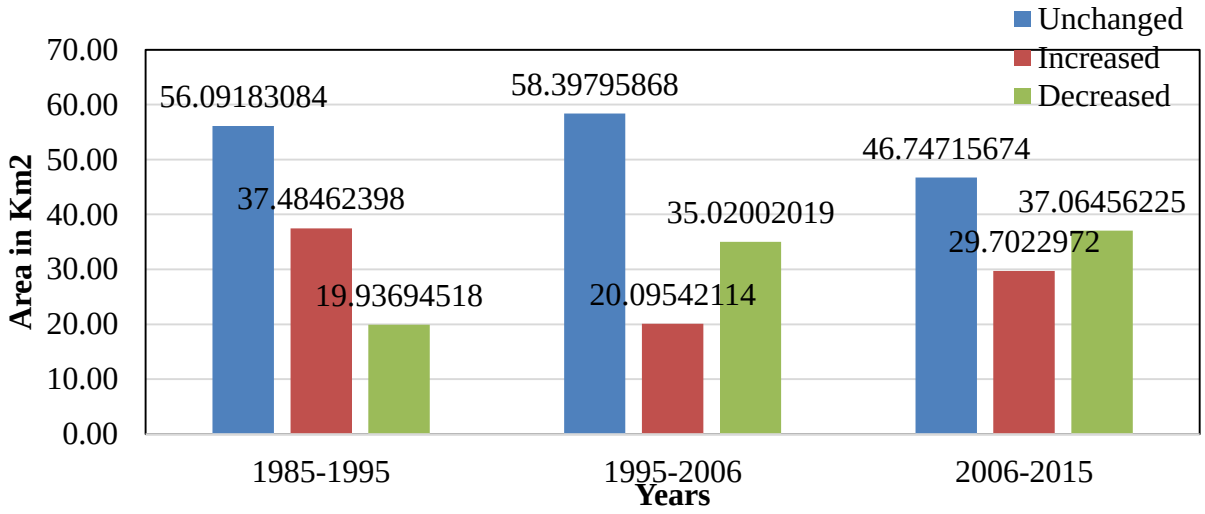


Figure 4.11 Overall Land use change in Km^2

Source*: Author's Data, (2018)*

The land use change in Marura for the past 30 years were depicted by the following change in images from 1985 to 2015.

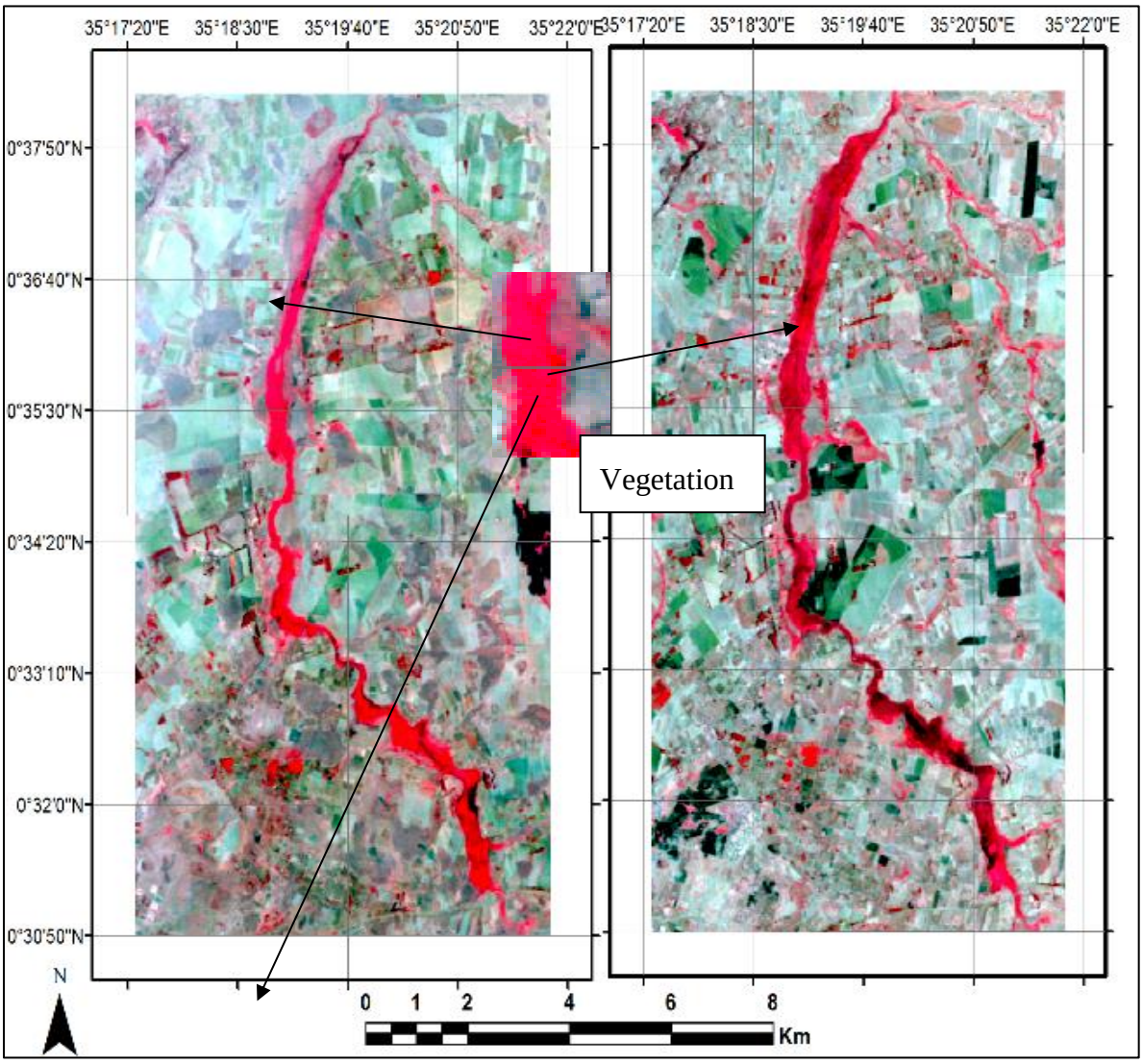


Figure 4.12a: Left: False Colour Image of March 1985 left and March 1995
Source*: GIS, (1995)*

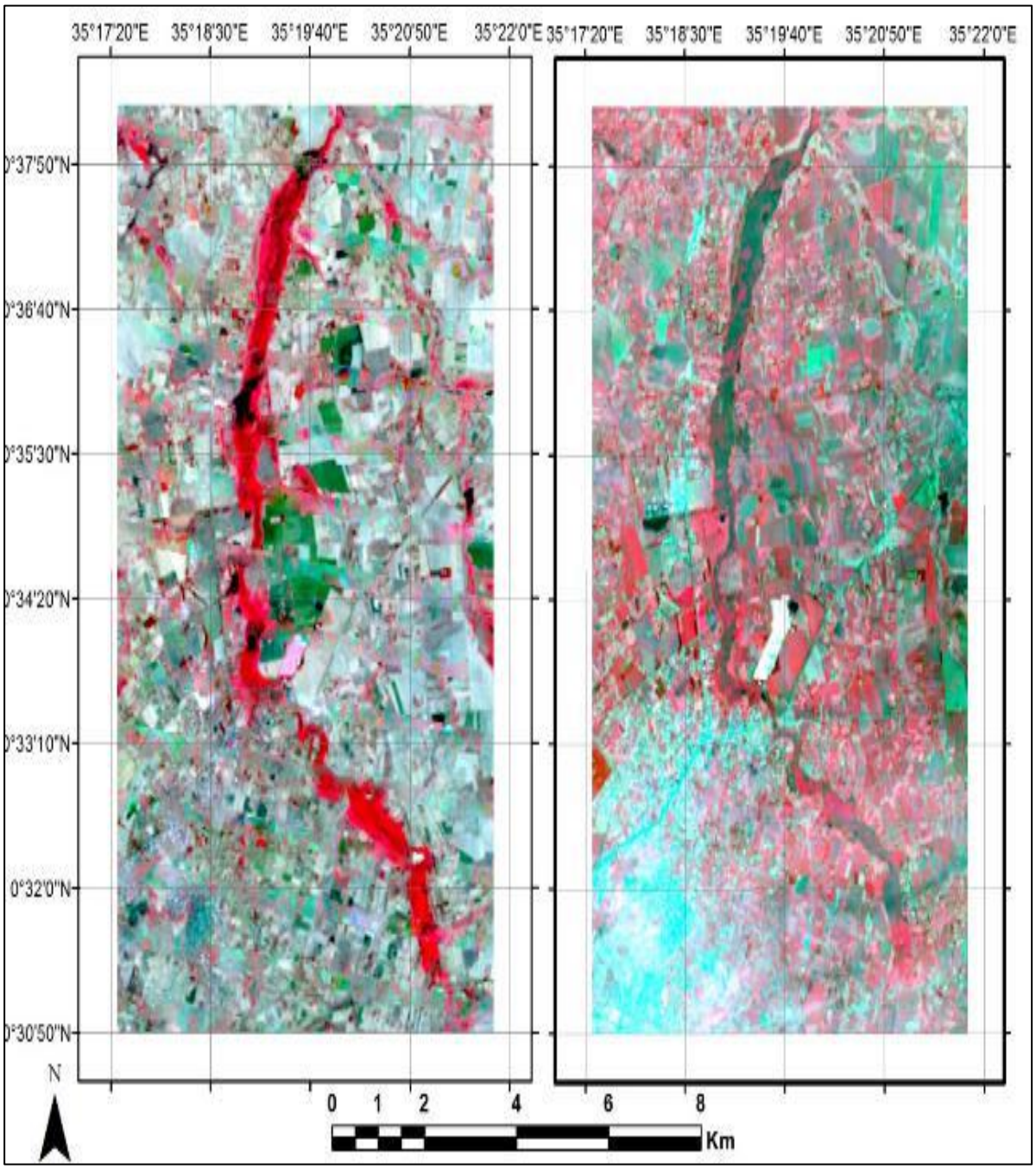


Figure 4.12b: Right: False Colour Image of March 2006 left and March 2015
Source*: GIS, (2015)*

Vegetation appears in different shades of red depending on the types and conditions of the vegetation, since it has a high reflectance in the NIR band while Clear water appears

dark-bluish (higher green band reflectance), while turbid water appears cyan (higher red reflectance due to sediments) compared to clear water. Bare soils, roads and buildings may appear in various shades of blue, yellow or grey, depending on their composition.

The above images show a false colour image of the study area for a period of 30 years from 1985 to 2015 March. From the image it can be observed that there is an increase in swamp size from 1985 to 2015 and an increased settlement in the year 2015 (depicted by the cyan colour). From the images the vegetation increased North East and North West. Equator flowers and other farms cover these arears. It can be noted that the increased swamp size towards equator flowers could be due to nutrients discharge rich in phosphorous from the flower farms. Gilliam (1994) notes that wetland systems also play an important role in retaining nutrients because of their position in the landscape and this retaining of nutrients can cause them to bloom and grow robustly.

4.14.5: Land Cover Changes per Year (1985 – 2015)

The land use changes based on the intervals were provided in the flowing series of images depicting a change in land cover with a steady growth in urban areas and reduction in grassland and land cover.

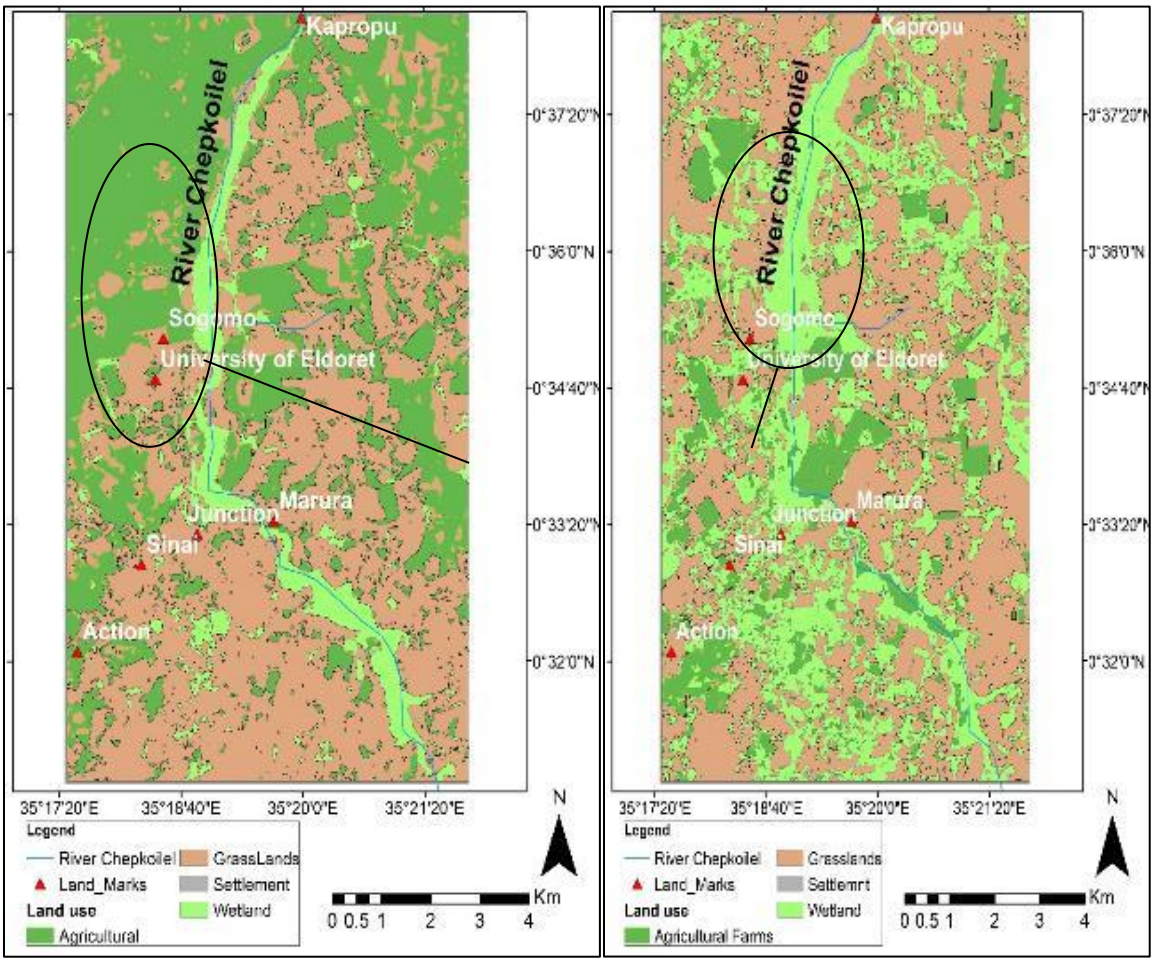


Figure 4.13 Left 1985 and Right 1995 Land use change

Source*: GIS, (1995)*

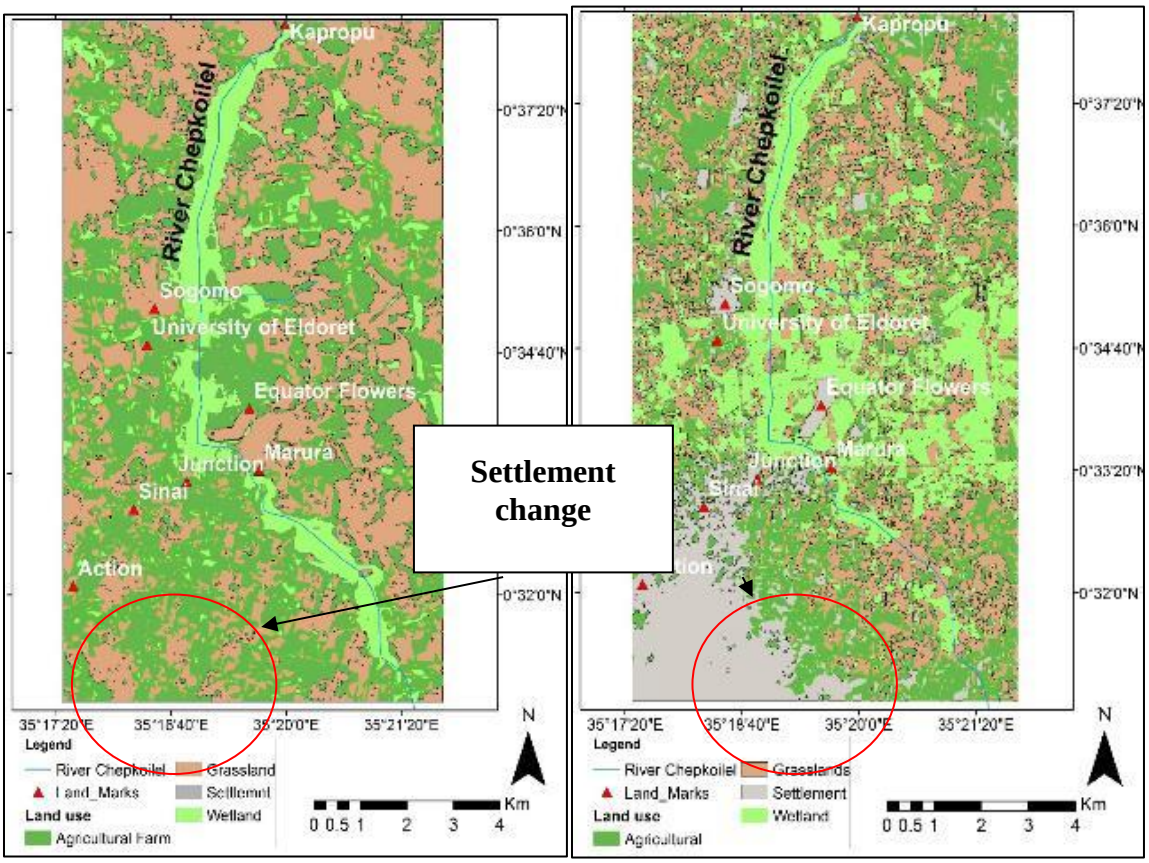


Figure 4.14 Left 2006 and Right 2015 Land use change depicting settlement
Source*: GIS, (2015)*

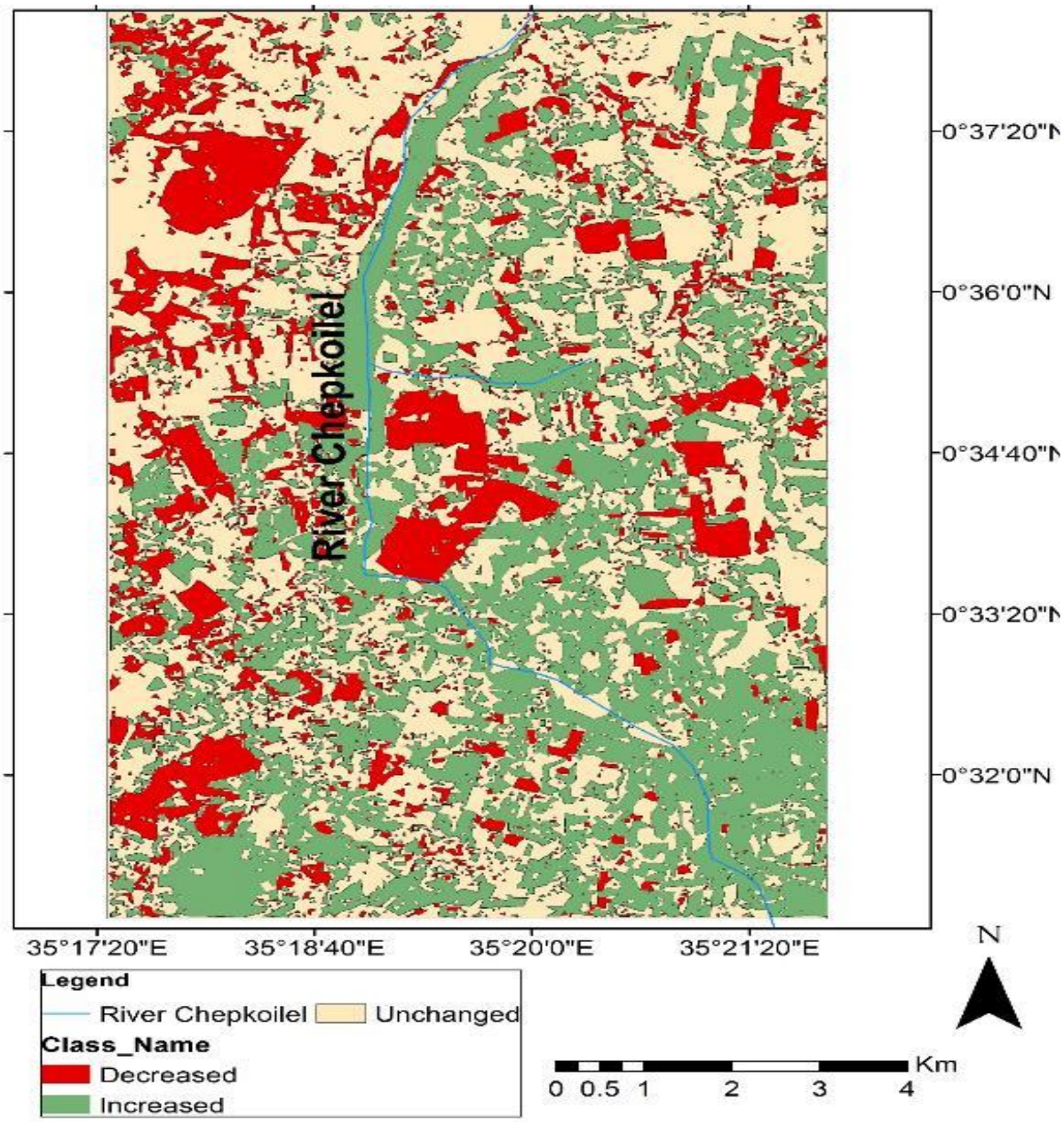


Figure4.15 Land use/Cover change between 1985 to 1995 depicting increased and reduced land size

Source*: GIS, (1995)*

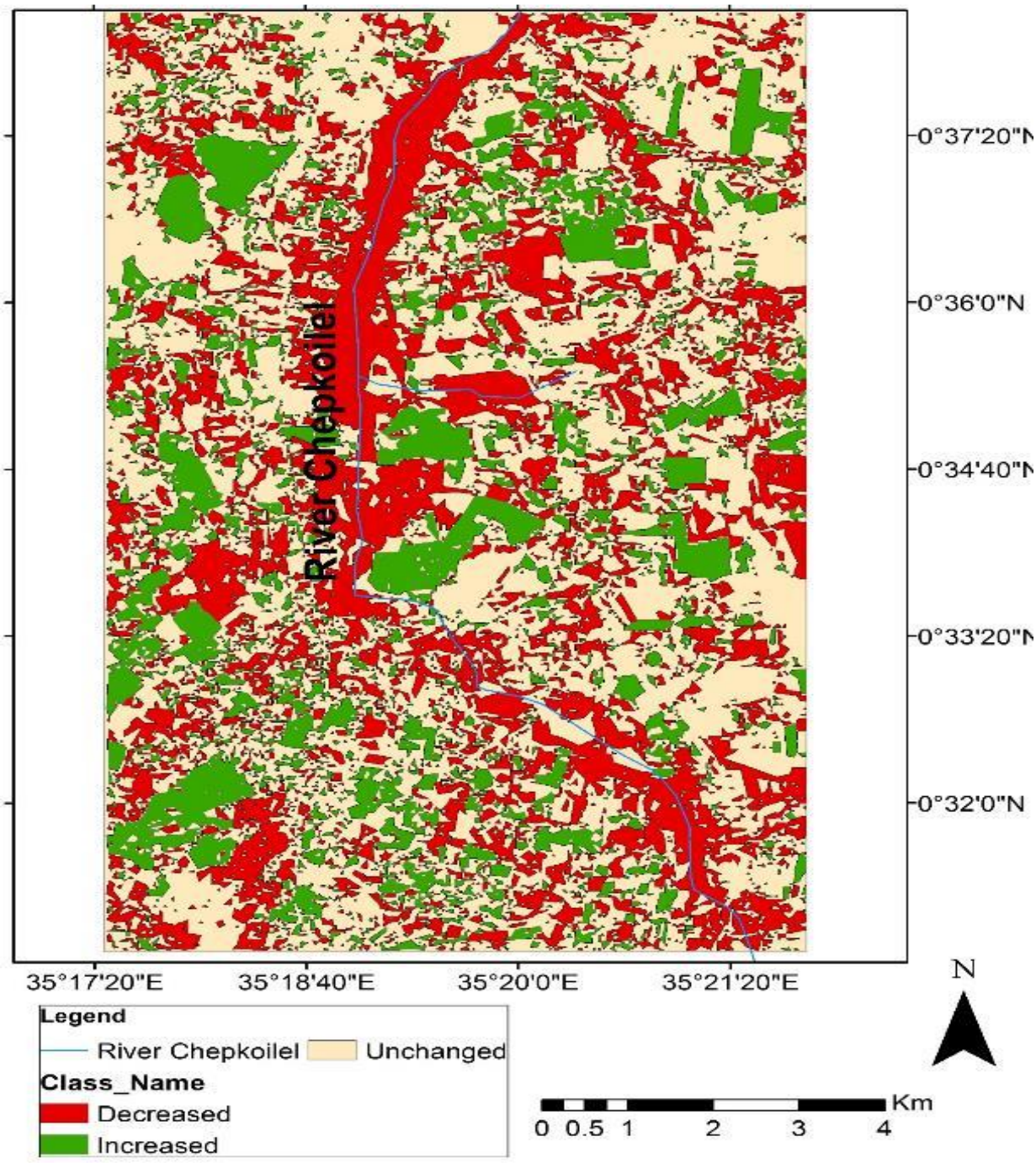


Figure 4.16 Land use/Cover change between 1995 to 2006 depicting increased and reduced land size

Source*: GIS, (2006)*

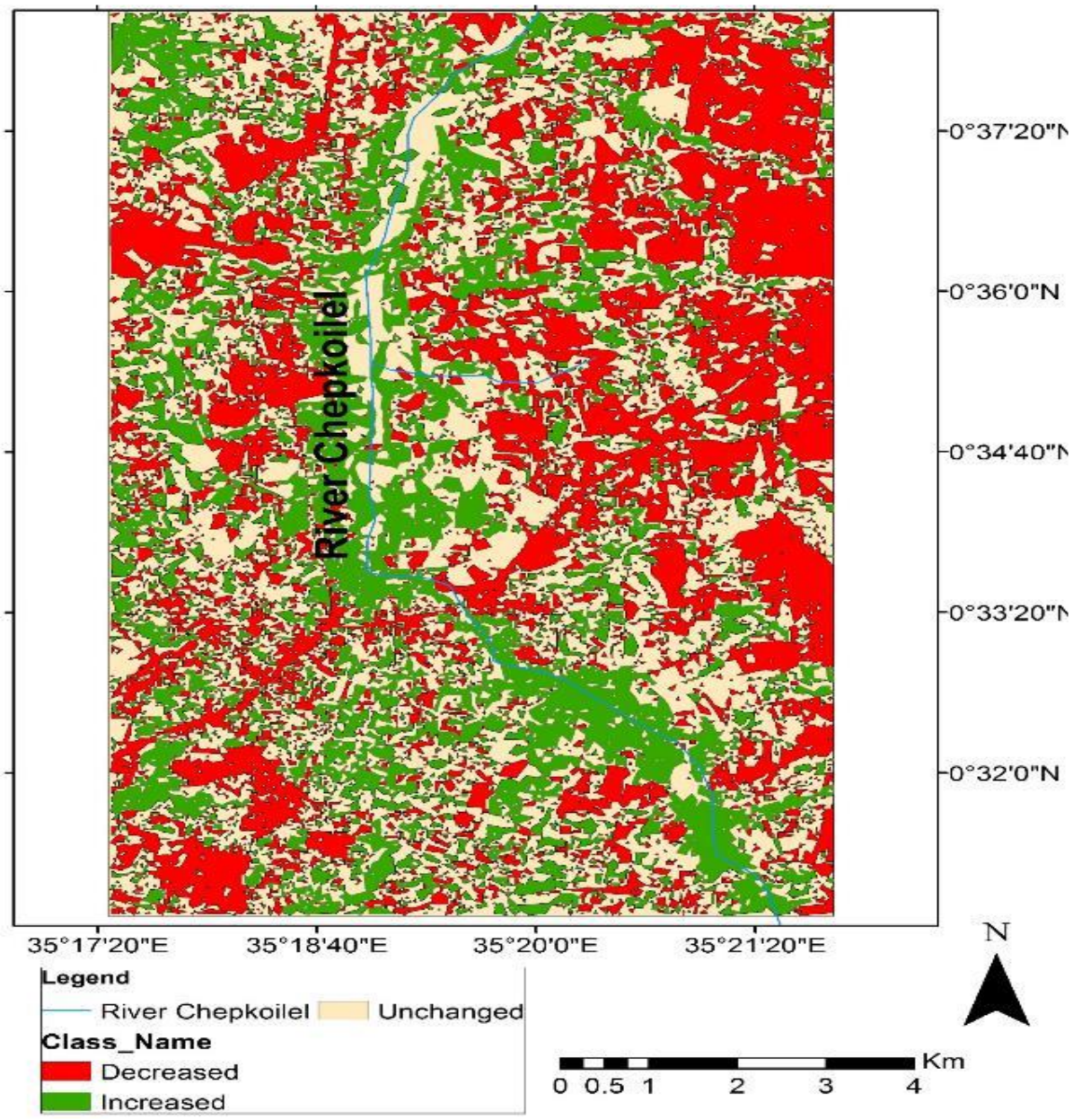


Figure 4.17 Land use/Cover change between 2006-2015 depicting increased and reduced land size

Source*: GIS, (2015)*

4.15 Impacts of Land use on Marura Wetland

The fourth objective of the study establish the relationship between land use activities/anthropogenic activities and the integrity of Marura wetlands. The study found out that; construction and human settlement/encroachment 135 (69.7%) are the main factors impacting on the wetland functions followed by farming 83 (43.2%).

4.15.1 Anthropogenic Activities and Integrity of Marura Wetlands

The study sought to establish the current and main land use activity in Marura wetland area. The findings were as presented on Figure 4.18.

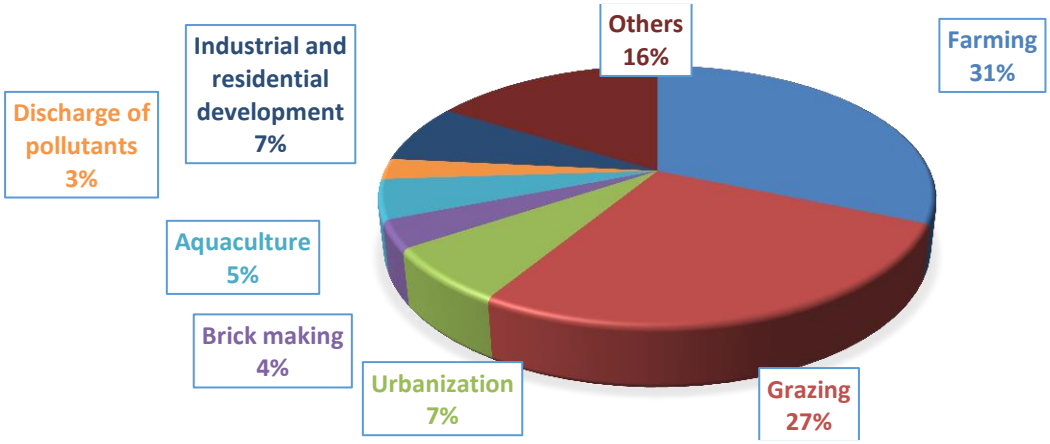


Figure 4.18 Anthropogenic activities in Marura swamp
Source*: Authors data, (2018)*

The study indicates that 31.4% stated that farming is the main land activity. 27.9% opined that grazing is the main land activity. 16.1% were of the opinion that other activities such as bee keeping are the main activity. 7.4% stated that Industrial and residential development were main land use. 7% opined that urbanization was the main

activity. 5% stated that aquaculture was the main activity and 4% said brick making while 3% indicated that Discharge of pollutants were the main activity.

4.15.2 Opinions of the Respondents on the Effects of Land Use on Integrity of Marura Wetland

Opinions on land use and its effect on wetland integrity was studied and the findings indicated that farming has negative effects on wetland integrity (82.6%), Urbanization has also negative effects on wetland integrity (90.2%), Discharge of pollutants to the wetlands have negative effects on wetland integrity followed by industrial and residential development (75.8%). Aquaculture is of more positive effects to wetland integrity (50.8%) followed by farming (8.3%) and brick making (7.6%)

4.15.3 Attitudes towards Wetlands Conservation, Sustainability and Restoration

Survey findings show that 80% of the respondents were of the opinion that wetlands have value whether people are present or not. The primary value of wetlands is to provide products useful to people, 76% were of the opinion that legislation should be implemented, 70% were of both opinions that wetland wildlife, plants have as much right to exist as human beings and that national, and local policies should be strengthened.

There were 62% who stated that attention is given to preserving wetlands in our society, 58.8% were of the opinion that the primary value of wetlands is to generate money and economic self-resilience for communities, 56.4% opined that wetlands should not be altered for human benefit while 43.2% stated that Wetlands are not worth spending money to save.

Table 4.3 Informants attitudes towards Wetlands conservation, sustainability and restoration

KEY; F- frequency %- percentage 5-strongly agree, 4-agree, 3-undecided, 2-disagree, 1-strongly disagree, T-total

ITEM	5	4	3	2	1
Wetlands have value whether people are present or not. The primary value of wetlands is to provide products useful to people.	22.3	54.9	7.3	7.3	8.8
Tough wetland laws are needed even if they interfere with development.	22.1	54.8	7.1	7.1	8.9
Wetlands are not worth spending money to	18.2	42.4	5.3	31.1	3
Wetland wildlife and plants have as much right to exist as human beings.	8.3	9.1	18.9	37.9	25.8
The primary value of wetlands is to generate money and economic self resilience for	32.6	15.9	25.6	11.4	14.5
Wetlands should not be altered for human benefit	21.3	13.6	15.9	34.8	14.4
Attention is given to preserving wetlands in our society	14.4	21.2	22.7	15.2	26.5
National and local policies should be	18.2	31.1	9.1	28	13.6
Legislation should be implemented	17.9	44.6	7.2	14.3	16

Source: *Author's Data, (2018)*

4.15.4 Main cause of degradation on Marura Wetlands

Table 4.4 Main cause of Degradation on Marura Wetlands

	Yes	No	Total
Overharvesting of papyrus reeds	12.9	87.1	100
Burning	46.2	53.8	100
Agriculture	81.8	18.2	100
Livestock grazing	73.5	26.5	100
Climate change	59.1	40.9	100
Waste disposal	42.4	57.6	100
Human settlement	69.7	30.3	100
Others	2.3	97.7	100

Source*: Author's Data, (2018)*

The study found out that the main causes of degradation of Marura wetland are agriculture at (81.8%), human settlement (69.7%), and livestock grazing (73.5%). Climate change is the fourth cause of wetland degradation (59.1%), waste disposal is the fifth (42.4%), burning is the sixth (46.2%) while other causes come last (2.3%).

4.15.5 Respondents Participation in the Conservation of Marura Wetlands

The research sought to establish the participators in the conservation of Marura Wetlands. The findings were as presented on table 4.5.

Table 4.5 Participation in the conservation of Marura Wetlands

		Yes	**No**	**Total**
Individuals	F	51	142	193
	%	26.5	73.5	100
CBO/NGOs	F	158	35	193
	%	81.8	18.2	100
National Government	F	168	25	193
	%	87.1	26.5	100
County government	F	135	58	193
	%	69.7	30.3	100
International organization	F	82	111	193
	%	42.4	57.6	100
Others	F	4	189	193
	%	2.3	97.7	100

Source*: Author's Data, (2018)*

the finding indicates that the national government (87.1%) are the main participants of the conservation of Marura wetlands, CBOs/NGOs (81.8%) are the second main participators of conservation of Marura wetlands, the county government are third

(69.7%), international organizations are fourth (42.4%), individuals also participate in conservation (26.5%) while other participants constituted (2.3%) participated ?

Evidently, the national government has been the biggest participants in the environmental conservation. This could be because the government is very much concerned with the conservation of the natural resources and have put on streamlined measures and policies to help conserve the Marura wetlands. The government may have set aside funds to see to it that the Marura wetlands are conserved for the good of the people around the wetlands

Government involvement in regulation/minimization of exploitations of wetland indicates that 63.6% of the respondents opined that the government has been involved in regulation/minimization of exploitation of wetlands while 36.4% denied. This could be because of the fact the government regards the wetlands as a national natural resource and is also a way of its vital importance to the people living around is willing to go an extra mile to help prevent exploitation. Consequently, the wetlands are also of economic importance to the government and hence they have set rules, policies and regulations to help minimize exploitation of the wetlands by the people.

In assessing the regression model for the wetland conservation as per the indicators in the study, the study evaluated the standardized coefficients of the study and illustrated the results, Wetland conservation = 0.219 (farming) + 0.214 (discharge of pollutants) + 0.213 (urbanization).

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.1 Introduction

This chapter discusses the findings makes interpretation on the data found in the field and gives a vivid argument to the findings in Chapter Four.

5.2 Marura Wetland Usage

From the findings, the main benefit of human from the wetlands is water. This is because wetlands have capacity to hold a lot of water owing to the fact that most of them have aquifers or channels that allows constant capacity of water to a given wetlands. In that case, people are able to get constant supply of water for domestic use as well as animals to quench their thirst.

Most wetlands supply water to the nearest communities directly. However, other significant importance according to the study is grazing 134 (69.7%). This could be because of the fact that the lands around the wetlands are most of the times fertile and unused leaving it suitable for grazing of animals.

5.2.1 Information on wetlands

Most of the respondents were aware of the importance of wetlands through radios 145 (74.2%). This could be because radio is the most available mode of communication the community can afford. In addition, there are many more stations around the region, the involved people in conservation of the wetlands could be using the medium to

communicate to the communities living around the wetlands and thus they came to hear about the wetlands through the radio.

Majority of the respondents were however, of the opinion that they are approaching the limit of the number of people that Marura wetlands area can support. This could be because the wetlands may be experiencing the surge in terms of population and may have forced the relevant authorities to step in and maintain the number of people the wetlands can hold to ensure that it is not degraded. This may have been done by preventing migration into the area and also securing lands around the wetlands to ensure people do not move to it thus degrading the wetlands.

5.3 Land use and Change in Land Cover

There was increased wetlands area from 2006 to 2016 and this could be attributed to increased siltation downstream at sections of Kaprobu with soils full of fertilizers from the farms favoring the growth of papyrus, the increased papyrus has also been favored by increased riparian plantations from exotic trees by resident within the swampy areas.

The settlement change between 2006 and 2015 indicates that there is increased settlement on the South west part of the map circled in red Figure 5-o.The increased settlements is directly proportional to the increase in population of Eldoret town as per 2009 census and also the availability of land for residential settlements in areas of Action, Munyaka and Junction.

5.4 Impact of Land use on Marura Wetlands

The construction of settlements and grazing on the swampy areas of Marura could be attributed to the fact that recently there has been continuous construction and human settlement along the wetlands. Human encroachment on the other side has threatened the size of the wetlands, as people are moving in more and more everyday on the wetlands thus reducing their size and water table. For this reasons, construction/human settlement and farming has been an impact to the wetland functions.

The anthropogenic activities and integrity of wetlands were major on Marura wetland with 76.5% of respondent's indicating a possible impact. This could be because in most instances, land use activities include construction, farming and grazing and also mining. Such activities are known to be crucial to degradation of wetlands. For instance farming along the wetlands is a threat to reduction of water at the acquifers as well as the size of wetlands and in that case if there is more farming along the wetlands, it is more likely to drive the wetland to extinction.

Majority however indicate that farming is the main land use activity in the region (31%). This could be because the soil; and the climate around the wetlands is economically viable and for that reasons most of the people around the wetlands have taken advantage of the farming viability and are therefore farmers.

Majority of the respondents stated that Urbanization is of the most negative effects to wetland integrity. This is attributed expansion of the urban towns near wetlands that have resulted to people constructing buildings and infrastructure to the lands that have been set

aside for the wetlands. This therefore has resulted to the reduction of the lands meant to be for the wetlands and eventual degradation.

5.5 Attitudes towards Conservation of Marura Wetland

From the findings, majority of the respondents had opined that wetlands have value whether people are present or not. The primary value of wetlands is to provide products useful to people. This could be attributed to the fact that wetlands have essential use to the people such as providing water, and food among other essentials such as providing fertile grass for animals to graze in. It is also in the wetlands that people could grow rice and vegetables to cater for hunger and ensure food security. For that matter, wetlands have paramount values to the people whether they are present or not and people should conserve wetlands to give them useful products, livestock grazing and agriculture.

Agriculture is the greatest cause of degradation because people have encroached to the supposed land for wetlands increasing the loosening of the soils and causing soil erosion at some point. This has changed the water channels and the water tables have also gone down resulting to diminishing of the wetlands. For that reasons people have continued encroaching and using the land that have remained with less water resulting to the degradation.

5.6 Summary of the findings

The study indicates that 193 (98%) of the respondents were of the opinion that the most important aspect of the wetlands in the community is that it is the water source. This could be because of the fact that most communities living near wetlands depend on them for water source and also take their animals there for water. Most wetlands supply water

to the nearest communities directly. The findings indicate that most of the respondents were aware of the wetlands through radios at 74.2%. The study indicates that 80% of the respondents were of the opinion that they are approaching the limit of the number of people that Marura wetlands area can support. 76% stated that humans have the right to modify the natural environment to suit their need. 74% were of both opinions that local communities are severely abusing the wetlands and that When humans interfere with nature, it often produces disastrous consequences. 70% were also of both opinions that the earth has plenty natural resources if we just learn how to develop them and that plants and animals have as much rights as human beings to exist.

The study indicate that construction and human settlement/encroachment 69.7% are the main factors impacting on the wetland functions followed by farming 43.2%. The study indicates that 76.5% were of the opinion that there is a relationship between land use activities/ anthropogenic activities and integrity of wetlands while 24.5% denied.

The study indicates that 75.6% stated that farming is the main land activity. 65.9% opined that grazing is the main land activity 38.6 were of the opinion that other activities such as bee keeping are the main activity. 17.4% stated that Industrial and residential development were main land use, 16.7% opined that urbanization was the main activity, 6.1% stated that aquaculture was the main activity, 11(8.3%) said brick making while eight (6.1%) stated that Discharge of pollutants were the main activity.

The findings indicate that for the past 30 years farming 81.8% has reduced in changing the land around Marura wetland, grazing has also reduced by significant percentage

69.7%. The study also indicates that there has been increase in industrial and residential development 54.5%. The findings also indicate that presently, wetland area has reduced 84.8% while there has been increased industrial and residential development.

The findings show that 80% of the respondents were of the opinion that wetlands have value whether people are present or not. The primary value of wetlands is to provide products useful to people, 76% were of the opinion that legislation should be implemented, 70% were of both opinions that wetland wildlife and plants have as much right to exist as human beings and that national and local policies should be strengthened. 62% stated that attention is given to preserving wetlands in our society, 58.8% were of the opinion that the primary value of wetlands is to generate money and economic self-resilience/reliance for communities, 56.4% opined that wetlands should not be altered for human benefit while 43.2% stated that Wetlands are not worth spending money to save.

the study indicates that agriculture is the biggest cause of wetland degradation in Marura 81.8%, human settlement 69.7% comes second, livestock grazing is the third cause 73.5%, climate change is the fourth cause of wetland degradation 59.1%, waste disposal is the fifth 42.4%, burning is the sixth 46.2% while other causes come last 2.3%.

the finding indicates that the national government 87.1% are the main participants of the conservation of Marura wetlands, CBOs/NGOs 81.8% are the second main participators of conservation of Marura wetlands, the county government are third 69.7%, international organizations are fourth 42.4%, individuals also participate in conservation 26.5% while other participants 2.3% participated last.

The study indicates that 63.6% of the respondents opined that the government has been involved in regulation/minimization of exploitation of wetlands while 36.4% denied. The study also indicates that farming have negative effects to wetland integrity 82.6%, Urbanization has also negative effects to wetland integrity 90.2%, Discharge of pollutants to the wetlands have negative effects on wetland integrity followed by industrial and residential development 75.8%. Aquaculture is of more positive effects to wetland integrity 50.8% followed by farming 8.3% and brick making 7.6%.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter discusses the summary, conclusions, recommendations and suggestions for further studies.

6.2 Conclusion of the study

The study draws the following conclusions based on the studies objectives and findings:-

- The most important aspect of the wetlands in the community is that it is the water source. This could be because of the fact that most communities living near wetlands depend on them for water source and also take their animals there for water. Most wetlands supply water to the nearest communities directly. However, other significant importance according to the study is grazing 69.7%. This could be because of the fact that the land around the wetland is most of the times fertile and unused leaving it suitable for grazing of animals.
- Most respondents in the region are aware of the wetlands through radios 98(74.2%). This could be because most radio is the most available mode of communication the people of the community can afford. In addition, there are many more stations around the region, the involved people in conservation of the wetlands could be using the medium to communicate to the communities living around the wetlands and thus they came to hear about the wetlands through the radio. This has seen tree nurseries being adopted by the communities around the wetland which has seen reduced cases of fires in the dry seasons from 2003-2015.

- The respondents in the area are approaching the limit of the number of people that Marura wetlands area can support. This could be because the wetlands may be experiencing the surge in terms of population and may have forced the relevant authorities to step in and maintain the number of people the wetlands can hold to ensure that it is not degraded. This may have been done by preventing migration into the area and securing lands around the wetlands to ensure people do not move to it thus degrading the wetlands.
- Main factors impacting on the wetland functions followed by farming 57(43.2%) this could be attributed to the fact that of late, there has been continuous construction and human settlement along the wetlands. Human encroachment on the other side has threatened the size of the wetlands as people are moving in more and more everyday on the wetlands thus reducing the size of the wetlands and water table. For this reasons, construction/human settlement and farming has an impact to the wetland functions.
- Land use activities in Marura include construction, farming, grazing, and mining. Such activities are known to be crucial to degradation of wetlands. For instance, construction of buildings around the wetlands is a threat to reduction of water table as well as the size of wetlands and in that case, if there is more construction around the wetlands, it is more likely to be threatened to extinction. It is also evident that farming is the main land use activity in the region. This could be because the soil; and the climate around the wetlands is economically viable and for that reasons most of the people around the wetlands have taken advantage of the farming viability and are therefore farmers

- Over the past 30 years, there has been reduced farming and grazing as well as increased industrial and residential development and wetland area. This could be attributed to the fact that increased industrial and residential development has eaten into the wetland area and the consequences have been the reduced size of the wetland area resulting to decrease farming and grazing.
- Wetlands have value whether people are present or not. The primary value of wetlands is to provide products useful to people. This could be attributed to the fact that wetlands have essential use to the people such as providing water, and food among other essentials such as providing fertile grass for animals to graze in. It is also in the wetlands that people could grow rice and vegetables to cater for hunger and ensure food security. For that matter, wetlands have paramount values to the people whether they are present or not and people should conserve wetlands to give them useful products.
- Agriculture has been found to be the biggest cause of Marura wetlands degradation. This could be because people have encroached to the supposed land for wetlands increasing the loosening of the soils and causing soil erosion at some point. This has changed the water channels and the water tables have also gone down resulting to diminishing of the wetlands. For that reasons people have continued encroaching and using the land that have remained with less water resulting to the degradation.
- The national government has been the biggest participants in the environmental conservation. This could be because the government is very much concerned with the conservation of the natural resources and have put on streamlined measures

and policies to help conserve the Marura wetlands. The government may have set aside funds to see to it that the Marura wetlands are conserved for the good of the people around the wetlands

- Urbanization is of the most negative effects to wetland integrity. This is attributed to the expansion of the urban towns near wetlands that have resulted to people constructing buildings and infrastructure the lands that have been set aside for the wetlands. This therefore, has resulted to the reduction of the lands meant to be for the wetlands and eventual degradation.

6.3 Recommendations

The government should step up measures to curb exploitation of the humans to the wetlands through processes such us urbanization and construction. This will help maintaining the wetlands to ensure they are useful to the people.

Individuals, CBOs/NGOs and the county government should highly invest and advocate for the conservation of the wetlands to ensure they remain of value to the people living around and that they are not degraded. These measures will prevent individuals that exploit such resources from doing so. This has been done through NEMA and WARMA who are the key players especially on an Urban Wetland like Marura.

The wetlands in the region should be gazette by the government and their lands demarcated to ensure that individuals with selfish interest do not grab or exploit the land meant for the wetlands

There is a need for policies to be enacted to ensure that farmers around the wetlands use proper mechanisms of farming to prevent soil erosion and therefore conserving the wetlands. This will ensure that the wetlands are there to support the future generations

6.7 Suggestions for further studies

Further studies should be conducted on the policies and measures enacted by lawmakers to prevent exploitations of wetlands and natural resources at large.

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APPENDICES

APPENDIX I

		Positive	**Negative**	**No Change**	**Total**
Farming	F	16	159	18	193
	%	8.3	82.6	9.1	100
Grazing	F	23	144	26	193
	%	12.1	74.2	13.6	100
Urbanization	F	12	174	7	193
	%	6.1	90.2	3.8	100
Brick making	F	15	85	93	193
	%	7.6	43.9	48.5	100
Aquaculture	F	98	75	20	193
	%	50.8	38.6	10.6	100
Discharge of pollutants	F	0	182	9	193
	%	0	95.5	4.5	100
Industrial and residential development	F	23	146	24	193
	%	12.9	75.8	11.4	100
		Positive	Negative	No Change	total
Farming	F	16	159	18	193
	%	8.3	82.6	9.1	100

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	%	12.1	74.2	13.6	100
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Discharge of pollutants	F	0	182	9	193
	%	0	95.5	4.5	100
Industrial and residential development	F	23	146	24	193
	%	12.9	75.8	11.4	100

APPENDIX II: INTRODUCTION LETTER

Dear Respondent

I am a postgraduate student from the School of environmental studies in the University of Eldoret. As a partial requirement of the degree assessment, I am required to submit a research report on: **IMPACTS OF LAND USE ACTIVITIES ON WET LANDS; A CASE STUDY OF MARURA WETLAND IN UASIN GISHU COUNTY, KENYA** I would highly appreciate if you could kindly complete the Questionnaire to assist me collect data. Your information alongside others will help me in my research and will be used strictly for academic purposes and will be treated as confidential, therefore, do not write your name on the questionnaire.

Thank you in advance,

Yours faithfully,

AARON NAOMY CHEPCHUMBA

APPENDIX III: QUESTIONNAIRES

Please give answers in the spaces provided and tick (.√) in the box that matches your responses to the questions where applicable

SECTION A: SOCIO-ECONOMIC CHARACTERISTICS OFRESPONDENT

1. Gender (Tick as applicable)?

   Male ( )

   Female ( )

2. What is your age bracket (Tick as applicable)?

   a) Under 30years ( )

   b) 31-40 years ( )

   c) 41-50 years ( )

   d) Over 50 years ( )

3. For how long have you been living around Marura wetland area (Tick as applicable)?

   a) Below 30years ( )

   b) 31-40 years ( )

   c) 41-50 years ( )

   d) Over 50 years ( )

4. What is your primary occupation?

   ……

5. How many children do you have (Tick as applicable)?

a) None ( )

b) 1-3 ( )

c) 4-6 ( )

d) More than 6 ( )

6. Do your children go to school?

If yes to what level have they reached (Tick as applicable)?

a) Primary level ( )

b) Secondary level ( )

c) College ( )

d) University ( )

7. How would you describe the size of the community around Marura wetlands area?

a) Rural, farm ( )
b) Rural non-farm ( )
c) Small city (10,000 to 100,000) ( )
d) Mid-sized city (100,000 to 1 million) ( )
e) Small town (under 10,000) ( )
f) Large city (over 1 million) ( )

8. Do you belong to any conservation groups? Yes ( ) No ( )

9. What goods and services does the local community get from Marura wetlands?

……

SECTION B: ENVIRONMENTAL AWARENESS AND ATTITUDES TOWARDS WETLANDS.

10. What is the main land use activity around Marura wetland area (Tick as applicable) ?

a) Farming ( )

b) Grazing ( )

c) Urbanization ( )

d) Construction (bridges/roads, etc) ( )

e) Others specify……

11. How have land use activities around Marura wetlands changed in the last 30 years?
    ……
    ……

12. **Environmental Attitudes.** Kindly Tick as applicable whether you Strongly Disagree, Disagree, Slightly Disagree, Unsure, Slightly Agree, Agree Strongly Agree.

	Strongly Disagree	**Disagree**	**Unsure**	**Agree**	**Strongly Agree**
We are approaching the limit of the number of people that Marura wetlands area can support.					
Humans have the right to modify the natural environment to suit their need.					
When humans interfere with nature, it often produces disastrous consequences.					
Humans are severely abusing the environment.					
The earth has plenty natural					

resources if we just learn how to develop them.					
Plants and animals have as much right as humans to exist.					

13. What are the main anthropogenic activities along Marura wetland area (Tick as applicable)?

    a) Hydrological alteration ( )
    b) Sivilculture/timber harvesting ( )
    c) Agriculture ( )
    d) Construction ( )
    e) Industrialization ( )
    f) Urbanization ( )
    g) Mining ( )
    h) Atmospheric deposition ( )

i) Others, specify
……

14. What are the impacts of anthropogenic activities on Marura wetland?
……
……

15. Is there a relationship between land use activities/ anthropogenic activities and integrity of Marura wetlands (Tick as applicable)?

    YES ( ) NO ( )

    b) If YES explain
……
……

SECTION C: Attitudes towards Wetlands Conservation and Restoration.

People have different reasons for thinking wetlands are important to our society. Indicate below how strongly you AGEE OR DISAGREE with each of the following statements. While some of the following statements may sound similar, please read each and respond by TICKING whether you AGREE OR DISAGREE.

	Strongly Disagree	**Disagree**	**Unsure**	**Agree**	**Strongly Agree**
Wetlands have value whether people are present or not.					
The primary value of wetlands is to provide products useful to people.					
Tough wetland laws are needed even if they interfere with development.					
Wetlands are not worth spending money to save.					
Wetland wildlife and plants have as much right to exist as people.					
Tough coastal wetland laws interfere with human development.					
The primary value of wetlands is to generate money and economic self-resilience for Communities.					
Wetlands should not be altered for human benefit.					
Too much attention is given to preserving wetlands in our society.					

16. In your own opinion what is the main cause of wetland degradation around Marura wetland?

    ……

    ……

17. Is the government doing enough to regulate/ minimize exploitation levels of wetlands to balance the livelihood aspects and sustainable management of urban wetlands (Tick as applicable)?

    YES ( ) NO ( )

    B) If YES explain

    ……
    ……

    C) If NO why do you say so?

    ……
    ……

18. In your opinion what should be done to minimize wetlands degradation around Marura wetlands?

Thank you for your participation.