IMPACTS OF CONSTRUCTION ON WETLANDS IN BUNGOMA TOWN

by

RODGERS STEPHEN WAKHUNGU

B42/82057/2012

Research project submitted to University of Nairobi, School of Built Environs, Department of Real Estate and Construction Management, in partial fulfilment of the requirement for the award of a Post Graduate Diploma in Housing Administration

October 2013

DECLARATION

I hereby declare that this project is my original work and has never been submitted for the award of a degree in any university. All cited pieces of work from other authors to enhance this work have been recognized in the references.

…….. Date ……...

RODGERS S. WAKHUNGU

B42/82057/2012

This research was carried out and submitted for examination with my approval as the university supervisor.

……. Date ……

MR. NZIOKI NICKY

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT

UNIVERSITY OF NAIROBI

ACKNOWLEDGEMENT

I would like to acknowledge all individuals who assisted me to complete this project, particularly my supervisor Mr. Nicky Nzioki, Ministry of Housing, in particular our Permanent Secretary Mr. Tirop Kosgey for the support and funding.

My special gratitude to the Directors of Housing and Slum Upgrading Programme for their tireless efforts to ensure we were well facilitated and catered as we undertook this course of Post Graduate Diploma in Housing Administration

DEDICATION

To God for the special anointing, good health and strength He granted me throughout the study. To Family (Mum Dad and siblings). To the Ministry of Housing and close friends.

Special dedication to the love of my life for the support and encouragement and understanding as i strived to undertake the studies while pursuing my carrier as a Housing Officer

Abstract

From colonial times until recently, wetlands have been usually regarded as nuisances, only fit to be drained, cleared, filled, inundated, degraded with toxins and nutrients, and exploited for whatever resources could be extracted from them (*Maltby, 1986*). The nature of wetland benefits are such that the owners of wetlands usually cannot capture the benefits for their own use or sale. The flood protection benefits accrue to others downstream. The fish and wildlife that breed and inhabit the wetlands migrate, and are captured or enjoyed by others. The ground water recharge and sediment trapping benefits cannot be commercially exploited. For the owner of a wetland to benefit from his resource, he often has to alter it, convert it, and develop it. That is why, despite their value, wetlands are being eliminated.

In their natural state, wetlands produce numerous benefits for society. Benefits which are either irreplaceable if lost or can only be replaced at immense expense. (*Shanbhag et al 2008*). Wetlands provide a vivid example of the dynamic, yet fragile interactions that create, maintain, and repair the world's ecological system. Unfortunately, the fate of many wetlands can also offer concrete evidence of the harmful consequences of human activities that are carried out without regard for, and often without knowledge of, the relationship of each part of the ecosystem to the whole.
By and large construction is the major cause of urban environmental degradation not only from the construction process effects but also from the resulting human settlements activities.

The study sought to investigate the impacts of property development on existing wetlands in Bungoma Town. From the findings it emerged property development was the single most destroyer of wetlands in the municipality through drainage, dredging deposition of fill material, dyking and damming, construction, run-off, air and water pollution, changing nutrient levels and release of toxic chemicals. The study concluded and recommended that the future for these wetlands will really depend on how humans choose to use their wetlands and the measures they take to mitigate impacts that their activities have on these special environments.

Table of content

LIST OF TABLES

List of acronyms

UN-HABITAT	United Nations Human Settlements Programme
IUCN	International Union on Conservation of Nature
UNEP	United Nations Environmental Programme
WWF	World Wildlife Fund
FAO	Food and Agricultural Organisation
SPSS -	Statistical Package for Social Scientists
EMCA	Environmental Management and Coordination Act

CHAPTER ONE

1.0 Background information

It is always difficult to generalize about wetlands because they are so diverse with respect to their hydrology, plant communities and landscape position. In a real sense, no two wetlands are similar in their quality or function. In addition, the nature of land development (property development) in the areas covered with wetlands often differs greatly from site to site (*Tiffany et al. Undated*).

Despite this variability, several consistent and similar impacts can be observed in different wetlands around the country with the severity being most profound in urban areas.

Linda McDowell (1981) argues that if the 19th century was referred to as the century of industrial revolution, the twentieth century might equally as well be dubbed the century of urban revolution. Statistics point out that in the last 70 years, the world's urban population has more than quadrupled. Therefore among the contemporary issues, Urbanization and growth of cities is the most profound trend in its impact on the way we live. (*UN-HABITAT, 2009*).

Cities present unparalleled opportunities for creating wealth and prosperity. They are the driving force of global trade and engines of economic growth. In addition cities are the nexus of our global financial markets and service centres of our information society. Urbanization contributes to sustained economic growth which is critical to poverty reduction. The economies of scale and agglomeration in cities attract investors and entrepreneurs which is good for overall economic growth. Cities also provide opportunities for many, particularly the poor who are attracted by greater job prospects, the availability of services, and for some an escape from constraining social and cultural traditions in rural villages (*UN-HABITAT, 2009*).

On the other hand, urban areas bring about irreversible changes in consumption and production patterns especially in land use, water, energy and other natural resources. With over half of the World's population living in cities, urban areas are already consuming most of the world's energy and natural resources while generating the bulk of our waste. Many

cities also harbor very many worrisome trends in terms of permanent destabilization of natural settings and environmental destruction.

In the contemporary World Economic view, the term sustainable development cannot be overemphasized when it comes to urban development vis a vis environmental concerns. In addition, it is been argued that housing consumes 60 to 70% of major land use in urban areas depending on the level of population density (*Syagga, 2012*).

It therefore goes without saying that housing is the major cause of urban environmental degradation not only from the construction process effects but also from the resulting human settlements activities. As noted earlier most of these effects bring about irreversible environmental degradation which leads to permanent loss of some vital ecosystems previously prevalent in these urban areas. In support of this, Tiffany (undated) points out that property development in urban and rural areas is the cause of more than 60% of national wetland loss.

A casual observation of some settlement areas in Bungoma town such as Mashambani and Sinoko, among others reveals massive destruction of Wetlands largely resulting from effects of construction activities. These wetlands were initially areas of grazing and grass harvesting as well as sources of water for domestic use. But now it appears, the community perception on these traditional uses of wetlands has shifted. Another trend is that land traditionally used to be communally owned, but due to urbanization and high population growth, individual land ownership is popular.

It could be for these reasons that individuals want to maximize profitability from their property and it appears that property development is the best alternative.

1.0.1 Fragile ecosystems

There is a growing scientific consensus that habitats are altered and species are disappearing at rates never witnessed on the planet before (*Myers, 1990*). There is also a growing public concern about this problem and different actions have been taken to retard impoverishment of natural diversity.

Within the overall goal of development, these actions strive to match every ecosystem or landscape to the most appropriate uses (*IUCN/UNEP/WWF 1991, Steinitz, 1990*).

Towards this end species, communities or ecosystems that are most likely to be damaged or become extinct because of human activities are termed as fragile, sensitive or vulnerable.

Two distinctions can be made from available literature: areas that are naturally fragile because of large natural and internal succession changes (i.e. they change by themselves) and those areas that change as a result of external pressures, most often induced by humans (*Goldsmith, 1983*).

In a restricted sense, then fragile areas should only be those affected by external disturbances, either produced by alteration of internal disturbances such altered fire, grazing regime, etc or human activities.

Of this, wetlands are termed fragile ecosystems that have been credited as the lifeline of nature's equilibrium and climatic stability (*Shanbhag et al, 2008*). Wetlands provide a vivid example of the dynamic, yet fragile interactions that create, maintain, and repair the world's ecological system. Unfortunately, the fate of many wetlands can also offer concrete evidence of the harmful consequences of human activities that are carried out without regard for, and often without knowledge of, the relationship of each part of the ecosystem to the whole. Once regarded as useless swamps, good only for breeding mosquitoes and taking up otherwise valuable space, wetlands have become the subject of increasingly heated debate. Many people want to use them for commercial purposes such as agricultural and residential development. Others want them left in their natural state because they believe that wetlands and their inhabitants are indispensable parts of the natural cycle of life on Earth. Wetlands occur naturally on every continent except Antarctica. They can also be constructed artificially as a water management tool, which may play a role in the developing field of Water Sensitive Urban Design.

The UN Millennium Ecosystem Assessment determined that environmental degradation is more prominent within wetland systems than any other ecosystem on Earth.

1.0.2 Importance of wetlands

From colonial times until recently, wetlands have been usually regarded as nuisances, only fit to be drained, cleared, filled, inundated, degraded with toxins and nutrients, and exploited for whatever resources could be extracted from them. In urban areas construction on them has been the in thing (*Maltby E, 1986*).

In their natural state, wetlands produce numerous benefits for society. Benefits which are either irreplaceable if lost or can only be replaced at immense expense. Broadly speaking, wetlands regulate water flows, storing water and buffering the effects of storms; filter and help to purify water; and provide essential habitat for flora and fauna.

Wetlands provide habitat for many species of fish and wildlife, including migratory birds, endangered species, commercially and recreationally important finfish, shellfish, and many species of wild plants.

As natural regulators of water flows, wetlands provide a cost-effective means of flood control, slowing and retaining water during periods of high runoff. This buffers the impact of storms and reduces shoreline erosion, thereby protecting against the loss of life and property. By holding water and releasing it slowly, wetlands help to recharge groundwater supplies and offset the effects of drought. Moreover, through processes not fully understood, wetlands can moderate local temperature and precipitation.

By filtering out pollutants and trapping sediments, wetlands help to maintain water quality. Indeed, artificial wetlands are now being created as a means of treating sewage. When wetlands are seriously altered or destroyed, rivers, lakes, and streams are subjected to more agricultural and urban runoff. This runoff can flow into sensitive estuaries, harming fisheries, and it can also impair drinking water supplies. The ability of wetlands to assimilate wastes, however, can be exceeded. Degradation of the water quality in wetlands is becoming a serious national problem.

Thus, although wetlands are generally recognized as a vital element in the biosphere, they continue to disappear and be degraded.

1.0.3 Bungoma Town

Much of the western and eastern part of the municipality is covered by wet grasslands and patches of marshlands. River Khalaba runs across the eastern part and provides grounds for recreation, fishing and a host of other anthropogenic activities. These grasslands were originally set aside for grazing and grass harvesting for traditional thatched houses, both activities which are of relatively less importance compared to property development in the municipality in contemporary times.

The wet grasslands have now been subdivided into individual plots and are being developed to ease the ever increasing demand for housing in the municipality. Reconnaissance field study revealed that most of them on the eastern side had already been developed. It is observable that these developments are rarely approved. Most of the houses developed here have raised floors as a counter measure for flooding and effects of underground water as the water table is very low in these parts.

1.1 Statement of the problem

The hypothesis that urbanization can have direct and indirect impacts on the environment, and that wetlands are particular susceptible to negative change, has long been proven (*Darnell, 1976; Maltby, 1986*). Yet despite this, the march of urbanization continues to destroy and degrade natural capital.

Relatively flat terrains are easier to urbanize than upland areas resulting in a concentration of human developments on these habitats (*Zedler and Leach, 1998*). This has resulted in a progressive direct loss of wetlands around the globe, through activities such as drainage or infilling, and indirect degradation, through activities away from these areas such as water abstraction or conversion of wetlands to agricultural land (*Lee et al., 2006; Bolca, et al., 2007*).

Bungoma Town is situated on a relatively flat terrain which supports grasslands, marshes and wet meadows important for livestock and wildlife. To facilitate city development rapid and unplanned land reclamation has been achieved by draining and infilling marshes and wet meadows where possible. Not only has this impacted directly on wetland biodiversity, the destruction of marshes and wet grasslands has reduced the flood storage capacity of the land resulting in increased flush floods.

This research aims to determine the impacts construction activities have on wetlands, which include wet grasslands, river Khalaba and marshes. Bungoma Town is especially at risk as already a majority of wetlands have already been converted for other uses, the leading of which is property development. To my best knowledge, most similar studies have been focused on lakes and the coastal region in this country

1.2 Research questions

What are the types of wetlands found in Bungoma Town?

What are the impacts of construction activities on wetlands?

What are the conservation measures in the County?

How do the residents perceive existing wetlands?

1.3 Objectives

The overall objective is to determine the impacts of urbanization on wetlands in Kenyan.

Specific objectives include:

To determine the traditional uses of existing wetlands in the town

To investigate the impacts of construction on wetlands in the town

To investigate the perception of residents on the importance of existing wetlands

To identify measures put in place to conserve wetlands

1.4 Scope and limitations of the study

The study will focus on construction impacts on wetlands in Bungoma Town including residents perception on the importance of wetlands in their natural state and traditional uses. Where some wetlands such as the wet meadows of Mashambani and Sinoko areas as well as river Khalaba extend outside the municipality, the other areas will not be considered.

The study will seek to determine impacts on water quality and quantity, flora and fauna and extend of wetlands. Any other impacts will be ignored.

1.5 Justification

Many wetlands in the tropical regions have not been adequately studied as compared to those in the temperate regions (*FAO, 1998*). Most wetlands research in Kenya have been concentrated in lacustrine wetlands of the rift valley formation (*Kelebogile, 2005*). Neverthertheless, Kenya is endowed with numerous scattered pockets and belts of wetlands comprising mostly of marshes, wet meadows, streams and rivers.

The importance of this ecosystems and the role they play in the country socially, economically and especially environmentally cannot be overlooked.

In recent times, wetlands have assumed new attraction and value as potential agricultural lands, settlement areas due to their relative levelness, waste disposal sites because of their perceived worthlessness as well as a host of other uses. In summary, these have rendered wetlands to be truly threatened landscapes and ecosystems.

Wetlands need to be appreciated and conserved for their traditionally perceived values and hydrological- physical, biological and socio economic functions.

The study will seek to evaluate and determine how residents in Bungoma municipality perceive wetlands in the area. Focus will be on the impacts of property development on the existing wetlands and any conservancy measures that maybe in place. Effects on water quality and quantity, flora and fauna and extend of wetland loss will especially be evaluated.

It is important to point out that I have not come across any similar study in the area, thus further necessitating the study.

Findings will be used to inform the public and decision makers on importance of conserving wetlands as well as pointing out gaps that may not be filled by this study for further action.

The paper will be focusing on freshwater wetlands found within Bungoma town residential area, which fit into the following categories:

River Khalaba – and its banks (called ‘riparian’ zones)

Marshes

Wet Meadows

1.6 Theoretical framework

In line of thought, the study seeks to utilize the theory of cognitive dissonance and pragmatism. These two theories best reflect the attitude and character change that leads to destruction of wetlands and the measures required thereof to preserve the wetlands viv avis property development.

Cognitive dissonance

Leon Festinger formulated the original theory of cognitive dissonance in the mid-1950s, and the first formal and complete presentation of the theory appeared in 1957. Festinger theorized that, when an individual holds two or more elements of knowledge that are relevant to each other but inconsistent with one another, a state of discomfort is created (*Eddie and Cindy, 2007).*

Persons are motivated by the unpleasant state of dissonance to engage in "psychological work" so as to reduce the inconsistency, and this work will typically support the cognition most resistant to change.

One of the most often assessed ways of reducing dissonance is change in attitudes. Attitude change is expected to be in the direction of the cognition that is most resistant to change. In tests of the theory, it is often assumed that the knowledge about recent behavior is usually most resistant to change, because if a person behaved in a certain way, it is often very difficult to undo that behavior. Thus, attitude change would be consistent with the recent behavior.

Pragmatism

Pragmatism characterizes truth in terms of usefulness and acceptance. In general, truth is found by attending to the practical consequences of ideas. To say that truth is mere agreement of ideas with matters of fact, according to William James, is incomplete, and to say that truth is captured by coherence is not to distinguish it from a consistent falsity *(William, 1907*). In a genuine sense, James believes we construct truth in the process of successful living in the world: truth is in no sense absolute. Beliefs are considered to be true if and only if they are useful and can be practically applied. At one point in his works, James states, ". . . the ultimate test for us of what a truth means is the conduct it dictates or inspires."

1.7 Operational definitions

Ecosystem: A specific biological community and its physical environment, interacting to produce an exchange of matter and energy, comprise an ecological system. An ecosystem may be large, such as a forest, or very small, such as a pond or even the surface of a persons skin.

Biosphere: is a planetary life support system extending from the bottom of the oceans to the upper limits of the troposphere (the lowest layer of the atmosphere). It is a large scale system of integrated parts that contains and sustains life.

Anthropogenic: of, relating to, or resulting from the influence of human beings on nature.

Fragile environment: A fragile environment is an ecosystem or community which lacks resilience or which is so heavily impacted by an 'un-natural' (generally human) event that it changes in unexpected and undesirable ways. Any definitions of fragility must be relative to the normal disturbance regime which that community would be expected to encounter.
Disturbance regimes cover a spectrum which includes small frequent events and everything up to extreme uncommon events. All communities and ecosystems are vulnerable or fragile to some extent. Recognizing the limits is the key to understanding and management.

Wetland: any land that is flooded shallow water all or most of the time.
Federal definition of wetlands is “Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.” (Environmental Laboratory, 1987)

Philosophy: In Geography, we describe philosophy as the line of thinking that shapes and guides a research.

1.8 Methodology

The aim of this research is to evaluate urbanisation impacts on wetlands in Bungoma municipality. To achieve this purpose, data will be collected through literature review and desk study as well as qualitative research interviews for primary data.

Analysis of the collected data will be through SPSS (statistical package for social scientists) programme and chi- square for inference of the stated hypothesis.

1.9 Summary of the chapters

Chapter one will deal with introductory part of the research including background information, statement of the problem, justification, objectives and hypothesis as well as theoretical frame work. Chapter two will be concerned with the review of existing literature on wetlands from a global perspective narrowing down to the study area. In Chapter research methodology will be outlined. Chapter four will focus on the research design and analysis. In chapter five results and findings from the research will be discussed in detail including conclusion and recommendations from the research as well as a discussion of research efforts that need to be made in the future.

CHAPTER TWO

2.0 Literature Review

2.1 Definition of wetlands

Generally speaking, a wetland is an area that is neither dry land nor open water (*Florida State of the Environment, undated*). All wetlands are formed and sustained by the influence of water on land. However, the depth and duration of water in different types of wetlands can be extremely variable. In some wetlands the water is at ground level, where the saturated soils stay wet most of the time. While other wetlands are inundated, with normal water levels above ground. To make the situation even more confusing, the water levels in some wetlands can fluctuate dramatically. Many wetlands are dry for extended periods, but these same wetlands at other times may contain several feet of water. These are some of the reasons why it can be difficult to define and delineate a wetland.

Ramsar convention definition

Wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres, (Article 1.1). It further adds, in Article 2.1, that wetlands may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands."

Regional definitions

Although the general definition given above applies around the world, each country and region tends to have its own definition for legal purposes. For example, in the United States, wetlands are defined as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. For example the Maryland Wetland Conservation Plan (2003) briefly summarizes wetland as follows:

“Wetlands may be permanently flooded by shallow water, permanently saturated by groundwater, or periodically inundated or saturated for varying periods during the growing

season in most years. Many wetlands are the periodically flooded lands that occur between uplands and salt or fresh water bodies (i.e., lakes, rivers, streams and estuaries). Other wetlands may be isolated in areas with seasonally high water tables that are surrounded by upland or occur on slopes where they are associated with groundwater seepage areas or drainageways.

The State of Florida defines wetlands in Section 373.019 (17) of the Florida Statutes, and Section 62-340.200 (19) of the Florida Administrative Code, as follows:

"'Wetlands' . . . means those areas that are inundated or saturated by surface water or ground water at a frequency and a duration sufficient to support, and [that] under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Soils present in wetlands generally are classified as hydric or alluvial, or possess characteristics that are associated with reducing soil conditions. The prevalent vegetation in wetlands generally consists of facultative or obligate hydrophytic macrophytes that are typically adapted to areas having soil conditions described above. These species, due to morphological, physiological, or reproductive adaptations, have the ability to grow, reproduce or persist in aquatic environments or anaerobic soil conditions.

According to Environmental Management and Coordination Act of 1999(*EMCA 1999, pg 6*) "wetland" means areas permanently or seasonally flooded by water where plants and animals have become adapted;

Dictionary definition

Wetlands are, according to dictionary.com, lands that have a wet and spongy soil, as marsh, swamp or bog.

Therefore several definitions exist but for this study, the EMCA 1999 definition will apply since it defines all wetlands found in Kenya in respect to geographical, topographical and climatic patterns.

2.2 Wetland Types

Typical names for wetlands are bogs, bottomlands, fens, marshes, swamps, wet meadows, and wet prairies. Each of these are common names for a wetland, but each have different meanings. Mitsch and Gosselink (2000) defined these types of wetlands as follows:

Bog. A peat-accumulating wetland that has no significant inflows or outflows and supports acidophillic mosses, particularly sphagnum.

Bottomland. Lowlands along streams and rivers, usually on alluvial floodplains that are periodically flooded. When forested, it is called a bottomland hardwood forest in the south-eastern and eastern United States.

Fen. Peat-accumulating wetland that receives some drainage from surrounding mineral soils and usually supports marsh like vegetation.

Marsh. A frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions.

Swamp. Wetland dominated by trees and shrubs (U.S. definition).

Wet Meadow. Grassland with waterlogged soil near the surface but without standing water for most of the year.

Wet Prairie. Similar to a marsh, but with water levels usually intermediate between a marsh and a wet meadow.

The study area is endowed with wet meadows, Marshes and riparian wetlands and therefore in accordance with EMCA 1999 definition, this three types apply.

2.3 Characteristics of wetlands

Wetlands have unique characteristics: they are generally distinguished from other water bodies or landforms based on their water level and on the types of plants that thrive within them. Specifically, wetlands are characterized as having a water table that stands at or near the land surface for a long enough period each year to support aquatic plants. Wetlands have

also been described as a transition between dry land and water bodies, so that they exist at the interface between truly terrestrial ecosystems and aquatic ecosystems, making them inherently different from each other, yet highly dependent on both. They may be classified as natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt. It also includes, in areas of marine water, the depth of which at low tide does not exceed six metres.

2.3.1 Ecology

The most important factor producing wetlands is flooding. The duration of flooding determines whether the resulting wetland has aquatic, marsh or swamp vegetation. Other important factors include fertility, natural disturbance, competition, burial and salinity. When peat accumulates, bogs and swamps arise.

2.3.2 Hydrology

Wetland hydrology is associated with the spatial and temporal dispersion, flow, and physiochemical attributes of surface and ground water in its reservoirs. Based on this, wetlands can be categorized as riverine (associated with streams), lacusterine (associated with lakes and reservoirs), and palustrine (isolated). Sources of hydrological flows into wetlands are predominately precipitation, surface water, and ground water.

Water flows out of wetlands by evapo-transpiration, surface runoff, and sub-surface water outflow. The movement of water through and from a wetland is also known as hydrodynamics. Hydrodynamics affects temporal fluctuations in water levels (hydroperiods) by controlling the water balance and water storage within a wetland.

Landscape characteristics control wetland hydrology and hydrochemistry. The oxygen and carbon (iv) oxide concentrations of water depend on temperature and atmospheric pressure. Hydrochemistry within wetlands is determined by the pH, nutrients, salinity, soil composition, conductivity, hardness, and the sources of water. Water chemistry of wetlands varies across landscapes and climatic regions. Wetlands are generally minerotrophic with the exception of bogs. That is, they usually have high mineral ionic composition.

Bogs receive their water from the atmosphere and therefore their water has low mineral ionic composition: ground water has a higher concentration of dissolved nutrients and minerals in comparison to precipitation.

2.3.3 Soil

Carbon is the major nutrient cycled within wetlands. Most nutrients, such as sulphur, phosphorus, carbon, and nitrogen are found within the soil of wetlands. Anaerobic and aerobic respiration in the soil influences the nutrient cycling of carbon, hydrogen, oxygen, and nitrogen, and the solubility of phosphorus thus contributing to the chemical variations in its water. Wetlands with low pH and saline conductivity may reflect the presence of acid sulphates and wetlands with average salinity levels can be heavily influenced by calcium or magnesium. Biogeochemical processes in wetlands are determined by soils with low redox potential.

2.4 Significance of wetlands

Wetlands hold a lot of potential for bird watching tourism where Kenya, according to Wikipedia, attracts an annual 500,000 bird watching tourists. Wetlands also act as water filters against pollutants like fertilisers from crop lands.

While wetlands have the potential of contributing significantly to the socio-economic development of Kenya, they face diverse and severe threats. These threats include among others inappropriate anthropological activities within the catchments and in the wetlands, lack of coordinated and holistic policy guidelines, and climate change. The threats have induced changes that have eroded the ecological and socio-economic values and services derived from wetlands. The underlying threat remains lack of recognition of the importance of these wetlands.

The United Nations Millennium Ecosystem Assessment and Ramsar Convention found wetlands to be of biosphere significance and societal importance in the following areas: Flood control, Groundwater replenishment, Shoreline stabilisation and storm protection, Water purification, Reservoirs of biodiversity, Wetland products, Cultural values, Recreation and tourism, Climate change mitigation and adaptation.

2.5 Wetlands biodiversity

Biodiversity includes species of invertebrates, fish, amphibians, reptiles, mammals and flora. However, many of the flora and fauna that are part of wetlands are disappearing. As most species are endemic to wetlands, biologists and other scientists routinely census wetland biota to look for threatened populations. The IUCN is the body responsible in determining whether a species is endangered or threatened. Biodiversity loss occurs in wetland systems through land use changes, habitat destruction, pollution, exploitation of resources, and invasive species. Yet, all these are controllable.

2.6 Wetland products

Wetland systems naturally produce an array of vegetation and other ecological products that can be harvested for personal and commercial use. The most significant of these is fish which have all or parts of their life-cycle occur within a wetland system. Another staple food found in wetland systems is rice. Food converted to sweeteners and carbohydrates include the sago palm of Asia and Africa (cooking oil), the nipa palm of Asia (sugar, vinegar, alcohol, and fodder) and honey collection from mangroves.

Other mangrove- derived products include fuel wood, salt (produced by evaporating seawater animal fodder, traditional medicines (e.g. from mangrove bark), fibres for textiles as well as dyes and tannins

2.7 Wetland versus climate change

Wetlands perform two important functions in relation to climate change. They have mitigation effects through their ability to sink carbon and adaptation effects through their ability to store and regulate water

2.8 Wetlands conservation

Wetlands have historically been the victim of large draining efforts for real estate development, or flooding for use as recreational lakes (Gooselink and Mitch, 1999). Since the 1970s, more focus has been put on preserving wetlands for their natural function yet by 1993 half the world's wetlands had been drained. Wetlands provide a valuable flood control

function. Wetlands are very effective at filtering and cleaning water pollution, (ironically from agricultural runoff from the farms that replaced the wetlands in the first place). To replace these wetland ecosystem services enormous amounts of money had to be spent on water purification plants, along with the remediation measures for controlling floods: dam and levee construction.

In order to produce sustainable wetlands, short-term, private-sector profits need to come secondary to global equity. Decision-makers must valuate wetland type, provided ecosystem service, long-term benefit, and current subsidies inflating valuation on either the private or public sector side.

2.9 Pollution of wetlands

Many wetlands, particularly those near cities and towns, have been polluted by human activities. Waterways often carry toxic loads of nutrients, heavy metals, pesticides and contaminants from previous activities that involved sewage plants, chemical factories, refineries and industry.

Non-point source (single location) pollution resulting from broad-scale land-use practices such as land clearing, urbanization, cropping and grazing is a more widespread issue. Changed land use has led to the eutrophication of wetlands due to increased nutrients in the form of sedimentation, fertilizer run-off and organic wastes entering wetlands. These nutrients cause rapid increases in phytoplankton and aquatic plant growth. The high levels of organic matter may cause massive de-oxygenation of the wetland resulting in a decline in water quality and a severe loss of aquatic life.

The effects of non-point source pollution are less easily and less quickly reversed than are those of point source pollution. Most industries including agriculture have and are continuing to improving their best management practices to reduce the effects of non-point source pollution on wetlands and the surrounding environment.

The protection and re-establishment of riparian vegetation to act as buffers is a good step in limiting the impacts of non-point source pollution

2.10 Wetlands habitat alteration

Snags (fallen timber), rocks and submerged aquatic vegetation are important in stream habitats, providing sheltered areas, spawning sites and habitat diversity. In stream habitat alterations including de-snagging (removing submerged or emergent logs or branches from watercourses) and channelization (artificial modification of watercourses to ensure maximum flow and minimum flooding) of waterways have reduced the diversity and availability of aquatic habitat. Changes to the natural flow regime variation have reduced aquatic habitat diversity and availability.

The clearing of riparian vegetation leads to habitat loss, as this vegetation contributes directly to in-stream habitat through fallen trees, leaf litter and branches. For example, clearing of riparian vegetation is one of the major causes of habitat loss in Queensland's freshwater wetlands (*Queensland report*). Submerged roots and logs provide important shelter and spawning areas for native fish. Loss of aquatic habitat creates a shortage of feeding, hiding and spawning sites, and results in a subsequent loss of diversity of fauna present.

Impoundments act as sediment traps and can trap over 95% of the sediment load transported by a river, with the water passing over the impoundment relatively free of sediment. This can lead to a significant re-adjustment of the downstream channel morphology and substrate composition. If the flow velocities leaving the impoundment are sufficient, then considerable scouring and subsequent entrainment (washing away) of the downstream bed sediment can result. This can cause considerable erosion and downstream channel migration as well as the destruction of important habitat for in-stream animal and plant life.

2.11 Impacts of construction on wetlands

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 (*Ajibola et al, 2012*). It is estimated that around 5 percent of agricultural land globally (264 million ha) 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 area and 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 Analysis*

of Global Ecosystems P.A.G.E, 2000). Irrigation accounts for approximately 70 percent of the water withdrawn from freshwater systems for human use. Only 30 – 60 percent is subsequently used downstream, making irrigation the largest net user of freshwater. Estimates also show that the share of cropland that is irrigated has grown by 72 percent from 1996.

Millennium Ecosystem Assessment (2005) stated that the degradation and loss of inland wetlands and species has been driven by infrastructure development (such as housing, dams, dikes, and levees), land conversion, water withdrawals, pollution, overharvesting, and the introduction of invasive alien species. 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 (*Gosselink and Baumann, 1980; Gagliano, Myer-Arendt, and Wicker, 1981*). Literally hundreds of reports have been written about the complex physical and biogeochemical processes and their interdependencies that are responsible for wetland loss (*Day et al., 2000 and Penland et al., 2000*). 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 in wetlands. Degradation of inland wetlands through land development and water management reduces the capacity of wetlands to provide significant ecosystem services. Human activities intended to reduce damage to life and properties from climate extremes have unintentionally increased the vulnerability of wetlands 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. Filling or draining a wetland can so alter the water regime that the land can no longer support the wetland vegetation and maintain hydric soils. For example, if a wetland is lost, most if not all of its wetland functions are also lost.

As stated in the literature, the loss and degradation of wetlands has resulted in increased risks from floods, coastal storms and tidal surges, leading to unintended consequences for both human and natural systems.

Mironga (2005), in a study conducted on Kisii District of Kenya, points out that drainage and other forms of disturbance associated with agriculture and property development are the main

contributors to wetland loss. Williams (1990) states that globally, wetlands have been drained, primarily for agriculture and construction purposes. In a study conducted in Zimbabwe, Madebwe and Madebwe (2005) conclude that growth in population, high drought incidence rates, national and economic developmental challenges resulted in destruction of wetlands. 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.

Water withdrawals for irrigation in some cases can act to exacerbate the effects of other stressors on the wetland ecosystems, resulting in effects that exceed those that would be expected from dewatering alone. Altinsacli and Griffiths (2001) identify Lake Kus in Western Turkey to be under stress from a growing use of the lake by the local human population. One of these stresses is the increasing pollution of the lake by organic materials. This, in conjunction with dewatering for irrigation, has resulted in the increasing eutrophication of the lake and changes in the aquatic biota toward an assemblage more characteristic of nutrient rich systems. Wildlife responses to the implementation of irrigation schemes can, in turn, result in stress to wetlands. Water withdrawal was also identified as a source of stress around Lake Kus. There is no known mechanically operated irrigation activity past or present in Bungoma town. The major pressure is wetland reclamation and conversion to development purposes.

All these are the outcome of unconcerned attitude of both the people and government of Kenya to protect the wetlands, which are incessantly converted to other uses allegedly for higher economic gains.

While there had been studies on wetland loss in places such Louisiana, USA, Zimbabwe, Kisii (Kenya), one cannot categorically say that such studies had been conducted on wetland loss in Bungoma town, however all the factors contributing to wetland losses as identified in the literature are highly noticeable in the study area.

2.12 Effects of Market Failure on Urban Wetlands

The market system is a powerful, relatively inexpensive, self-adjusting and responsive mechanism for resource allocation. Yet market failures occur when the price mechanism fails to come up with the social optimum in resource allocation. Environmental resources, such as wetlands, become difficult to value when they do not pass through regular pricing mechanisms (the market). Wetland values are often not taken into account properly or fully in decision making, or are only partially valued, often leading to degradation or even destruction of a wetland. The reasons why wetlands are undervalued and/or overused according to (*Vorhies 1999; Stuip, Baker and Oosterberg, 2002*) include:

• *Market failure*: public goods. Many of the ecological services, biological resources and amenity values provided by wetlands have the qualities of a public good; i.e., many wetland services are seen as "free" and are thus not accounted for in the market (e.g., water-purification or flood-prevention);

• *Market failures: externalities*. Another type of market failure occurs when markets do not reflect the full social costs or benefits of a change in the availability of a good or service (so-called externalities). For example, the price of agricultural products obtained from drained wetlands does not fully reflect the costs, in terms of pollution and lost wetland services, which are imposed upon society by the production process;

• *Perverse incentives* (e.g., taxes/subsidies stimulating wetland over-use). Many policies and government decisions provide incentives for economic activity that often unintentionally work against the wise use of wetlands, leading to resource degradation and destruction rather than sustainable management (Vorhies 1999). An example might be subsidies for shrimp farmers leading to mangrove destruction;

Unequal distribution of costs and benefits. Usually, those stakeholders who benefit from an ecosystem service, or its over-use, are not the same as the stakeholders who bear the cost. For example, when a wetland is affected by pollution of the upper catchment by runoff from construction impacts, the people living downstream of the wetland could suffer from this. The resulting loss of value (e.g., health, income) is not accounted for and the downstream stakeholders are generally not compensated for the damages they suffer (*Stuip, Baker and Oosterberg, 2002);*

• *No clear ownership*. Ownership of wetlands can be difficult to establish. Wetland ecosystems often do not have clear natural boundaries and, even when natural boundaries can be defined, they may not correspond with an administrative boundary. Therefore, the bounds of responsibility of a government organization cannot be easily allocated and user values are not immediately apparent to decision-makers.

• *Devolution of decision-making away from local users and managers*. Failure of decision-makers and planners to recognize the importance of wetlands to those who rely on them, either directly or indirectly.

It is prudent to point out that market failure as stated above could also be a factor in the noticeable degradation of wetlands in the study area.

2.2 Impacts of Urbanization on Wetlands

Urbanization impacts wetlands in numerous direct and indirect ways. For example, construction reportedly impacts wetlands by causing direct habitat loss, suspended solids additions, hydrologic changes, and altered water quality (*Darnell 1976*). Indirect impacts, including changes in hydrology, eutrophication, and sedimentation, can alter wetlands more than direct impacts, such as drainage and filling (*Keddy 1983*). Urbanization may affect wetlands on the landscape level, through loss of extensive areas, at the wetland complex level, through drainage or modification of some of the units in a group of closely spaced wetlands, and at the level of the individual wetland, through modification or fragmentation (*Weller 1988*). Various impacts already identified include the ones discussed below:

2.2.1 Hydrologic Impacts

The changes on wetlands by hydrologic impacts had been far more dramatic than other impacts. Hydrologic changes have large and immediate effects on a wetland's physical condition, including the depth, duration, and frequency of inundation of the wetland. The changes in hydrology caused by urbanization can exert complete control over a wetland's existence and characteristics. Hopkinson and Day (1980) predicted that urbanization bordering a swamp forest would increase runoff volumes by 4.2 times. Greater surface runoff is also likely to increase velocities of inflow to wetlands, which disturb wetland biota and scour wetland substrates (*Stockdale 1991*). Increased amounts of storm water runoff in wetlands alters water level response times, depths, and duration of water detention (*US EPA*

1993). Reduction of watershed infiltration capacity is likely to cause wetland water depths to rise more rapidly following storm events. Diminished infiltration in wetland watersheds can also reduce stream base flows and ground water supplies to wetlands, lengthening dry periods and impacting species dependent on the water column (*Azous 1991*). All these are glaringly effects of Bungoma town growth on the wetlands. In the past few years, the rate of water runoff has increased within the town, to an alarming rate.

Every slight rain has resulted into hazardous flash floods in the town due high rate at which wetlands are still being converted into economic uses.

2.2.2 Impacts to Vegetation

Impacts on wetland hydrology and water quality can, in turn, affect wetland vegetation. Horner (1989) stated that emergent zones in Pacific Northwest wetlands receiving urban runoff are dominated by an opportunistic grass species, Phalaris arundinaceous, while non-impacted wetlands contain more diverse groupings of species. There have been numerous reports on the tolerance to flooding of wetland and non-wetland trees and plants (e.g. US EPA 1993).

2.2.3 Impacts to Wetland Fauna

Just as hydrologic changes affect Wetland plants they also affect wetland animal communities. Increased imperviousness in wetland watersheds can reduce stream base flows and groundwater supplies, prolonging dry periods in wetlands and impacting species dependent on the water column (*Azous 1991*). Many amphibians require standing water for breeding, development, and larval growth. Amphibians and reptile communities may experience changes in breeding patterns and species composition with changed water levels (*Minton 1968 in Azous 1991*). Water Quality Impacts to Wetland Fauna -- Pollutants can have both direct and indirect effects on wetland fauna. Portele (1981) reports that road runoff containing toxic metals had an inhibitory effect on zooplankton, in addition to algae. The increase in impervious surface associated with urban land conversion also leads to a decrease in infiltration and an increase in surface runoff, sedimentation, and eutrophication of wetlands. Uncontrolled urban expansion also leads to the fragmentation of landscapes, destruction of wildlife habitat, and reduction in biodiversity. These impacts make an understanding of the factors driving urban expansion essential to global environmental change research.

Wetlands also have considerable aesthetic, cultural, educational and spiritual values (*Papayannis, 2008*) and provide sustainable opportunities for recreation and tourism (*Oumou et al., 2006*). In some developed countries urban wetlands may be the last remaining opportunities for urbanites to interact with nature and green spaces (*Chiesura, 2004*).

It is clear that whilst humanity is becoming increasingly urban the quality of urban life is still dependent on 'nature', and particularly global ecosystem services, for its survival (*Bolund and Hunhammar, 1999*).

It's therefore prudent that the high economic value of this wetland must be protected and the economic costs associated with the degradation of these values must be offset against gains arising from wetland modification for residential and industrial development (*Emerton et al., 1998*).

2.2.4 Urbanization Impacts on Wetlands in Bungoma town

As earlier stated, growth of Bungoma town has led to population pressure on existing land thus high value of real Estates. It is for this reason that most of the wetlands are being converted for other uses, leading among being property development. In addition, according to A Guide to Living with Florida's Wetlands (undated) ,although wetlands serve society in multiple ways, the nature of wetland benefits are such that the owners of wetlands usually cannot capture the benefits for their own use or sale. The flood protection benefits accrue to others downstream. The fish and wildlife that breed and inhabit the wetlands migrate, and are captured or enjoyed by others. The ground water recharge and sediment trapping benefits cannot be commercially exploited. For the owner of a wetland to benefit from his resource, he often has to alter it, convert it, and develop it- construction seems to be the in thing.

CHAPTER THREE

3.0 RESEARCH DESIGN AND METHODOLOGY

3.1.0 Study Area

Bungoma town was established as a trading centre in the early 20th century. The town is the headquarters of Bungoma County and hosts a municipal council. Bungoma municipality has an urban population of about 120,000 (*2009 census*) with the rate of growth at 4% per annum.

The major economic activity within the municipality is farming and business supported by the Kenya-Uganda railway which passes through the town. There are no large scale industries within Bungoma town.

The town is located 450 km from the Kenyan capital Nairobi, on the Great North road to Kampala in Uganda at an altitude of 1,385 m or 4,547 feet above sea level. Bungoma has become alluring to investors because of availability of land for development most of which is freehold on freehold tenure (*westgateinnbungoma.com, Wikipedia.org/wiki/Bungoma)*.

3.1.1 History of Bungoma Town

Bungoma Town's history dates back to the construction of the Kenya Uganda Railway in the 1920s but recent growth is attributed to its location in the Western Sugar belt with both Nzoia and Mumias sugar factories only a short drive away as is the Pan African Paper Mills factory at Webuye.

The origin of the name Bungoma has two versions. One, that the site was inhabited by a Kalenjin sub tribe called "Bangot" and two, that it was a meeting place by the Bukusu elders who used drums "engoma'' to summon people to meetings- consequently, it was referred to as the place of drums by the local Bukusu hence the name Bungoma.

The oldest building in the town was a chief's office erected around 1140.Besides, it is near here that the Lumboka war against the British by the Bukusu was waged in 1892 culminating in the deaths of many locals at Chetambe hills near Webuye about 25 km away. At the time, the colonial District Commissioner was based in Mumias.

In 1956, Bungoma became the headquarters of Elgon Nyanza district and then granted Urban Centre status with 31 sq km and eight wards in 1964 shortly after independence. It then became a Town Council in 1973 before being elevated to a Municipality in 1980. Seventeen years later in 1997, the number of wards was increased to eight with a total land area rising from 31 sq km to 57 sq km. These wards are Namasanda, Siritany, Musikoma, Sinoko, Khalaba, Mjini, Stadium and Sio. The Council has eight elected and two nominated councilors.

During the 1999 population census, Bungoma Municipality had a population of 60,279, which has since more than doubled beyond 120,000 today because of the huge influx from rural areas coupled with a high population growth rate of over 7% per year.

Administratively, Township and Musikoma locations make up the area covered by the Municipal Council of Bungoma. The former is composed of Khalaba and Township sub-locations while the later is made up of Namasanda and South Kanduyi.

Currently Bungoma municipality has eight wards, four of them (Khalaba, Mjini, Sinoko and Stadium) are part of the Kanduyi Constituency and the remaining four (Namasanda, Musikoma, Sio and Siritanyi) are part of the Bumula Constituency.

Wetlands in Bungoma town

Bungoma town is endowed with extensive wet meadows on both the western and eastern frontiers. In real sense the town seems to have been part of massive wet grassland that was suitable for grazing.

Mashambani and Sinoko areas are also covered with patches of marshes. River Khalaba, which is the major river, runs across the eastern boundary forming a rich riparian wetland.

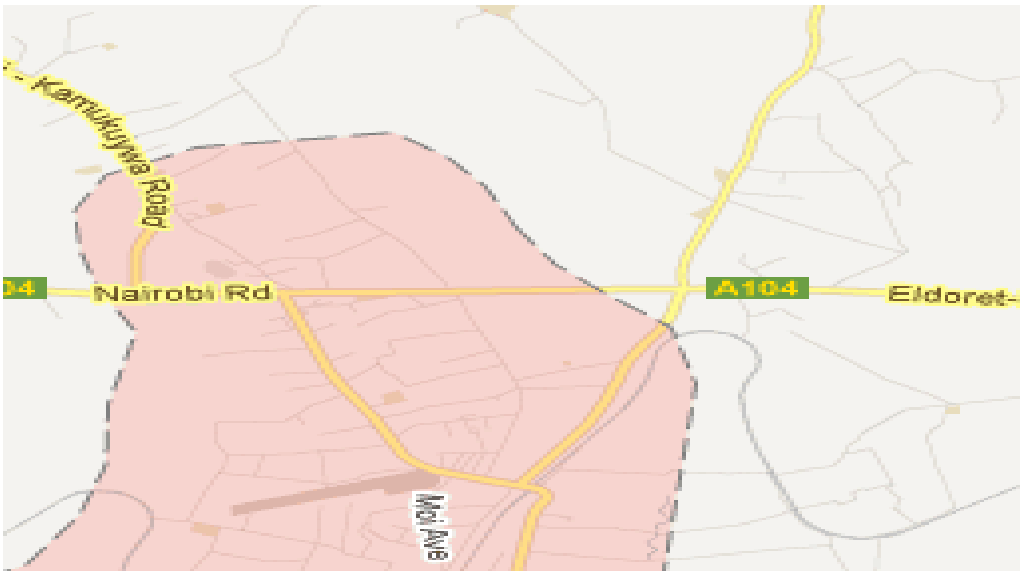


Fig 1, Bungoma municipality-courtesy of Google

Fig 2, satellite imagery depicting Bungoma town location- source Adam Morley, 2005

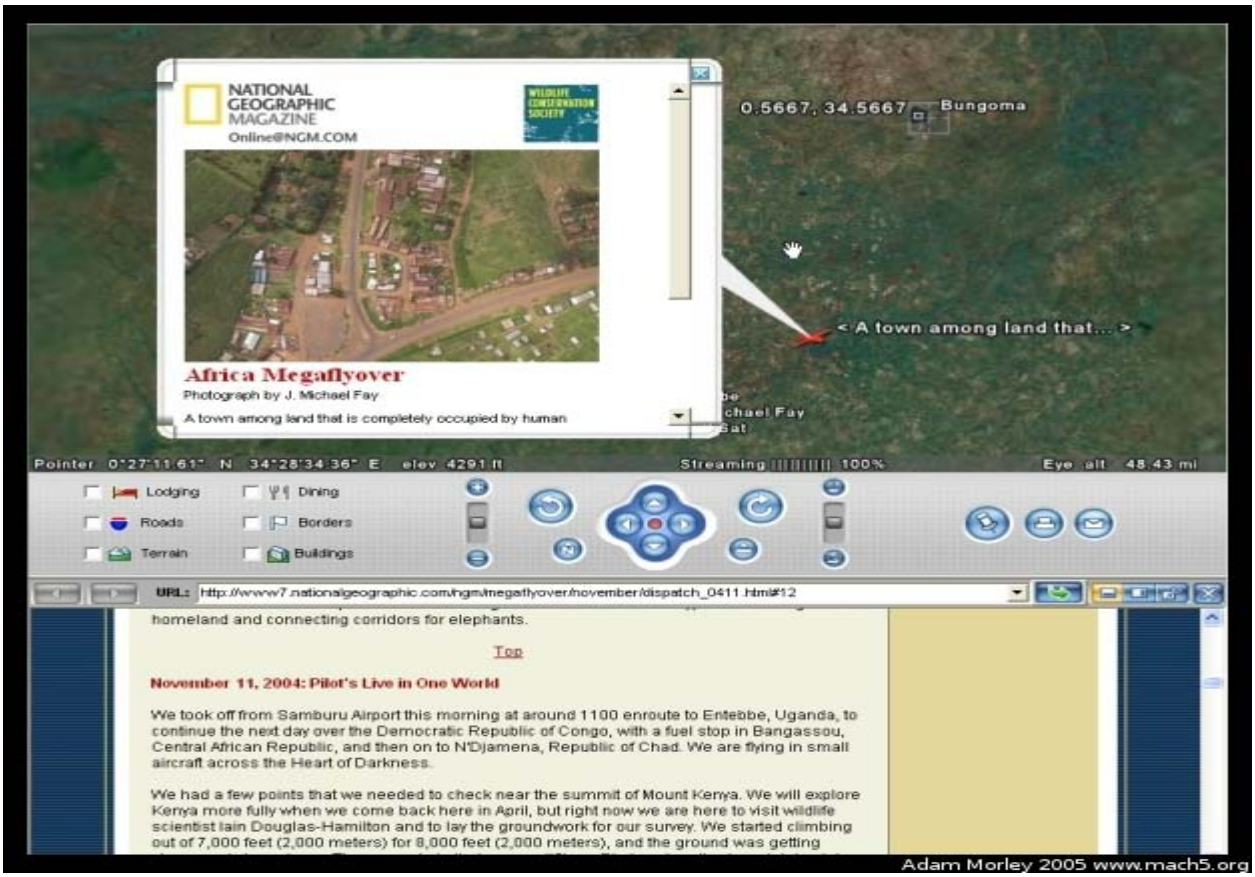


Fig 3- location of Bungoma town, source Adam Morley

Fig 4- River Khalaba riparian wetland- source Bungoma online

3.2 Research Design

According to Mugenda (1999), research design is the plan, structure and strategy of investigation conceived so as to obtain answers to research questions. Research design

involves the arrangement of the conditions for collection and analysis of data in the manner that aims to combine the relevance to the research purpose with economy in the procedure (Selltiz *et al*, 1962). The study took a descriptive and quantitative approach to get the residents perception on existing wetlands and offer adequate data analysis. In many cases a likert scale was used to determine these perceptions ranging from agree to disagree, e.t.c. This approach sought to collect data without manipulation or alteration of the research variables or the respondents in its investigation process.

3.3 Target Population

According to Mugenda (1999), target population is a population to which a researcher would like to generalize the results of a study. In accordance with 2009 national population and housing census Bungoma Municipality population was 120,000. However the research focused on inhabitants of Mashambani and Sinoko areas thus an estimated target population of 500 as estimated from chiefs in these areas.

3.4 Sample Size and Design

According to Kothari (*2004*), sample design is a definite plan for obtaining a sample from the sampling frame. It is decided before data collection. If descriptive study is used 10% of the target population is adequate (*Mugenda, 1999*). Therefore as a result, this study targeted to investigate fifty respondents. The decision was also due to time and pecuniary constraints that could not enable any large sample than this to be studied. In addition, the respondents from the residents were chosen on a cluster sampling mainly as a means of saving money because the population is spread out, and the researcher could not sample from everywhere.

3.5 Sources of Data and Data Collection

The data for this study was obtained from primary and secondary sources. The instruments for collection of primary data (firsthand information) ranged from semi-structured questionnaires, unstructured interviews and observation. Use of focus groups also contributed significantly on primary data. Secondary data was obtained from information on websites, published materials such as books and journals and other relevant unpublished materials such as class notes. Unstructured questionnaires and interviews enabled the researcher to obtain adequate data from the respondents especially as regarding perception and construction impacts on the existing wetlands.

3.6 Data Analysis and presentation

Data was analyzed by use of MS Excel and Statistical Package for Social Science (SPSS) computer program version 16. Data generated from the questionnaire were coded appropriately. Demographic data was treated as nominal data. Responses for each of these factors; gender, age, level of education, and occupation were accorded arbitrary category code (like gender; 1=male, 2=Female).

The analysed data was diagrammatically presented in form of pie charts and bar graphs. Tables were also used to present analysed data while the text was descriptive and narrative.

CHAPTER FOUR

4.0 DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents the data analysis and the interpretation of findings. This research aimed at determining the impacts of construction on urban wetlands, using the case of Bungoma Municipality riparian, wet meadows and marshland. A total 36 out of fifty respondents interviewed duly filled and returned the questionnaires / interview schedules. The data collected through these aforementioned data collection tools were analyzed using MS Excel and the statistical package for social sciences (SPSS) version 16.0. The results are presented based on the specific objectives in the subsequent section. This chapter thus considers 36 to be the valid, total number of respondents.

4.2 Research findings

4.2.1 Demographics of respondents

A total of thirty six respondents interviewed duly filled the questionnaire. The table below summarises the gender of the respondents. From the table, it shows that the majority of respondents (63.9%) were males while the rest (36.1%) were the females.

Table 4.1: gender of respondent

	Frequency	Percent	Valid Percent	Cumulative Percent
male	**23**	**63.9**	**63.9**	**63.9**
female	**13**	**36.1**	**36.1**	**100.0**
Total	**36**	**100.0**	**100.0**	

Source - Author

When it came to the age of the respondents, out of the thirty six, 16 represented respondents of ages between 18 and 25, hence a representation of 44.4%. Both the respondents of age bracket 26-35 and 36-45 were half the number of those in 18-25 and had an equal representation of 22.2%. The least represented group was of respondents with more than 46

years of age and was represented by the remaining 11.1% as summarised in the table 4.2 below.

Table 4.2: Age of respondent

	Frequency	Percent	Valid Percent	Cumulative Percent
18-25	**16**	**44.4**	**44.4**	**44.4**
26-35	**8**	**22.2**	**22.2**	**66.7**
36-45	**8**	**22.2**	**22.2**	**88.9**
over 46	**4**	**11.1**	**11.1**	**100.0**
Total	**36**	**100.0**	**100.0**	

Source - Author

From the responses gathered, very few people (5.6%) had lived in Bungoma Town for more than 50 years of their lives. A quarter of them (25%) admitted to have lived in the Municipality for 21-35 years. A total of 11 respondents, represented by 30.6% indicated that they had inhabited Bungoma town for at least one decade but not more than two. However, majority admitted to have lived in the town for less than 10 years as summarised in the following table 4.3.

Table 4.3: Number of years the respondent has lived in Bungoma town

	Frequency	Percent	Valid Percent	Cumulative Percent
0-10	**14**	**38.9**	**38.9**	**38.9**
11-20	**11**	**30.6**	**30.6**	**69.4**
21-35	**9**	**25.0**	**25.0**	**94.4**
over 50	**2**	**5.6**	**5.6**	**100.0**
Total	**36**	**100.0**	**100.0**	

Source - Author

The following table 4.4 is a summary of the occupation of the respondents to the research. A total of 13.9% of the respondents had been employed by the government while 41.7% claimed to be self employed. The remaining 44.4% consisted of full time students, homemakers and the unemployed.

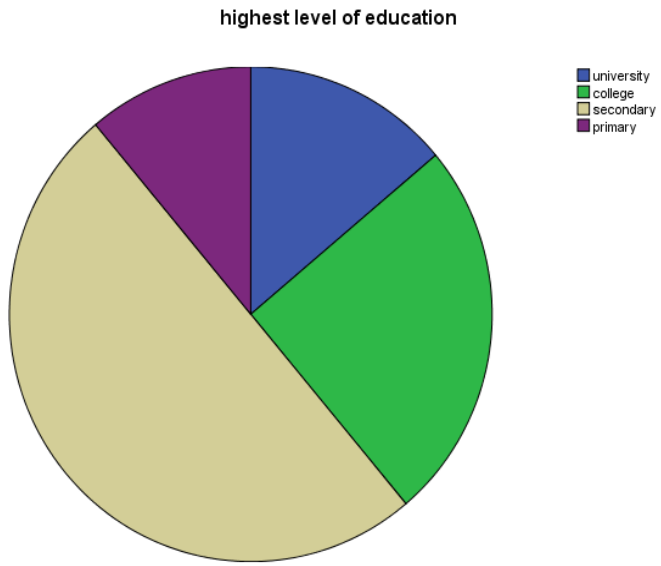
Table 4.4: Occupation of respondent

	Frequency	Percent	Valid Percent	Cumulative Percent
government employed	**5**	**13.9**	**13.9**	**13.9**
self employed	**15**	**41.7**	**41.7**	**55.6**
Others	**16**	**44.4**	**44.4**	**100.0**
Total	**36**	**100.0**	**100.0**	

Source - Author

On the highest level of education attained, a half (50%) of the respondents indicated that secondary level was their highest while a half of the remainder (25%) claimed that they had college diplomas. Those respondents with the highest level, university level, were represented by a total of 13.9%. Primary level was the lowest level of education and concurrently had the least representation of 11.1%.

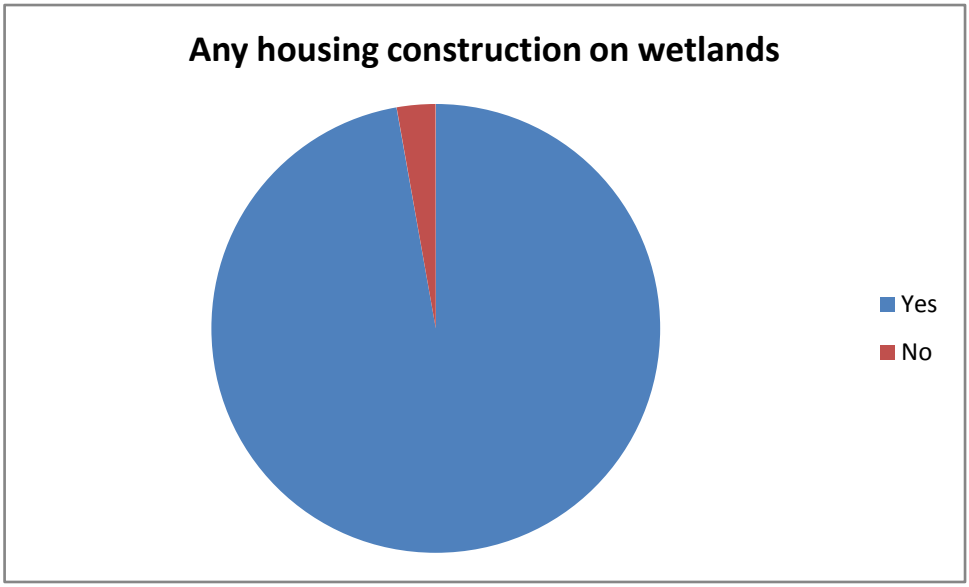
This information has been summarised in the chart 4.1 below.



Pie chart 4.1: highest level of respondents' education, - Source - Author

4.2.2 Specific information

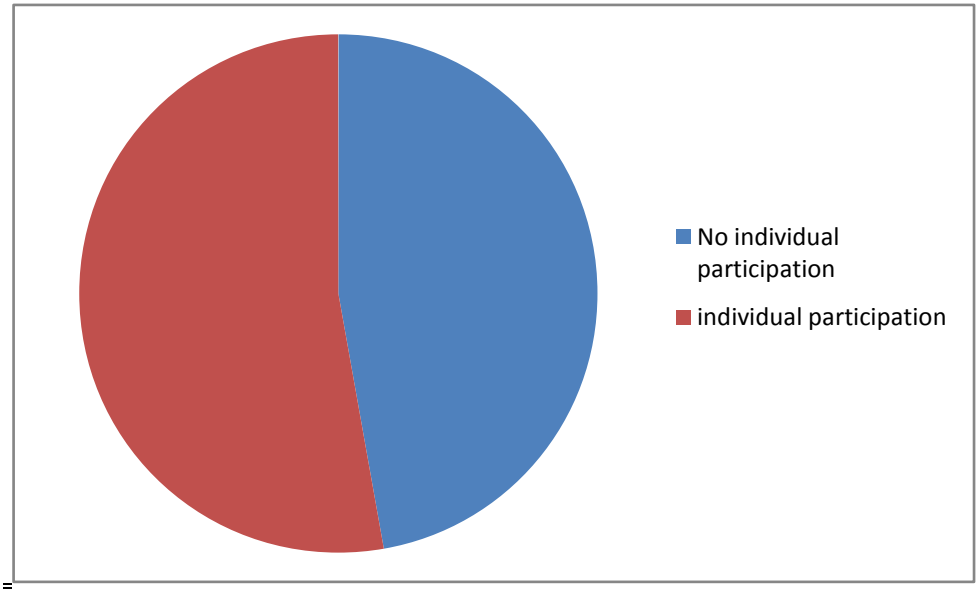
From the thirty six respondents interviewed, a majority of thirty five (97.2%) agreed that indeed housing construction was taking place in wetland areas. The rest (2.8%) denied this, claiming that there was no construction activity in these wetlands. This has been summarised in the pie chart 4.2 below.



Pie chart 4.2: Opinion on whether there is any housing construction on wetlands,

Source - Author

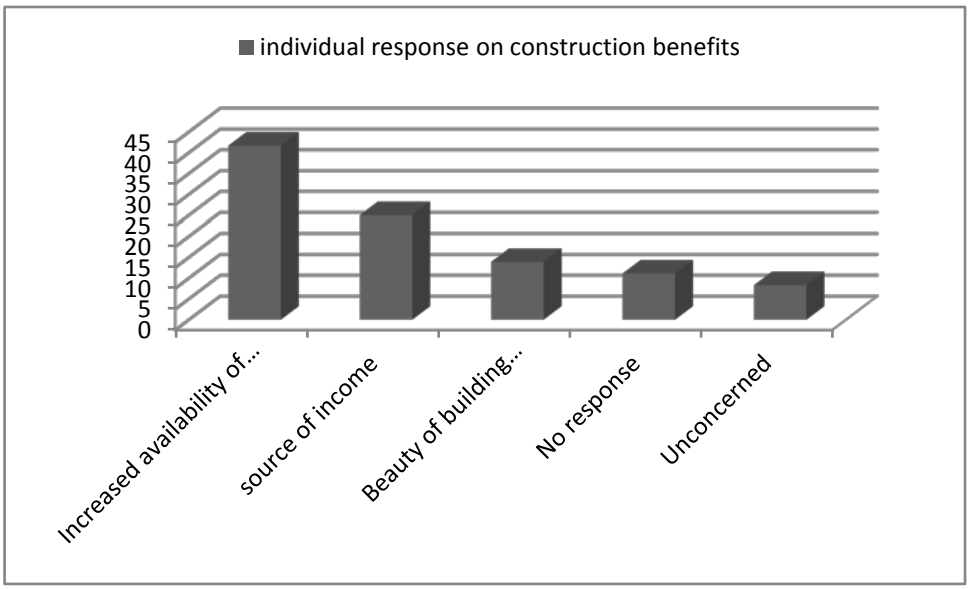
The respondents were asked whether they participated directly in any construction activity on wetlands. On this question a whole 100% of respondents who claimed that there were no construction activities on wetlands naturally agreed that they did not participate in any human activity around the wetland. On the other hand among the respondents that agreed that construction activities took place on the wetlands, a majority (52.8%) admitted that they individually participated. The remaining 47.2% denied direct individual participation in the activities. The pie chart 4.3 below represents this information.



Pie chart 4.3: Opinion if respondent individually participated in any construction activity on wetlands

Source - Author

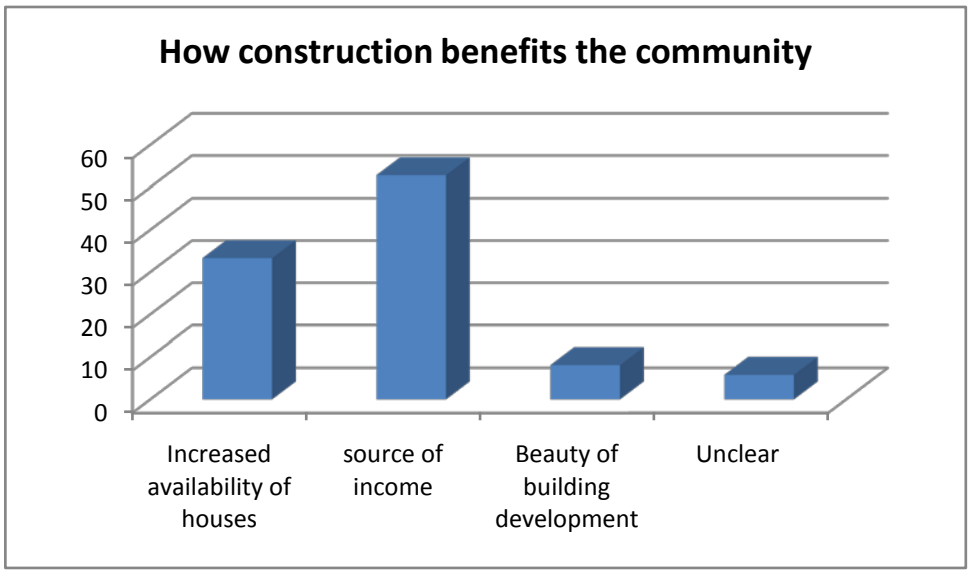
The respondents who agreed that construction activities were being carried out on the swamps also admitted that those activities benefited them as either as individuals or as a community, or both. A majority of 41.7% said that they benefited most by increased availability of houses. A quarter (25%) of the respondents said that deriving income was their most valued benefit while a total of 13.9% were comfortable with beauty of buildings as opposed to wastelands (wetlands). Another 11.1% did not respond on how the wetlands benefited them as individuals and the remaining 8.3% were unconcerned with the activities. The bar graph 4.1 below represents this information.



Bar graph 4.1: how construction activities on wetlands benefits individual respondent

Source – Author

On the question on how the community benefited from the construction activities being carried out in wetlands, the majority of respondents (52.8%) said income generation was the community's common benefit. A third of them (33.3%) believed that obtaining shelter was the major benefit. Another 8.1% believed that beauty of buildings benefited the majority of the community. However two respondents, representing 5.8% did not give a clear response to the question. This information has been summarised by the bar graph 4.2 below



Bar graph 4.2 how the construction activities benefits the community

Source - Author

Respondents were asked to give their opinion on the activity they thought was most beneficial to the wetland and those that was the most destructive to the wetland's well being. A majority of 27.8% of the respondents thought that construction activities were the most destructive. 16.7% decided that poaching was destructive while another13.9% felt that reeds harvesting was equally destructive. Crop farming and brick mongering were each chosen by 5.6% of the population interviewed. A small proportion (2.8%) felt that herding of animals was the most destructive activity. The rest (27.8%) was unsure of which activity to consider the most destructive.

Contrarily, crop farming was chosen as the most beneficial by a majority of 27.8%. Property development, reed harvesting and herding followed suite with 19.4%, 16.7% and 13.9% respectively. Fishing was also mentioned as very beneficial by a total of 11.1% of the respondents, while brick mongering took 2.8%. The remaining 8.3% were unsure of the most beneficial activity.

The tables 4.5 and 4.6 below summarises these information.

Table 4.5: Opinion of the respondent on the most destructive activity

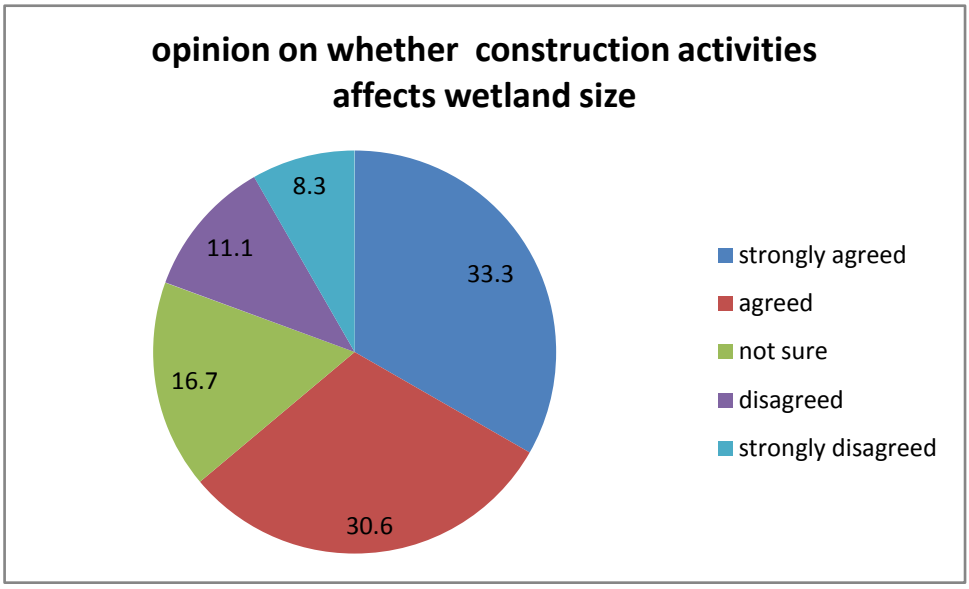
	Frequency	Percent	Valid Percent	Cumulative Percent
unsure	10	27.8	27.8	27.8
Construction activities	10	27.8	27.8	55.6
herding	1	2.8	2.8	58.3
bricks mongering	2	5.6	5.6	63.9
Crop farming	2	5.6	5.6	69.4
poaching	6	16.7	16.7	86.1
reeds harvesting	5	13.9	13.9	100.0
Total	36	100.0	100.0	

Source - Author

Table 4.6: Opinion of the respondent on the most beneficial activity to the wetland- Source - Author

	Frequency	Percent	Valid Percent	Cumulative Percent
Unsure	3	8.3	8.3	8.3
crop farming	10	27.8	27.8	36.1
Herding	5	13.9	13.9	50.0
bricks mongering	1	2.8	2.8	52.8
Reed harvesting	6	16.7	16.7	69.4
Property development	7	19.4	19.4	88.9
Fishing	4	11.1	11.1	100.0
Total	36	100.0	100.0	

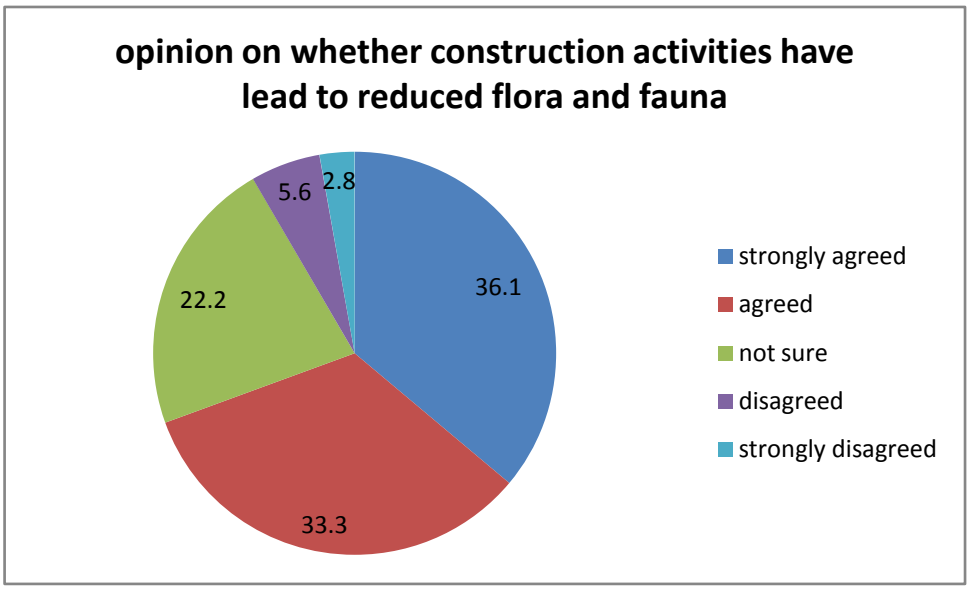
The thirty six respondents also responded to questions on how construction affected the wetlands. When asked about their opinion on how marsh and wet meadows size had been affected, a majority of 33.3% strongly agreed that construction activity had led to the wetland size decreasing. 30.6% also agreed to that. 16.7% of respondents were not sure if construction contributed to reduced size of the said wetlands. The rest were of contrary opinion with 11.1% disagreeing and another 8.3% strongly disagreeing that marsh and wet meadows size had decreased due to construction activity, as represented in the pie chart 4.5 below.



Pie chart 4.5: opinion on whether construction activity has affected marsh and wet meadows size

Source - Author

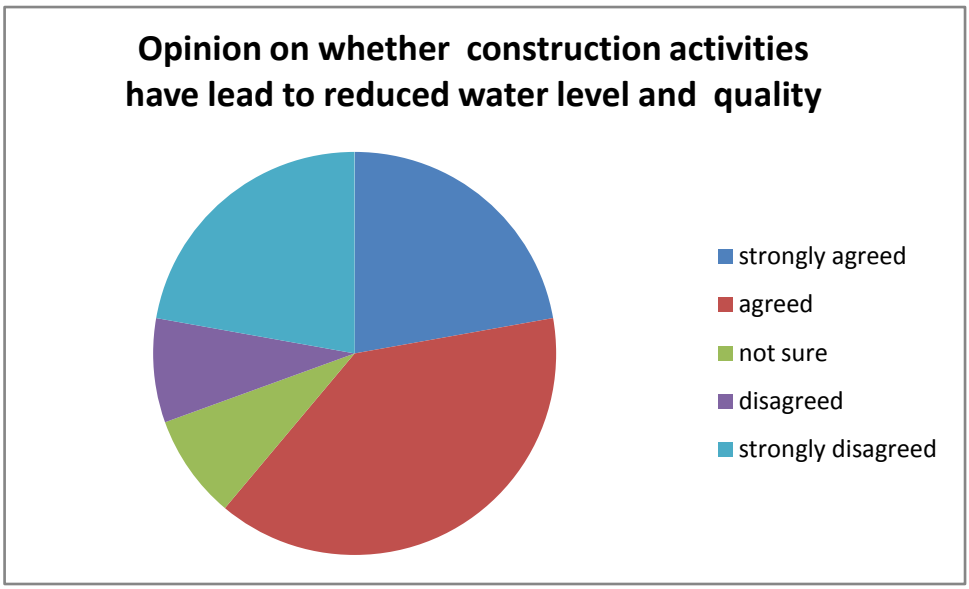
On the question of whether construction activities on the wetlands has reduced the number of fauna and flora, 36.1% of the respondents strongly agreed and another 33.3% merely agreed. 22.2% were not sure. The rest consisted of 2.8% who strongly disagreed and 5.6% who disagreed. The pie chart 4.6 below represents this information.



Pie chart 4.6: opinion on whether construction activity has affected flora and fauna in wetlands

Source - Author

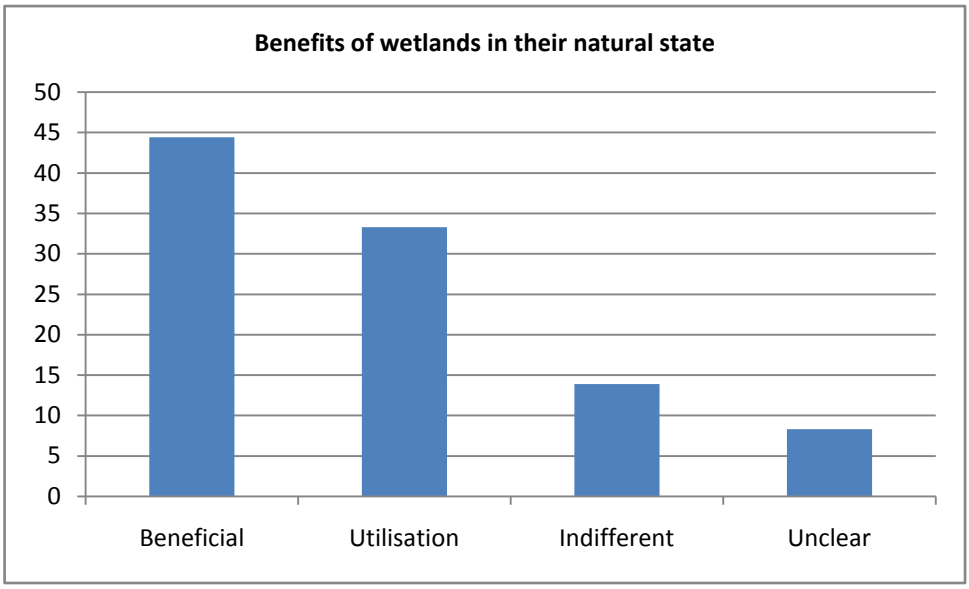
When it came to the water levels and quality, respondents were asked if they agreed that the water level and quality had reduced due to construction on wetlands in Bungoma municipality. The number of respondents who strongly disagreed equalled that of those who strongly agreed, each with a representation of 22.2%. Nevertheless, a majority of 38.9% agreed. Half of the rest disagreed and the remaining half were unsure as represented in the pie chart 4.7 below.



Pie chart 4.7: opinion of whether construction activities have led to lowered water level and quality

Source - Author

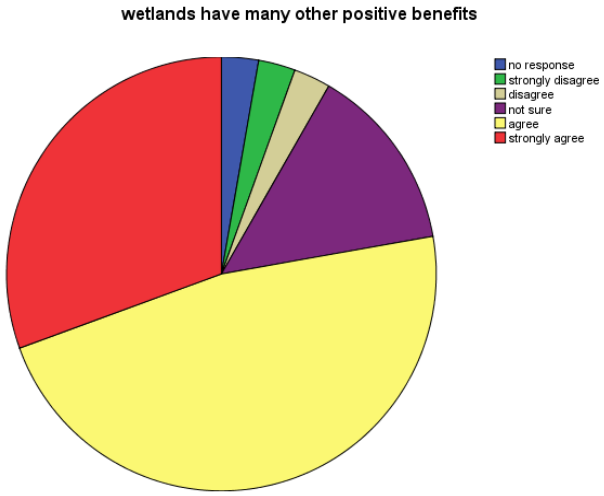
When asked on their thoughts about the benefits of wetlands in their natural state, 44.4% of the respondents said they were beneficial while 33.3% favoured other utilisation.13.9% were indifferent while the remaining 8.3% were unclear. Refer to the figure below for this information.



Bar graph 4.3: opinion on potential of wetlands in their natural state

Source - Author

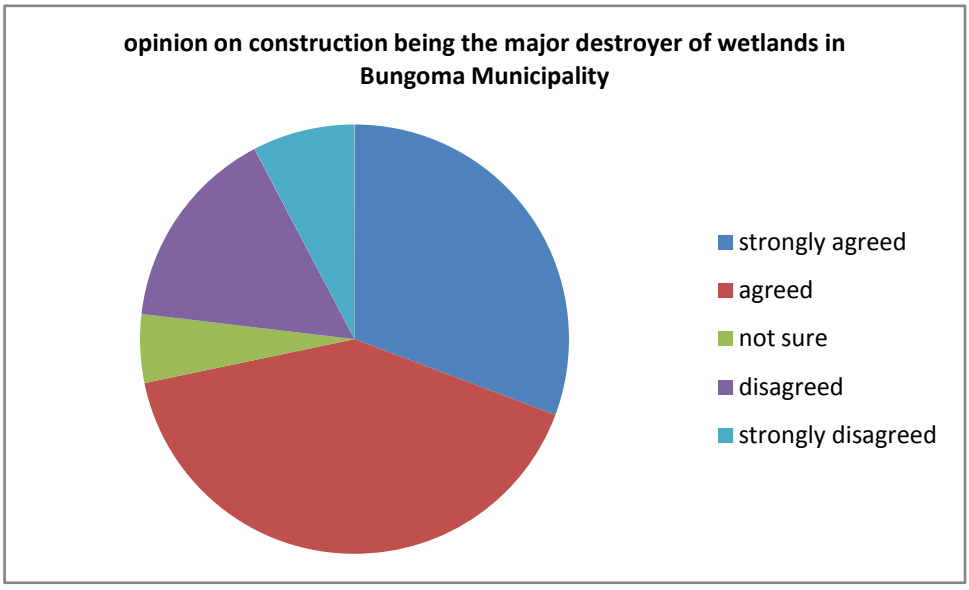
The respondents were also asked if they thought that there were any other positive benefits that could be derived from wetlands aside from traditional uses like herding, fishing, among others. A majority of 47.2% agreed that there was, and another 30.6% strongly agreed. 13.9% were unsure while the rest, in equal proportions of 2.8% indicated disagreement, strong disagreement and inability to respond. The pie below represents this information.



Pie chart 4.8: opinion that wetlands had many other positive benefits aside from the traditional uses

Source - Author

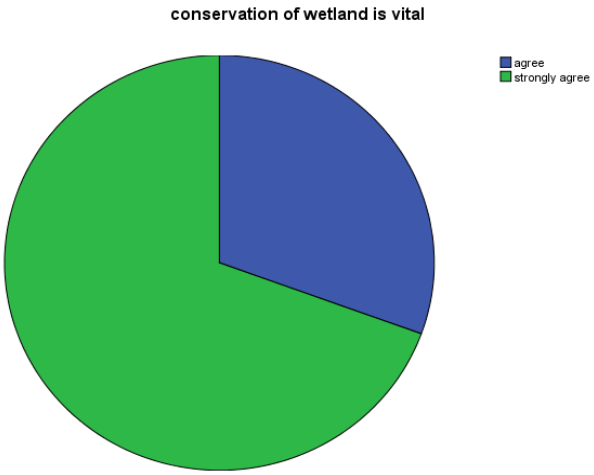
One of the questions asked was if respondents agreed to the statement that construction activities on wetlands are the main destroyer of wetlands. A total of 16.7% disagreed to this, half of whom strongly disagreed. Of the respondents, 5.6% were unsure. Those in agreement were 44.4% while the remaining 33.3% were in strong agreement.



Pie chart 4.9: opinion that construction activities are the main cause of wetlands destruction

Source - Author

All the respondents admitted that wetlands should be conserved. 30.6% of them agreed that wetland conservation was important and the rest, 69.4%, strongly agreed to the same. See the pie below for the summary of this.



Pie chart 4.10: opinion that conservation of wetlands is important.

Source - Author

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.0. Introduction

This chapter focuses on the discussion, conclusions and recommendations of the study. The cumulative data was analyzed quantitatively and presented in form of tables, charts and figures. Recommendations are made to stakeholders to the wetlands. The researcher , after having established the relationship between construction activities on wetlands and the effects of such activities gives possible measures to be put in place to ensure that the right form of property development and wetland conservation is encouraged. The impacts- the resultant beneficial or detrimental subsequence of the construction activities to the environment and ecosystem- therein will also be discussed.

5.1. Discussion of findings

5.1.1. Discussion of the general information of respondents

Basing on demographics, it was almost clear that culture still takes root among the residents of Bungoma town. It seemed that the community was a patriarchal one. This was so as there were more male volunteers (63.9%) as compared to women (36.1%). Particularly, in a few instances where there were both the males and females found together. Literacy level and age each seemed to be a factor. The older respondents, mostly little schooled had to be persuaded to complete the filling of questionnaires (even though there were assistants) accounting for the 11.1% of respondents between of age above 46 years and another 22.2% for age group 36-45 years. Although there were interview schedules, the response based on literacy was similar. Unlike them, most of their younger, more schooled counterparts filled the questionnaire completely with no or very little persuasion. Most of the respondents (69.4%) had lived in Bungoma town for at most 20 years. This meant that the immigrants and/or the young were more. Their information was therefore vital in analysing the present state of the wetland.

5.1.2. Discussion of specific information

There is evidence of housing construction on marshes and wet meadows in Bungoma town from observation, secondary data and the responses received. The researcher discovered that marshes were drained and filled up to enhance construction. The floors were raised up to one meter in most houses observed.

More than a half (52.3%) of residents engaged or participated in construction activities on the wetlands in way or another. Individual participation in these activities depended on various aspect such as gender, occupation and education level. Those who were employed by the government hardly participated in the activities directly. Men mainly participated in bricks making, car washing, herding and poaching. Females, on the other hand mainly engaged in cultivation and reeds harvesting.

Both the individuals and the community of Bungoma town benefited from the wetlands. The wetlands are of most significance to the residents when it came to generation of income. Property development followed suit. Shelter materials were obtained from the reeds and bricks. Food stuffs obtained from the wetlands included farm produce (kales, arrowroots, maize, cabbages et cetera), animal produce (milk and meat) and fish (mudfish, tilapia, et cetera). Income generation came about through commoditising the aforementioned wetlands products and through employment opportunities in the production of these products.

Property development was ranked as the second most beneficial of the wetlands. This was depicted by 33.3% of the respondents. On the contrary property development was considered the most destructive of the wetlands. Brick making was considered dangerous because it required the digging up of wetlands soil to make them, consequently destroying habitat for both plants and animals.

Residents had varied opinion on the effect of construction. Indicators used to measure the effects include the opinion on over time variation of the size of wetland, number of plants and animals diversity, water level, as well as quality of water. Majority of the people (63.9%) thought that the wetlands had decreased in size over time. They also agreed that this was due to human activities such as draining water to allow agriculture and construction. On the effect on biodiversity, the residents felt that the number of animals, particularly snakes, tortoise, birds and squirrels had reduced owing to loss of Habitat. However, those who claimed to be

unsure on the effect on wild animals said so because they did not know of the animal count in the wetlands. On plants diversity majority were of the opinion that it had been so affected so that some species that were common decades ago are being rarely seen nowadays. Following this blame was shifted to reeds harvesting. The water level and quality was agreed to have deteriorated, due to overuse and alteration of topography.

Many of the residents believed that there were many other benefits that could be derived from the wetland. This meant that despite the fact that they were already constructing on wetlands, they had not yet fully unleashed the wetland's potential.

5.1.3 Discussion of the effects of construction activities on wetlands.

It is believed that humans are the major threat in regard to wetland destruction while at the same time, ironically, the solution to problems facing wetlands.

Threats caused by humans stem from inappropriate water management , introduction of invasive alien plant/ animal species, industrial-scale production of palm oil, use of agricultural fertilizers, pesticides, and land use changes, overfishing and over harvesting of reeds. Other human activities which can have lasting effects on wetland ecosystems include, property development, stream channelization, dam construction, discharge of industrial wastes and municipal sewage All these have effects on the wetlands.

However, there have been other forces, natural or man-made, to point the blame to. For example,

Growth in population has led to much increased human needs for food, shelter and money to sustain themselves.

Major improvements in technology have led to increased agricultural activity. Thus wetlands have been encroached into.

Exploitation can occur at the community level where residents may obtain for themselves every consumable of the wetland (fuel wood, timber, honey, crab, grass and fish) which then becomes threatened through increasing population and continual harvest.

An uneven contribution of climate change and global warming is the other issues that occur on a global level. These are believed to have been caused by human activity over time. Consequently it has affected the natural state of wetlands by providing a

good environment for alien species to thrive. Changing climate also increases the vulnerability of coastal areas to flooding and erosion.

Pollution (point and non-point) caused by dumping of waste and use pesticides have affected both air and water quality. Sources of pollution have local and regional effects on the chemistry and quality of water flowing through wetlands. Point sources, such as municipal industrial sites, and non-point sources, such as agricultural lands and urban runoff, add materials to ground water and surface water that upset the balance of wetland water chemistry and the biogeochemical cycling of materials in wetland ecosystems. (*Mitsch and Gosselink, 1993*).

From the findings, it emerged that construction on wetlands impacts negatively on them. Seventy seven point percent of the respondents were of this opinion, that construction was the main destroyer of wetlands.

5.1.4 Discussion of the impacts of construction activities on wetlands

According to Wikipedia, the impacts of human activities on wetlands can be divided into three major types; direct impacts, indirect impacts and cumulative impacts.

Direct impacts result from disturbances that occur within the wetland. Most disturbances that result in direct impacts to wetlands are controlled by National Environment Management Authority wetland regulatory programs. Common direct impacts to wetlands including Bungoma town are: filling, removal of vegetation, changes in water levels and drainage patterns.

Indirect impacts result from disturbances that occur in areas outside of the wetland, such as uplands, other wetlands or waterways. Common indirect impacts include influx of surface water and sediments, fragmentation of a wetland from a contiguous wetland complex, loss of recharge area, or changes in local drainage patterns. Given that most indirect impacts are difficult to control by local community and the County Government, National Government. Wetland protection can be provided by a management plan under local implementation.

Cumulative impacts are those impacts resulting from combined direct and indirect impacts to the wetland over time. For instance, property development has facilitated erosion due to drainage and infilling. In turn, this has reduced the wetlands ability to control floods,

especially in rainy seasons. Thousands of acres of wetland are also disappearing annually to give room to agricultural development. Other areas have had trouble maintaining the stability of their wetlands. Many wetland systems are no longer able to function in all the ways formerly possible. Many factors are contributing to the loss of wetlands resulting from both human and natural processes.

The research found out that construction on wetlands affected water quality and quantity, flora and fauna as well as reduced extent of wetland sizes. For instance, 61.1% of the responds were of the opinion that water levels and quality had reduced.

5.1.5 Discussion of the conservation practise

Human uses of wetlands, such as drainage for agriculture and filling for industrial or residential development, can impose irreversible impacts to wetlands. In the past, the societal and ecological values of wetlands were not widely recognized and many wetlands were destroyed.

Since conservation of wetlands is vital, particularly for the future generation, it is also important to set objectives to act as principles for the practise. Such objectives may include; maintenance of water quality, reduction of erosion, processing airborne pollutants, providing a buffer between wetlands and adjacent urban or industrial uses and maintenance of diverse community of wetland plants and a diverse gene pool among many other possible, sustainable objectives.

There was no clear effort from the County government in terms of policy and legislation on the conservation of wetlands in Bungoma town. In addition, the residents are either ignorant of the benefits of wetlands or they have taken them for granted. Construction was found the in thing as compared to traditional uses which tended to be sustainable. In hindsight the residents do not have any measures to conserve these wetlands.

It emerged that construction on them was the greatest destroyer, therefore developments on them should be discouraged. Alternative sites should be considered.

Some animals are drawn to marsh environments and have an impact. Included are ducks and geese. They have all had a long-term relationship with wetland ecosystems, and the systems

may have evolved under the pressures of their impacts. Thus it should be encouraged that such animals be introduced to the wetlands as opposed to alien species.

5.2 Conclusion

Property development and other human influences have caused significant changes in the function and quality of many wetlands. These changes have resulted from alteration of the physical, chemical and biological components of wetland ecosystems. To maintain natural hydrology, native vegetation and local and migratory wildlife habitats construction on wetlands in the municipality should be discouraged. This is because property development causes irreversible impacts thus reduction of vital wetland functions that are either impossible to replace or may come at a great expense.

From the findings it emerged property development was the single most destroyer of wetlands in the municipality through drainage, dredging deposition of fill material, diking and damming, construction, run-off, air and water pollution, changing nutrient levels and release of toxic chemicals. The future for these wetlands will really depend on how humans choose to use their wetlands and the measures they take to mitigate impacts that their activities have on these special environments.

5.3 Recommendation

In order to reduce the adverse effects of construction activities, the County government should be advised to apply sustainable practises especially discouraging property development on wetlands. It is prudent to utilise alternative sites.

The residents should establish ways of owning the wetlands and its resources. For example through a local organisation, which should, in turn make policies that shares the benefits equitably to the stakeholders.

People living and/or working around wetlands should be sensitised on proper waste management to avoid pollution of wetlands.

Conservation practises such as planting of indigenous trees should be encouraged so as to sustain existing wetlands.

Further studies are encouraged on the following areas:

Using GIS to map and delineate wetland boundaries in the municipality

A chemical analysis of the quality of water in River Khalaba

Impacts of population growth on the value of land in Bungoma town.

REFFERENCES

Dugan, Patrick (1993) Wetlands in Danger, World Conservation atlas series

Gottmann J. and Robert A. Harper, *Metropolis on the Move: Geographers Look at Urban Sprawl.* 1967

Human impact on wetlands, www.wetlandsresearch.tripod.com/impact.html (26th March, 2013)

Importance of wetlands; www.reefed.edu.au/home/students/ (24th March, 2013) International, New Delhi (2nd Edition)

IUCN – The World Conservation Union. http://www.iucn.org/ (2nd February, 2013)

Jones E.H and C. H.Jones ,*Cognitive Dissonance Theory after 50 Years of Development*, Texas A&MUniversity, College Station, TX, USA, 2007

Kathryn. C.H. and Galbraith J. M., *Literature Review for Development of Maryland Wetland Monitoring Strategy: Background Information on Maryland's Wetland Type*, Department of Crop and Soil Environmental Sciences ,Virginia Tech and Denise Clearwater Wetlands and Waterways Program ,Maryland Department of the Environment, September 2009

Keddy P.A. (2010). Wetland Ecology: Principles and Conservation (2nd ed.). New York: Cambridge University press

Kinaro Z.O, *Wetland Conversion to large-scale agricultural production; implications on the livelihoods of rural communities, Yala Swamp, Lake Victoria basin, Kenya*. A thesis, January 2008

KNBS *2009 Kenya Population and Housing Census*, Vol 1 A, KNBS 2010

Kombo and Tromp, (2006) *Proposal and Thesis Writing: An Introduction.* Nairobi: Paulines

Kothari C. R., (2004), Research Methodology: Methods and Techniques. New age

Linda M. *economy and society: a comparative reader,* Harper & Row in association with the Open University Press London, 1981

Maltby, E.: *Waterlogged wealth. London*: Earthscan, International Institute for Environment and Development, 1986

Mitsch W. J. and Gosselink, J.G. (2000). Wetlands (4th ed.). New York:John Willey & sons.

Mugenda and Mugenda.research methods. (1999), online books

Myers, R. H. (1990), *Classical and Modern Regression with Applications*. PWS-Kent Publishing Company.

Nielsen J., A *Cumulative effects approach to Wetland Mitigation*, A thesis, Department of Geography and Planning, University of Saskatchewan, Saskatoon, 2010

Nilsson C. and Grelsson G., *The fragility of Ecosystems: a review*, online books

Orodho, A., and Kombo D., (2002), Research Methods. Kenyatta University, Institute of Open Learning, Nairobi. Publications Africa

Ramsar convention Secretariat, 2007

Selltiz Claire *et al*, Research Methods and in social relations, rev ed. New York. Holt, Rinehart and Winston Inc., 1959.

UN- Habitat, *World Urban status Report*, 2009

William J. *Pragmatism: A New Name for Some Old Ways of Thinking*. New York: Longman Green and Co., 1907.

Bungoma Municipal council data

Dictionary.com

http://en.wikipedia.org/wiki/Wetland_conservation

Wikipedia.com

westgateinnbungoma.com,

Wikipedia.org/wiki/Bungoma

APPENDICES

Appendix 1: questionnaire on construction activities on wetlands

QUESTIONNAIRE ON CONSTRUCTION ACTIVITIES ON WETLANDS

I am a student of the University of Nairobi pursuing a Post Graduate Diploma degree in Housing Administration. I am carrying out a research on Impacts of Housing Construction On wetlands. I humbly request you to fill this questionnaire to the best of your knowledge and ability to help me have enough information and collect data to be analyzed for the study. The information provided will be treated with utmost confidentiality and may not be used for other purpose other than the intended study.

SECTION A: PERSONAL DETAILS

Tick where appropriate

1. What is your gender?
    a) Male
    b) Female
2. What is your age (years)?
    a) 18- 25
    b) 26-35
    c) 36-45
    d) Over 46

3. For how long (years) have you lived in Bungoma Town?

    a) 0-10
    b) 11-20
    c) 21-35
    d) 35-50
    e) Above 50

4. What is your highest level of education?

a) University
b) College
c) Secondary
d) Primary

5. What is your occupation?
    a) Government Employed
    b) Self employed
    c) Others

SECTION B: **QUESTION ON CONSTRUCTION ACTIVITIES**

6. In your own observation, are there human activities being carried out in wetlands in this area?
   a) Yes
   b) No

   i. If yes in (6) above, briefly state them.

   _____

   _____

   _____

   _____

   _____

   ii. If no, in (6) above, why?

   _____

   _____

7. As an individual, do you engage in any construction activity on wetlands?
   a) Yes
   b) No

8. How have the activities mentioned above benefited you as an individual?
   a) Food provision
   b) Income generation
   c) Shelter materials
   d) other

   (specify)_____

9. How have the activities mentioned above benefited the community living around wetlands?
   a) Food provision
   b) Income generation
   c) Shelter provision

d) Beauty of buldings

e) Others (specify)

_____

10. In your own understanding, list the most beneficial and the most destructive human activity to the wetlands.

Most beneficial

_____

Most destructive

_____

SECTION C: QUESTIONS ON THE EFFECTS OF CONSTRUCTION ON WETLANDS

	Strongly Disagree	**Disagree**	**Not sure**	**Agree**	**Strongly Agree**
The size of wetlands have been affected by human activities (property development)					
Plants diversity in the wetlands has reduced due to construction activities					
Wild animals numbers have reduced due to the construction activities taking place in the wetlands					
The water level of the wetlands has gone down over years resulting from construction activities					
The quality of water from the wetlands has reduced due to					

construction activities.					

11. To what level do you agree with the following statements

12. Briefly, give your own assessment on the condition of the wetlands for the period you have known/ lived in this area.

    _____

    _____

13. Are there strategies that have been put in place to enhance conservation of these wetlands? If so, briefly explain.

    _____

    _____

    _____

    _____

14. What (other) strategies would you suggest to help enhance conservation of these wetlands?_____

    _____

    _____

To what extent do you agree with the following statements?

	Strongly Disagree	**Disagree**	**Not sure**	**Agree**	**Strongly Agree**
Wetlands have created job opportunities					
Wetlands act as a sources of income					
There are many others positive benefits from wetlands					

Construction activities are the cause wetlands destruction					
Conservation of wetlands is important					

This is the end of the questionnaire. Thank you for your time.