

**EFFECTS OF HUMAN ACTIVITIES ON WETLAND: PERSPECTIVES FROM
KING'WAL WETLAND IN NANDI COUNTY, KENYA**

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DECLARATION AND APPROVAL

Declaration by the Candidate

This thesis project is my original work and has not been submitted for an academic award in any other university.

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DEDICATION

I dedicate this piece of work to my husband Solomon Serem and daughters Carol and Grace for the moral and financial support.

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ABSTRACT

Wetlands across the world offer a variety of essential ecosystem services that are essential to people and biodiversity's continued existence, health, and wellbeing. Despite the benefits provided by wetlands, they continue being encroached through human activities, hence there is need to put in place mechanisms to conserve them. The study main objective was to investigate the effects of human activities on wetland vegetation: Perspective of King'wal in Nandi County, Kenya. Specifically, the study sought to establish how brick making causes wetland de-vegetation, to examine the effects of farming on the biomes of King'wal wetland in Nandi County and to assess the level of awareness of the community on the importance of wetlands in relation to their encroachment activities. The study adopted Ecological theory. The study used descriptive survey research design. The study utilized questionnaires and interview schedule as the main data collection tools. The target population was 1325 household units. The sample size of the study was 126 brick makers and farmers. Purposive sampling technique was used to select brick makers and farmers while census sampling method was used to choose 10 key informants charged with the responsibilities of dealing with environmental matters. Quantitative data collected was analyzed using both descriptive statistics (frequencies, percentages and means) and inferential statistics (Pearson's moment of correlation) using SPSS and Microsoft excel, while the qualitative data was analyzed thematically. The data was presented in form of tables, frequencies, percentages and graphs. The study results established that there was a weak positive correlation between brick making and wetland de-vegetation, which was statistically significant ($r=.218$, $n=126$, $P=.014$). The study found that wetland degradation has occurred due to extensive farming on wetland vegetation by use of agrochemical and excessive leaching of nutrients. The study findings also revealed that there was a strong positive correlation between farming on biomes and wetland de-vegetation, which was statistically significant ($r=.724$, $n=126$, $P=.000$). There was a weak negative correlation between level of awareness and wetland de-vegetation, which was statistically significant ($r=-.299$, $n=126$, $P=.001$). The following conservation measures were mentioned by the respondents; enacting of legislation to curb use of wetland, controlling brick making, planting indigenous trees, conducting frequent barazas and enforcement of laws on wetland encroachment, stationing NEMA, KWS and County Government surveillance. The study concludes that extensive brick making poses a danger to wetland biomes going into extinction unless measures are taken to preserve the wetland. The continued expansion of both small and large scale farming areas has threatened the presence and existence of the ecosystem. Some of the largest impacts are through drainage and conversion of Kingwal wetland into cultivated land; that has drastically reduced the land under wetland. The locals were well aware of the value of wetlands. Rarely were community gatherings held with locals organized when they should have been instructed on how to prevent endangering Kingwal Wetland and the need of protecting it. The study suggests that, in order to protect Kingwal Wetland from unwarranted threats and promote its sustainability future generations, the County Government of Nandi and the Federal Government should create and strictly enforce policies governing human activities carried out within or close to the Kingwal Wetland.

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ACRONYMS

ASALS	Arid and Semi-Arid Lands
EMCA	Environmental Management and Coordination Act
ES	Ecosystems Services
HMG	His Majesty Government
IUCN	International Union for Conservation of Nature
KNBS	Kenya National Bureau of Statistics
MDGs	Millennium Development Goals
MoFS	Ministry of Forest and Soil Conservation
MWENR	Ministry of Environment, Water and Natural Resources
NACOSTI	National Commission for Science, Technology and Innovation
NEMA	National Environment Management Authority
PPA	Physical Planning Act
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Programme
UNEP	United National Environment Programme
WRMA	Water Resources Management Authority
WRUA	Water Resource Users Association
WWF	World Wildlife Fund

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Wetlands are among the most naturally beneficial biological habitats because they house a vast variety of species (Mwakaje, 2009). They are among ecosystems that are most productive and unique due to their attributes. Wetlands have been defined differently by different people, according to Ramsar Convention, it is known as “areas with marsh, fens, peatlands, or water, whether they are natural or man-made, long-term or short-term, with water that is still or moving, fresh, brackish, or salt, including marine areas with water that is less than six meters deep at low tide”. Wetlands give humanity access to natural resources and services (Mwakaje, 2009). This vital resource is a source of food, tourism, cultural resources, flood control and improved water quality. In addition, it is also important to biodiversity and wildlife conservation (Desta, 2003). As noted earlier by Hailu (2019), wetlands play a crucial role in the well-being of citizens in lesser developed nations, with Kenya being no exception.

In the context of socioeconomic roles in the environment, wetlands are crucial to human well-being; it plays an important role in water purification, flow regulation, storage, ecosystem balance through biodiversity preservation and conservation, carbon sequestration, and climate change mitigation. Because of the roles they can play in the hydrological and chemical cycles as well as the large food webs and rich biodiversity they sustain, wetland ecosystems are known as "the kidneys of the landscape" and "biological supermarkets" (Mitsch & Gosselink, 1993). Despite these advantages, more than 50% of the world's wetland have been transformed, deteriorated, or lost in the previous 150 years (Clarkson, Ausseil & Gerbeaux, 2013), primarily due to industrial, urban, and agricultural development. As a result, they confront a number of difficulties that are hurting their sustainable management. Paradoxically the wetlands provisioning services have led them to be overexploited. According to Dawson, Elbakidze, and Schellens (2021), wetland de-vegetation happens by clearing and draining for agricultural development and increasing removal of fresh water from swamps, marshes, rivers, and adjacent floodplain water bodies. By 1985, an estimated 56–65% of inland and coastal marshes (including small lakes and ponds) in Europe and North America, 27% in Asia, 6% in South America, and 2% in Africa (Khan and Arshad, 2014).

Globally, these practices have negative impacts on inland and coastal wetlands (Finlayson, 2013).

Both the extensive use of water for irrigation and excessive nutrient loading associated with the use of nitrogen and phosphorus in fertilizers have resulted in a decline in the delivery of services such as fresh water and some fish species (Wang, Li and Li, 2017). On the other hand, due to the expansion of paddy rice cultivation, artificial wetlands are increasing in some areas. Inappropriate use of wetlands, such as cattle grazing, also leads to destruction of wetland vegetation, especially in Limpopo, South Africa (Dale and Knight, 2008). Wetland vegetation and soil composition in ecosystems are severely affected by fire (Ondere, 2016). Fire seasons at brick sites and the time between successive fires determine, through selection, the composition of plant and animal species in most ecosystems (Agera and Agbidye, 2015). Brick is used in the construction of foundations, walls, piers, buttresses and arches of buildings and other structures and in the construction of ducts, flues, lining and chimneys of furnaces. Brick production have a high potential to impact on soil properties and vegetation through burning and excavation of clay soil, necessary process at times or it may be optional, depending on the nature of existing vegetation or immediate past land-use option. Access roads to brick sites are constructed to facilitate easy flow of vehicular transport for easy evacuation of burnt brick (Agera and Agbidye, 2015).

Ramsar convention raises concern that many wetlands are being degraded through encroachment by the surrounding populations, pollutions, poor waste management and infilling or other developments; hence these activities have diminished the ecosystem services that wetlands can provide moreover the recognition of their value and importance by both decision makers and the communities (Ndaruga, 2009). Hence, this study sought to investigate the relationship between human activities and the de-vegetation of King'wal wetland in Nandi County in Kenya.

1.2 Statement of the Problem

Despite the numerous benefits that wetlands offer, the sustainable management and use of wetlands still faces challenges (Republic of Kenya, 2013). The clearing of vegetation and the resulting drainage for agricultural purposes and brick making are still the leading human activities that threatens the existence of wetlands (Hansen, 2006). Cultivation in Kingwal wetland in time of dry season is on increase and causes the biggest threat to the ecosystem (Raburu, 2020). Extensive cultivation of maize and vegetables poses a threat not only to the alternative products from the wetland but also to the ecological functions of the wetland. The

local community also obtains bricks from this wetland. These activities have resulted to the shrinkage of once extensive wetland which is important breeding site to Sitatunga antelope (*Tragelaphus spekii*) which is rare and endangered species (Sitienei, Jiwen, & Mupenzi, 2012). The current situation if allowed to continue is likely to result to habitat destruction and loss of the wetland, hence the need for this study.

1.3 Objectives of the Study

The main objective of the study was to investigate the effects of human activities on wetland. The following specific objectives guided the study;

- I. To establish how brick making causes wetland de-vegetation.
- II. To examine the effects of farming on the biomes of King'wal wetland in Nandi County.
- III. To assess the community perspective on the value of wetland conservation

1.4 Research Questions

- I. To what extent does brick making causes the wetland de-vegetation in King'wal, Nandi County?
- II. What are the effects of farming on the biomes of King'wal wetland, Nandi County?
- III. What are the community perspectives on the value of wetland conservation?

1.5 Justification of the Study

Due to the hydrological and biological services, as well as the socio-economic and cultural values it represents, King'wal is a notable wetland. Despite serving as a refuge for the critically endangered Sitatunga, this wetland is threatened by anthropogenic pressures, in part because its critical functions and services go unacknowledged (Kenya Wetlands Forum, 2012).

The King'wal wetland has been drained for settlement and agriculture, while a portion of it has been mined for clay for the brick-making business. The marsh has become even smaller as a result of eucalyptus tree planting (Hansen, 2006). In addition, intensive farming has exposed the wetland to fertilizer leaching and eutrophication, which has led to the spread of alien species that have already taken over the swamp. It may be interesting and crucial to understand why previous efforts to restore the site have not produced the expected results.

In King'wal, resource utilization is seen in light of socially prescribed gender roles. For instance, while some activities are mostly dominated by women and young people, others are the purview of male adults (men). Men predominate in certain occupations, such as brickmaking and hunting. Women and young people are in charge of gathering firewood and water. This has an impact on how the riparian population feels about protecting the wetland as a resource. This study set out to determine if that was the case.

1.6 Significance of the Study

From the study findings, the local community may obtain some information on wetland conservation and sustainable management by creating awareness on the importance of wetlands and participation of the community as a whole in ensuring that the wetland areas are preserved and conserved.

To the National Government and County Government, the findings may be used to formulate comprehensive policies for wetland conservation and its sustainability. The County may also advocate for King'wal to be categorized by Ramsar convention as a wetland of international importance since it is a habitat to the rare Sitatunga antelope (*Tragelaphus spekii*) and hence the need for its conservation.

To conservators, the study findings may help them ensure the protection and conservation of the wetlands to safeguard their continuity through fencing and pegging to demarcate boundaries and prevent further encroachment.

This research findings and literature may also add to the body of general knowledge and serve as a foundation for more studies on the serious problem of wetlands and its effects on daily life. The results of this study may be helpful to continuing students since they can utilize them as resources and questions for their research.

1.7 Scope of the Study

The study was on human activities and their effects on wetland. Perspective of King'wal in Nandi County, Kenya. Farmers and brick makers were the main target population besides other wetland users that causes de-vegetation. This is because they are the people who interact directly with the wetland and whose activities directly influence wetland resource. A sample of 126 respondents was picked to represent the entire population. The data was collected by the researcher using observations, questionnaires administration, and focused group discussions. The study adopted descriptive survey research design. The study focused on determining the wetland cover's current spatial extent between 2000 and 2020. In order to offer crucial information on wetland use change and future planning strategies, this assisted

in the monitoring of diverse landscapes through the application of Remote Sensing (RS) and Geographic Information Systems (GIS). The information was gathered between the months of October and November of 2022.

1.8 Limitation of the Study

The study was limited to human activities such as brick making and farming on biomes. It was also limited to de-vegetation evident by visual indicators such as bare surfaces (exposed soils), burnt grasses, cleared reeds and grasses.

The respondents may not provide honest and objective responses and some respondents may be unwilling to answer some questions. The attitudes of the respondents may not be under the researcher's control and may influence their answers. The researcher gave respondents assurances about anonymity and the motivation for data gathering.

The research was affected by biased views due to the respondents' cultural backgrounds or perspectives on the topic under discussion. The researcher directly translated the interview questions to the locals using the native language explained vividly by directly translating to the participants the purpose of the research, clarified any misunderstanding and adjusted the data gathering process appropriately.

1.9 Definition of Operational Terms

Biodiversity: refers to the diversity of living things found in wetland environments and the ecological systems to which they belong. It includes species, the ecosystem, and genetic variety. In our case, it's the swamp with the Sitatunga that is found in King'wal wetland.

Conservation: it's the protection and preservation of natural resources from destruction, wastage or loss by careful use of environment.

Ecosystem: a community or collection of living things that coexist in a place and communicate with one another. In our case, King'wal wetland is a distinct ecosystem that is flooded by water, either permanently or seasonally, where oxygen-free processes prevail.

Environment: all external condition surrounding an organism which has influence on their behavior, organism can be plant, an animal or a person.

Management of Environment: it means effective planning, wise use, utilization, maintenance and improvement of the physical environment for present and future generations.

Riparian: is an interface between land and a river or stream. It is a zone adjacent to wetlands, found along the margins of streams and rivers.

Wetland Conservation: In this study, it is described as the application of tactics to protect wetlands, keep them in pristine condition, and limit overuse of wetland resources to ensure sustainability.

Wetland Management: according to this study, is the human use of wetlands in a way that is compatible with the preservation of their natural, physical, biological, or chemical components, such as soil, water, plants, animals, nutrients, and interactions between them, in order to produce the greatest continuous benefits for the present generations while preserving their potential to meet the needs and aspirations of future generations. This project included both promoting ecotourism and King'wal as a community conservancy.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed related literature on the use of wetland ecosystem under the sub themes; effects of brick making on wetland, effects of farming on biomes on wetland and community perception on the importance of wetlands in relation to their encroachment activities and conceptual framework.

2.2 Brick Making and Wetland

Brick making is a process that involves a number of steps, the most important of which are the extraction of soil from the earth's surface, kneading, moulding, and finally burning to create bricks (Akinshipe, 2013). Brick making dates back to 6000 years ago, when it began in Mesopotamia (Iraq) and later spread to Europe and lastly, European settlers spread it to the rest parts of the world. The following five labor-intensive phases are part of the brick production process: Using jembes, the soil is mined; it is then prepared by being mixed with water and kneaded to hold together; it is then shaped using brick moulders made of wood or metal; the bricks are dried in the sun, but not directly; grass is used to cover them; this grass is harvested from the wetland; and finally, the dried bricks are arranged in kilns for burning with wood fuel (Akinshipe, 2013). This research looked at how brick production affected the King'wal Wetland's vegetation in Kenya's Nandi County.

Uncontrolled brick production can have a variety of negative environmental repercussions. The resultant effects may include decreased crop yields since brick mining reduces soil fertility by removing the top soil cover, loss of natural habitat for some animals that flourish in marshy environments, and loss of soil fertility. The effects can be addressed through controlled brick production (Frasher, 2007). Swamps are a resourceful resource, and since time immemorial, people have exploited them to get sustenance like fish and grass for thatching houses among other benefits that accrues from this vital resource. The requirement for building materials like bricks poses a significant danger to these wetlands even as urbanization and technology advance. This has led to the ongoing devastation of marshes in an effort to find locations that might sustain brick production. The majority of people have favored constructing brick-based permanent structures. Regrettably, marshes and other wetlands that are vital to the production of bricks have been endangered by the drive for modern houses. Additionally, Frasher (2007) notes that activities like brick manufacturing,

charcoal burning, and agriculture are to blame for the depletion of the world's marsh and woodland resources. While this might be the case in other jurisdictions, this study seeks to establish the effects of brick production on Kingwal wetland.

Brick production has been linked to soil degradation in India, which lowers land productivity and affects rice cropping (Luby, Rutherford, Biswas, and Gurley, 2018). A study by the Bangladeshi Department of Agricultural Extension found that brick fields on 2,000 acres of land in Sayer, close to Dhaka, made agriculture impractical because of the carbon dioxide emissions from the brick field, 3,000 acres of crop productivity decreased from 80% to 0%. In the paddy, the processes of pollination and rice development are interrupted. As a result, there has been a 10% decline in global rice production. Acid rain, which is created when Sulphur Dioxide and water vapor mix with Sulphur, affects the soil's acidity and causes the grass to turn yellow. The volatile components created by the smoke and gases released by burning fuel have a negative impact on the fruits and vegetables that grow along the river banks. According to Tsega, Mosisa, and Fufa (2017), the gases combine in the air, spread, and settle on vegetation and crops, blocking stomata and lowering photosynthesis which subsequently affects agricultural yields (Environmental Social Report for VSBK, 2005). Brick Kilns release high temperatures that harm the ecosystems in brick-making regions. Due to the high temperatures generated during brick burning, the soil fertility reduces as a result of the destruction of the soil-forming organisms.

According to EAC Secretariat (2006), the Lake Victoria Basin's trees and vegetation are being destroyed by brick-making activities. Some countries such as Zimbabwe and Peru are a head of the curve in safeguarding forests, they have adopted environmental friendly ways of preparing bricks, and they don't use wood fuel in brick making (UNDP, 2008). Forests are being maintained as a result of not using wood for fuel (UNDP, 2008). A key element of the majority of UNDP conservation efforts is encouraging community participation in the protection of forests and ecosystems (UNDP, 2008). Residents of places with natural resources will have the opportunity to contribute to the sustainability of such areas through the projects. Research is required to determine the impacts of deforestation and loss of plant cover on private farms to human life since it also results in the damage of water catchment regions of the Maragoli Hill forest and Ebusiekwe (GoK, 2008).

In Sudan just like other Africa countries, the most reliant industry business is brickmaking. However, negative repercussions result from all operations, including digging the ground and burning bricks. Man is at risk from the pits left behind because they are responsible for 5% to 10% of accidents. When soil is removed for brick production, soil is reduced on the earth's

surface (Mazumdar, Goswami, & Debnath, 2018). Lowery and Octavio (1995) presented evidence of the intricacy of brick production challenges. They found that people were producing bricks because of their unemployment and the growing levels of poverty. There is a need for greater study since there may be other motivations for people to engage in brick-making activities than poverty and unemployment.

Removal of vegetation through brick making processes have resulted to various effects on flora, amongst these effects are; loss of moisture and hence less ability to support plant and vegetation growth. These adversely affect plant development including unalterable damage to plant growth and development, decreased photosynthesis, decreased amount of panicles in wetland plants. Wamithi (2018) undertook a study and established that increasing demand for bricks compete with demands for food and the environment, a drastic change in land use through brick making process have resulted to alteration, encroachment and inappropriate use of marginal lands thus leading to increased wetland de-vegetation, the study determined the extent to which brick making affected Kingwal Wetland. It also assessed whether the locals are aware of the effects this action has on wetland habitat.

Bricks that aren't burned contribute to the preservation of natural forests. The cemented bricks are among these bricks. These are created by combining water with sand and cement. After that, they are molded, producing sturdy bricks. Because it doesn't require cutting down trees to burn the bricks and because the bricks are sun dried, it is an environmentally good technique in today's society. This fits very well with environmental plans that aim to sustain economic growth Drausnut (2008). Brick production has aided in economic diversification. In many underdeveloped nations, this is done in conjunction with agriculture. Numerous farmers have expressed frustration over price swings, land scarcity, soil fertility issues, and weather changes. According to Somini (2007) brick production has given peasant farmers the ability to produce and sell bricks, enabling them to earn the most money, construct quality homes, raise their standard of life, and lower their levels of poverty. This has maintained economic growth in several underdeveloped nations.

Ecosystem is degraded due to the enormous amounts of gaseous and particulate pollutants that are released during brick production (Skinder, Pandit, Sheikh & Ganai, 2014). Brick kiln emissions are mostly made up of fine coal particles, dust, organic matter, and trace amounts of gases including SO₂, NO₂, H₂S, and CO₂. In the vicinity of the brick kilns, a significant amount of dust emerged from non-chimney sources. The dusty circumstances in and around the brick kilns are a result of these runaway dusts in the workplace, which are made worse by strong winds. By obstructing stomata openings and decreasing light penetration, these

contaminants can harm vegetation. These obstacles have a significant negative impact on photosynthesis, killing plants. The Sitatunga antelope (*Tragelaphus spekii*), a rare and endangered species, lives in Kingwal, along with other flora and fauna, thus the researcher was interested in learning how much vegetation loss is caused by brick-making activities there.

2.3 Effects of Farming on the Biomes and Wetland De-vegetation

Commercialization, which aims to boost food production, frequently converts natural areas into cultivated land, which can lead to local plant life eradication, the depletion of nutrients from the soil, and eventually soil erosion. Furthermore, these modifications may reduce crucial wetland Ecosystem Services (ES) (Bergius, Benjaminsen, Maganga & Buhaug, 2020), such as freshwater availability, the sustainability of food production, and the landscape's capacity to provide erosion control, flood regulation, and water infiltration. The need to find a solution to harmonize this mismatch led to the need to investigate the effects of crop cultivation on wetland de-vegetation. Sustainable management is threatened by the mismatch between supply (what services are generated within an ecosystem) and demand (people's need for these services) at various spatial and temporal scales.

Riverine wetlands have been considered as valuable land regions because they feature fertile soils thanks to regular sediment deposition during flood events, for the production of food and fodder from the beginning of agricultural operations. A significant additional benefit was having access to rivers for transportation (Verhoeven & Setter, 2010). With ever-more-effective drainage and land-improvement techniques, wetlands have been recovered for agriculture in various regions of the world over time. Wetland invasion has resulted in crop farming on previously wetland-occupied territory, which is now being referred to as "wasteland" (Ondiek, Vuolo, Kipkemboi, Kitaka, Lautsch, Hein & Schmid, 2020).

According to Spence, Shook, Pomeroy, Whitfield and Wolfe (2020) wetlands are considered to contain fertile soil that is suitable for farming, the need for increasing crop production and the export of agricultural products has led to a contemporary pattern in agriculture that involves draining wetlands for future cultivation. Wetlands ecosystem acts as a natural filters for pollutants and agricultural nutrients. The inherent inclination of the ecosystem to retain contaminants is significantly impacted by the draining of these wetlands for agricultural production. For instance, it was discovered that drained wetlands serve as P sources in Southern Manitoba (Badiou *et al.*, 2018). The actual wetlands themselves are contaminated as a result of excessive agriculture. It was found that farming in the Prairies was poisoning

surrounding wetlands with agrochemicals. In the ephemeral wetlands located within intensively farmed agricultural landscapes in the Prairie Provinces, traces of insecticides (such as neonicotinoids) and herbicides (such as glyphosate) have been found (Degenhardt et al., 2012; Main et al., 2014).

Many wetlands are today subject to substantial land use, which commonly combines agricultural production with other purposes including improving water quality, preventing flooding, or preserving biodiversity (Verhoeven and Setter, 2010). Contrary to intensive farming practices, which have degraded wetland services and functions everywhere. Examples of these land uses include animal grazing plans, conventional water management techniques, and traditional agricultural growing techniques without the use of artificial pesticides or fertilizers. Such tools are crucial for evaluating agricultural practices in wetlands because some farming methods have been found to have a greater negative impact on wetlands than others (Van Dam, Kipkemboi, and Denny, 2014). This study established that most of the people living around Kingwal wetland practice intensive farming near the wetland especially during the dry season. It could be paramount to establish the extent to which this farming causes the loss of wetland biodiversity.

Draining and reclamation of wetlands is one of the ways that agricultural activities alter the Physical Environment of wetlands, the physical part in this case being soil. As a result, soil degradation frequently happens when natural vegetation is converted to horticultural land. Currently, villages or places with subsistence agriculture where local groups raise food on a small scale, mostly for their own consumption can have such a diverse range of land uses. One such region is Sub-Saharan Africa (Turyhabwe, Tumusiime, Kakuru, & Barasa, 2013). In a semi-natural setting, local agricultural farming, fish farming, and grazing are all combined. In some cases, natural wetlands are used for agricultural production while natural hydrological processes are largely conserved. The other regulating and supporting wetland activities and services, like as biodiversity, are not necessarily completely eliminated by such systems. It will be paramount for this study to investigate the effects of crop farming on wetland vegetation.

2.4 Community Perspective on the values of Wetland Conservation

The importance of raising awareness of the benefits of wetlands cannot be overstated because without it, they will be irreparably damaged or destroyed, and future generations won't have anything to show them about how beautiful they are, how much can be gained from using

them properly, or how to protect the areas around them that serve as a buffer zone (Ibrahim, Aminudin, Young & Yahya, 2012).

Wetlands play a significant role in the global water cycle and control local water supply and quality, according to the World Agroforestry Center (2014). They support the nutrient cycle, sediment transport, retention and export of nutrients, as well as water filtration, denitrification, and detoxification. Additionally, wetlands can filter waste water and guard against coastal and river flooding. For instance, the Catskill/Delaware watershed supplies nearly 90% of the water consumed by residents of New York City. According to a 1997 assessment, it would cost between US\$6 and US\$8 billion to establish a new water treatment facility, compared to US\$1.5 billion to ensure excellent water quality by taking steps to reduce pollution on the watershed (UNEP, 2005).

The Ramsar Convention created its Programme on Communication, Capacity-building, Education, Participation, and Awareness (Resolution, 2015) to foster awareness of the values and functions of wetlands. This initiative promotes wetland research, management, and conservation training advancement and calls for integrated national and international wetland education, public awareness, and communication. State, territory, and County governments provide guidelines and policies on wetlands resources for landowners and the general public. Additionally, they ask for public input when developing seasonal watering plans, park management plans, and canal management strategies (Horne, Webb, Stewardson, and Rithcer, 2017). Additionally, landowners are urged to implement private conservation measures on their property. The biological benefits of wetlands that are not already protected by other measures may be preserved and restored using this method. This study looked into the viability of doing this in King'wal Wetland in Nandi County.

The initiatives will give residents in natural resource locations the chance to contribute to the sustainability of those areas (Kuya, 2015). There is a need for research to determine the effects of human activities like brick production on wetland de-vegetation since loss of vegetation cover has resulted in the degradation of water catchment regions of Maragoli Hill forest and Ebusiekwe, making it a serious problem for human life.

Long-term wetlands protection has helped nearby communities boost their income or temporarily meet their necessities. Education should be a part of conservation efforts, and new revenue streams or other options should be made available to the local community so that they may at least maintain and, ideally, raise their standard of living (Shrestha, 2011). The lack of local participation has led to the identification of several instances of system failure in rural areas. All conservation efforts should involve people, as should the

management and conservation phases of wetlands. The non-consultative approach to interacting with local communities disregards the function and expertise of those in responsibility of ensuring their health.

When wetlands are impacted in an unavoidable way, lost services are often replaced by compensatory mitigation, which involves creating, restoring, or enhancing additional wetlands using prescribed ratios based on area (Hruby, 2004). Recent scientific research has demonstrated that protecting the functions of wetlands only through the use of buffers and the establishment of "mitigation ratios" is sufficient because it only considers providing protection around a wetland and not potential landscape disturbances elsewhere.

2.5 Conceptual Framework

The ecological theory developed by Egerton (1973), which is connected to the natural succession (changing) of ecological systems, served as the study's guiding principle. According to ecology theory (Egerton, 1973; Pickett and White, 1985), systems should be closed, self-regulating, follow a specific change pathway to a single stable endpoint, and be free of disruptions (natural or human).

Contrary to what Egerton (1973) claimed, wetlands are among the habitat types that are disappearing most quickly. This is likely due to human invasion through activities like farming and the production of bricks on biomes. Wetlands, which were formerly thought, and regarded as unhealthy and unproductive environments, were frequently seen to have significant potential for drainage, urbanization, farming, tourism, and other industrial uses like brickmaking.

The wetlands have been converted for agricultural use by people living around the wetland, through crop cultivation on biomes and brick making (income), thus potentially depleting these resources or degrading the biological systems, such as soils on which their continued production depends.

In light of the above, it is evident that wetlands are no longer self-regulating; they have been interfered by human activities. The natural resource has experienced disturbances from external factors hence the equilibrium has lost balance.

The theory has been appraised as it has a wide range of applications; it provides actionable inputs, making it a practical framework. Most scholars have criticized the theory on the account that its terms and categories are sometimes vague.

This theory can be used in this study since it describes how human activities have an impact on the wetland ecosystem. The idea expands our knowledge of potential effects for various behaviors carried out inside the wetland ecosystem. It is concerned with the entirety of human activities and how they affect wetland.

In figure 2.1, the independent variables are farming on biomes and brick making activities, which led considerably to wetland alteration. Due to excessive farming on biomes, there has been extensive encroachment into the wetland areas; the vegetation cover is removed, therefore leading to soil erosion and loss of soil fertility. On the aspect of brick making, the growth of human population around wetlands and the existence of black clay soil have contributed to the sourcing of bricks from the swamps/wetlands. The over exploitation of these wetlands has considerably resulted in the degradation and de-vegetation of the wetlands. The study also sought to assess the local communities' attitude towards continual eking activities verses conservation.

The dependent variable in this study is the wetland de-vegetation. This is the end result of socio-economic operations carried out by humans, such as agricultural farming and brick production. When vegetation is removed from wetlands, moisture is lost, which reduces the area's capacity to support plant and vegetation growth. Due to brick making activities, there will be open pits. Also, the removal of vegetation may result to exposure of soil bare leading to soil erosion.

The Mediating variables in this study are the government policy and policy framework. The government policies are rules and regulations put in place by institutions like NEMA through policy developments that will be able to govern the management and utilization of the wetlands in this area. This will be effective in curbing illegal brick making and crop farming within wetland areas

The conceptual framework illustrates the relationship between the dependent and independent variables as shown in figure 2.1 below.

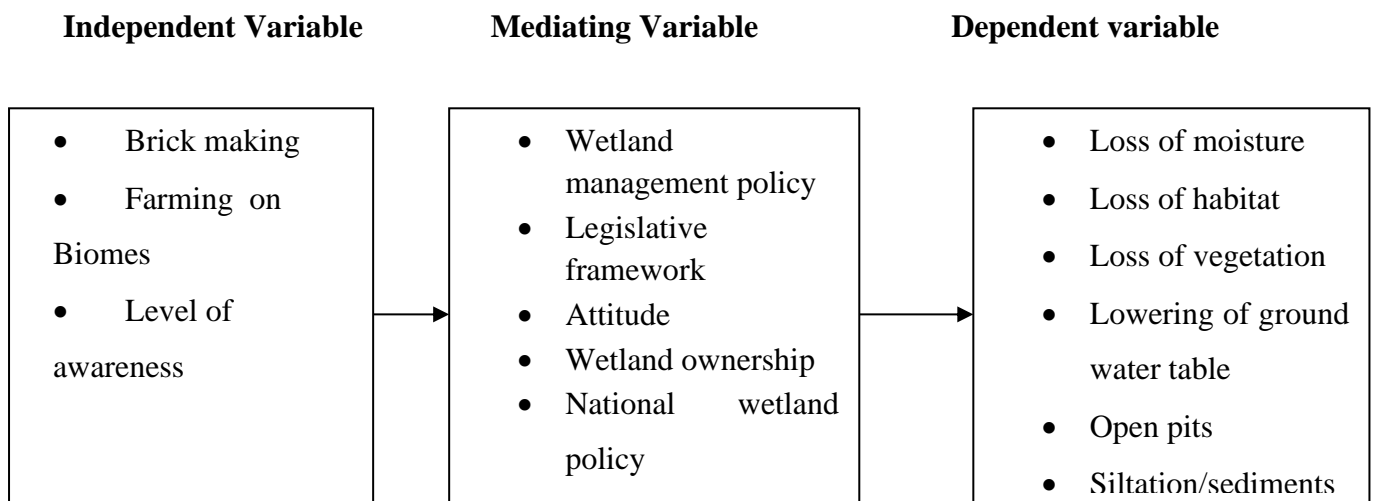


Figure 2.1: Conceptual framework showing the relationship between human activities and their impact on the de-vegetation of wetland ecosystem.

Source: (Researcher, 2021)

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter addressed the research paradigm, study area, target population, sample size and sampling techniques, data collection tools, data analysis and presentation and finally ethical consideration.

3.2 Research Design

The study adopted a descriptive survey research design. It is an approach that blends quantitative and qualitative data to provide the researcher with relevant and accurate information. The design is best suited to studies aimed at finding out the prevalence of a phenomenon, situation, problem, attitude or issue by taking a cross section of the population (Muse and Basak, 2017). It engages the people at the center of the study objective in getting a broad sense of the situation at the time of the study (Creswell and Poth, 2016). Because it illustrates the link between the result and predictor factors, this study design was appropriate for examining the impacts of human activities on wetland de-vegetation at a certain period (Vaske, 2019). The study looked into brick making, farming on biomes and level of awareness of the community on the importance of wetlands.

The design specifically estimated the extent to which local biomes are affected by human activities like farming and brickmaking. The study was useful in examining the effects of farming and brickmaking on biomes, including the depletion of topsoil nutrients and soil biota and changes to the physicochemical characteristics of soil. The design also provided information on the community perspective on the value of wetland conservation.

3.3 Area of Study

The King'wal Wetland in Nandi County served as the study's area. According to the (County Integrated Development Plan CIDP, 2018–2022), the King'wal Wetland is located in Nandi County, approximately 25 kilometers from Eldoret town in the direction of Kapsabet town. According to Sitienei *et al.* (2012), it is a massive swamp that is 2.73 square kilometers in size. Forests, meadows, bushes, and scrubland make up the wetland's vegetation; the most common grass species there are *Andropogon gayanus*, *Heteropogon contortus*, *Panicum maximum*, and *Sporobolus pyramidalis* (Mengist, 2019). The wetland was primarily used for substantial vegetable and maize farming, grazing, and brick production. Hunting and growing eucalyptus are some additional pursuits (Hansen, 2006).

The county is located in the former Rift Valley Province's, western region. According to the Republic of Kenya (2012), it is located between latitudes 0° 31' 0.00" North and longitudes 35°16' 59.88" East. According to the population census of 2019, Nandi County had a population of 885,711 persons made of 441,259 males and 444,430 females. Nandi Central had a total household of 34,400 and a population density of 328 people per km² (KNBS, 2019). The County has a cool and moderately wet climate; it receives an average rainfall of between 1200mm and 2000mm per annum (RoK, 2012)

Wetland and riparian land cover is around 1218 km² in total (Republic of Kenya, 2014). The wetlands' primary catchment area is in the Kesses area of Uasin Gishu County. It is a tributary to the River Yala, which empties its water into Lake Victoria, and consists of a network of streams, springs, and rivers that are connected to various wetlands in the area between Lolminigai and Kombe (Republic of Kenya, 2014). The area under study was chosen because despite being a tourist destination, a home to a rare and endangered Sitatunga (antelope), it has been heavily impacted by human activities like farming on biomes and brickmaking activities. Ecotourism is necessary to preserve the area for use as a tourist attraction. The area is protected by the Kenya Wildlife Service because of its biodiversity, but it has not been gazetted as a protected area, and its ownership is not clear, resulting in human-wildlife conflict.

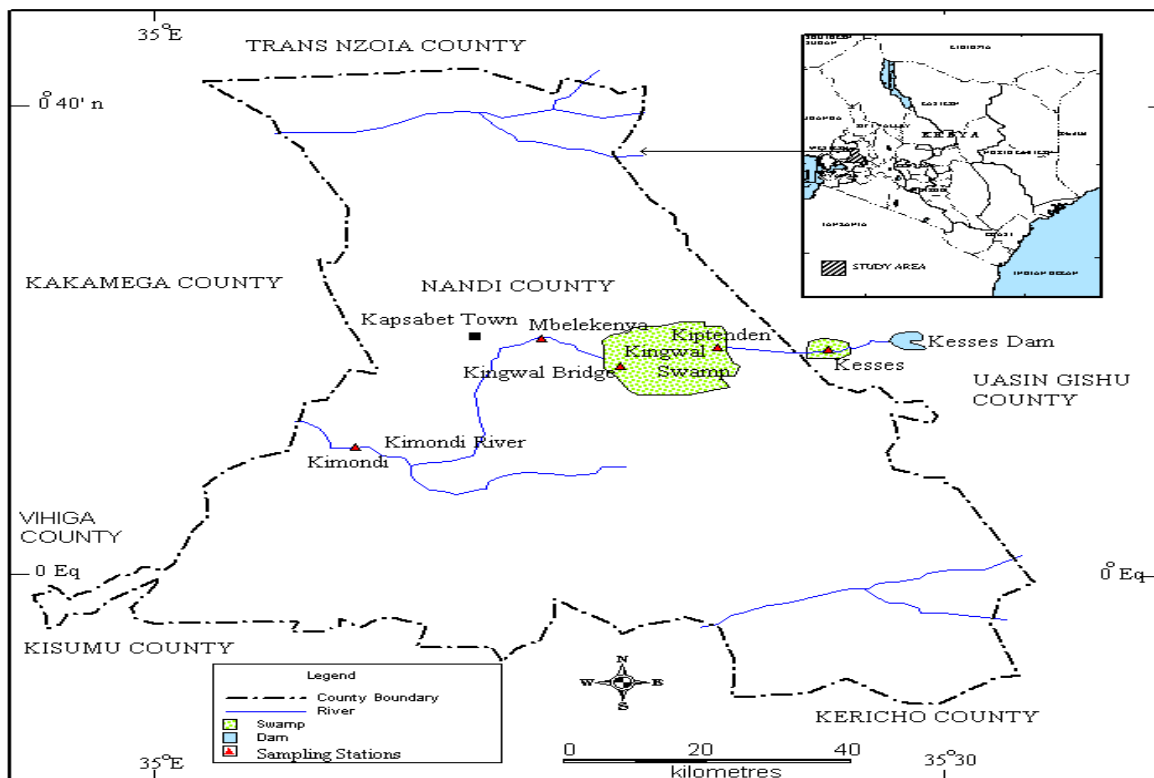


Figure 3.1 Map showing Study area

Source: (King'wal Integrated Wetland Management Plan, 2014-2018)

3.4 Target Population

The King'wal Wetland neighborhood's household heads and administrative leaders (village elders, the Assistant Chief, and the Chief) made up the research population. According to the KNBS (2019), there were 1325 homes and 5,772 people living there. From this demographic, 9% said that they used King'wal Wetlands resources (Chepkwony, 2018), and household heads were selected from this group to complete the questionnaire. 1325 heads of households, 10 community leaders, one representative from the Lake Victoria Environment Management Plan II, two from the King'wal integrated management plan task team, and two from the NEMA Nandi County office were the study's primary targets.

3.5 Sample Size and Sampling Procedure

Data from the head of families residing close to the marsh, who make up the majority of the population, were collected through purposive sampling. The researcher chose participants based on the objective of the study. The farmers and brick makers who directly interact with the wetland through farming in biomes and brick-making activities were chosen using this sampling technique. The researcher collected information or data from these individuals to get their ideologies and perceptions concerning the wetlands, their advantages, and the effects that wetlands' inevitable degradation might have on their lives. Wetland de-vegetation results from these actions (Bezabih, Gabayo, and Wakjira, 2020).

The census sampling method was utilized to collect information from the 10 community leaders because there were few individuals. In this study, the term "community leader" referred to community activists who are responsible for protecting wetlands. According to Mugenda & Mugenda (2010), the need to maintain the sample size acceptable is the main factor to take into account when choosing the sample size. This method ensured that the researcher obtained comprehensive information at a reasonable time, finance, and affordable cost. Therefore, the formula by Mugenda and Mugenda (2003) was used to determine the sample size (n):

$$n = Z^2 \left(\frac{pq}{d^2} \right)$$

Where;

n = the desired sample size

Z= standard normal distribution at 95% confidence interval

d = the acceptable margin of error (0.05),

p = the proportion of individuals using the swamp (9%), and q = the proportion of individuals not accessing the swamp = 1-p= (0.91).

Hence; d = 0.05, p = 0.09, z = 1.96 at 95% confidence level, q = 0.91.

Thus $n=1.96^2\left(\frac{0.09*0.91}{0.05*0.05}\right)=125.85$

Therefore, the desired sample size was 126 households units.

In addition, the researcher interviewed 15 key informants (10 community leaders, 1 person from Lake Victoria Environment Management Plan II, 2 people from King'wal integrated management plan task force and 2 people from NEMA Nandi County office). The study sample size was 141 respondents.

3.6 Research Instruments

3.6.1 Questionnaires

Data was gathered by the researcher using questionnaires. Both open-ended and closed-ended questions were included in the survey (Rowley, 2014). The survey's closed-ended questions were created to capture quantitative data. The surveys were self-administered by the researcher and given to farmers and brick makers who reside close to the King'wal Wetland in Nandi County. Part A contained social demographic data, whereas Part B had statements illustrating the impact of brick production on wetland. The responses were elicited using a 5-point Likert scale, where 1 stood for strongly agree and 5 for strongly disagree.

Part C, which included both open-ended and closed-ended questions, generated responses on the impact of farming on wetland biomes. On a scale of 1 to 5, where 1 meant "Strongly agree," and 5 meant "Strongly disagree," were the closed-ended questions. The awareness of the value of protecting wetlands was examined in Part D. The questionnaire asked various questions about how human activity affected the plants in wetlands. To make the surveys easier for the people to understand, they were translated into the language of the catchment region. The study tool provided a chance to learn about and assess the respondents' opinions of the data they provided, and it also helped them with sections (questions) they didn't fully comprehend.

3.6.2 Interview Schedule

Based on their expertise in the subject field, important informants were chosen using a purposive sampling technique. Key informants in the study area were only people who were familiar with the problems there (Rowley, 2014). Key informant responses were elicited

using an interview guide. The researcher spoke with the village elders, the chief, the assistant chiefs, and a KWS representative. Additional important informants included 2 members of the King'wal integrated management plan task force, 1 representative from the Lake Victoria Environment Management Plan II, and 2 representatives from the National Environment Management Authority (NEMA) Nandi County office.

Key informant interviews revealed details about the nature and kinds of human effects, how they relate to changes in wetland ecosystems, and the strategies used to advance the preservation of King'wal wetland. A qualitative analysis was done on the information obtained from key informant interviews. The data were carefully reviewed by the researcher to uncover recurring themes, subjects, concepts, and patterns of meaning. Thematic analysis is the term used to describe this type of analysis (Anderson, 2007).

3.6.3 Focused Group Discussion Guide

In order to determine the effects of human activity and how it affects the wetland ecosystem, focused group conversations were utilized to create Community conservation forums, women's and youth groups, as well as field visits and observation. For intensive group discussions and community-based conservation leaders, five groups were formed. The researcher guided the group in discussing the topics on human activities and wetland. In each group a minimum of 5 members were considered. The groups were selected based on the participant's role in conservation of the Wetland.

3.7 Piloting of Data Collection Instruments

Before conducting a full-scale study, a pilot experiment, also known as a pilot study, is conducted on a small scale to evaluate the feasibility, time, cost, adverse events, and effect size (statistical variability) in an effort to determine an appropriate sample size and improve the study design (Peat, Mellis, Williams, and Xuan, 2002).

In a pilot study members of the relevant population typically participate, but not those who will make up the final sample. This is because if research volunteers have already participated in the study, it could affect their behavior going forward.

The piloting study was done in Kibirong wetland, which is likewise in Nandi County and possesses characteristics comparable to those of King'wal wetland. All study tools were assessed to determine their effectiveness, validity, and reliability to capture data for the study. A pilot study helped identify the research tool's shortcomings. This aided the researcher in correcting the situation before the actual study.

3.8 Validity and Reliability of Research Instruments

3.8.1 Validity of Research Instruments

Validity must be established if the study's conclusions are to be trusted. Broadly speaking, there are three major types of validity i.e. face validity, content validity and criterion validity. The construct validity technique, which determines if the data produced from an instrument accurately reflects or represents a theoretical notion, was used to assess the instrument's validity (Mugenda, 2003). According to Mugenda (2003), it is a measure of how relevant and precise data from an instrument reflects or represents a theoretical concept.

In order to ascertain the accuracy and dependability of the data gathered from the field, it was necessary to determine the validity of the data collection tools. With the help of the expertise in the subject matter, two supervisors and one departmental lecturer evaluated the instrument's face value and substance and provided feedback. Before the actual study, the feedback was included into the final instruments.

3.8.2 Reliability of Research Instruments

The level of consistency that a research instrument produces after numerous trials is known as its reliability. A random error affects reliability in research. Reliability declines as random error rises. This can be the result of respondents receiving unclear instructions and erroneous coding (Mugenda, 2003). To confirm the results, it is necessary to examine the instrument's dependability.

Pre-testing the questionnaire with a chosen sample that was excluded from the main study improved the study's reliability. Cronbach's Alpha (α), a measure generated from pairwise correlations between items that should produce similar findings, was used as an internal consistency technique. The test-retest approach was used by the researcher. She gave the test to the same group of participants, gave it to them again two weeks later, and computed the findings from both administrations. The widespread consensus is that Cronbach's alpha scores above 0.7 are acceptable. More preferable are alpha values that are higher. According to Kothari (2004), a dependability of 0.7 or above (obtained on a sizable sample) is considered satisfactory as a general rule.

3.9 Data Collection Procedures

The researcher collected data from the selected respondents after receiving an authorization letter from Post Graduate School of Education, National Commission for Science, Technology and Innovation (NACOSTI), Office of the County Commissioner and County

Director of Education Nandi County to carry out a research in the study area. The researcher presented the research permit and introduction letter to the authorities in charge of the wetland and obtained the permission to collect the data. Once the permission was granted, the researchers briefed the participants on the purpose of the research and sought their consent to participate in the study. For those who gave their consent to take part in the study, they were issued with the questionnaire. For the interview and group focused discussion, the researcher proceeded to ask the prepared questions on the interview schedule while recording their responses on a notebook.

3.10 Data Analysis Procedures

Data analysis typically entails breaking down a large amount of data into manageable chunks, creating summaries, identifying trends, and using statistical approaches (Hsu, 2005). As soon as data gathering was complete, data editing got underway. To improve the accuracy of the findings, quantitative data was coded and grouped into emergent themes before being subjected to analysis using SPSS version 25.0 (Azen and Walker, 2021). Later, frequency distribution tables, pie charts, and bar graphs were used to illustrate the research findings.

Thematic data analysis was used to examine qualitative data in order to learn about people's experiences, viewpoints, and opinions. It detects linguistic patterns within a dataset that respond to the study topic (Braun and Clarke, 2006). Using this technique, responses from the interview schedules, focused group discussion and open-ended questionnaire items were evaluated.

Objective one was analyzed using: percentage distribution to show particular frequencies of the respondents, Pearson product moment correlation was used to show the relationship between brick making and wetland de-vegetation. Objective two was analyzed using measures of central tendency (mean), standard deviation, and percentage distribution. Additionally, Pearson product moment correlation was used to analyze the variation of the extent of farming on biomes on the wetland de-vegetation.

Objective three was analyzed using percentage distribution to display particular frequencies of the respondents. Pearson product moment correlation was used to analyze the relationship between level of awareness of the community on the importance of wetlands and wetland de-vegetation.

3.11 Ethical Consideration

Authority to collect data was sought from the Jaramogi Oginga Odinga University of Science and Technology, National Commission for Science, Technology and Innovation (NACOSTI),

and the County Government of Nandi. The researcher followed the ethical rules governing the data gathering once authorization had been obtained. Ethics are rules or benchmarks for moral judgments on human conduct and interpersonal interactions. Making sure that no one is hurt or suffers negative effects as a result of a study is the aim of research ethics (Cooper and Schnindler, 2003).

The following ethical concerns were taken into account whilst the study was being conducted. The goal of the study was explicitly communicated to the study respondents in order to get informed permission from them. The researcher gave the respondents an assurance that the information they provide would be kept confidential and used only for research purposes. Efforts were made to ensure that the languages used in the data collection instruments took the respondents' cultures, religions, and levels of comprehension into account.

Due to the respect for autonomy, no study participant was coerced into the research. Furthermore, the questionnaire had an introduction of the researcher and what they intend to do with the participants. As such it was clear from the beginning that the exercise is free to participate. The researcher clarified to the participants that any information they gave was kept private and confidential. The participants were not required to indicate their name on the questionnaire so that their identity could be protected.

The researcher acknowledged every work of other authors used in any part of the research; this helped in eliminating any form of plagiarism. The researcher also ensured that no duplication of another research work was used. In addition to this, the researcher maintained the highest level of objectivity in discussions and analyses throughout the research.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The study main purpose was to investigate the effects of human activities on wetland vegetation, perspective of King'wal in Nandi County, Kenya. The main objectives of the study were; to establish the extent to which brick making activities causes wetland de-vegetation, to examine the effects of farming on the biomes of King'wal wetland in Nandi County and to assess the community perception on the importance of wetlands in relation to their encroachment activities. Results discussed in this section were obtained from a sample of 126 questionnaires administered in the area which was a return rate of 100%.

4.2 Socio-Demographic Characteristics of the Respondents

Table 4.1 displays the local community's feedback in terms of their socio-demographic traits and profile. In terms of gender, 65.9% of respondents were men and 34.1% were women. As somewhat more than 30% of the respondents were female, this demonstrates that the two-thirds gender guideline was followed (GOK, 2010). Targeting interventions for management and conservation projects depends on how different gender roles participate in the utilization of the King'wal Wetland. The primary users who are affected by a resource's decline will be concerned about it, and they may be more motivated to cooperate to discover solutions. Therefore, diverse genders in the area should be the focus of future management and conservation activities (Kingw'al Integrated Wetland Management Plan, 2014-2018).

According to the study's findings, 3.2% of respondents had no formal education, compared to 26.2% who had completed primary school, 45.2% who had finished secondary education, and 25.4% who had completed post-secondary. These findings imply that 96.8% of the study population was knowledgeable, which may make it easier to comply with and enforce local wetland management regulations (Republic of Kenya, National Environment policy, 2013). Despite the fact that the majority of the study group had a formal education, they took advantage of the wetlands' resources to obtain startup capital for other businesses. Kingwal

Wetland provides resources that are free to use, including water, clay, grass, and other materials for building shelters or cottages. These imply that wetlands are a good support to livelihood if well used because people depend on them for livelihood for a long period of time.

As depicted in Table 4.1, 81.7% of the respondents were married, 17.5% were single while 0.8% were divorced. In terms of the number of dependents, 10.3% had no dependents, 46% had 1-4 dependents, and 41.3% had 5-10 dependents while 2.4% had more than 11 dependents. Such a high dependency ratio could exert high pressure by engaging themselves in livelihood activities such as brick making and farming on wetland biomes to support the family and ostensibly this push them to engage in activities that could contribute to wetland disturbance. We can also insinuate that limited time and resources were devoted for wetland conservation practices due to pressure to fend for themselves and their families (Kingw'al Integrated Wetland Management Plan, 2014-2018). Nevertheless, the large family size could act as a source of wetland labour for wetland conservation measures.

As per table 4.1, 52.4% of the respondents live less than 1 km from the wetland, 15.9% live between 1-4 km from the wetland, 15.9% also live between 5-10 km from the wetland while 5.6% live between 11-15 km from the wetland and 10.3% of the respondents lived more than 15 km from the wetland. The mean distance from the wetland was 1.3 km. In terms of income per month, 46.8% of the respondents earned less than 81 dollars, 20.6% earn between 81 to 162 dollars, 12.7% earn between 162 to 244 dollars, 11.9% earn between 244 to 325 dollars and 7.9% earn between 325 to 407 dollars. From the study results, it's evident that the majority 46.8% of the respondents earned less than 81 dollars per month which is too little to cater for their basic needs. The mean income per month was 85.5 dollars. Low income causes the community living near wetlands to engage in destructive farming practices such as cutting down trees for firewood and charcoal, draining wetlands for cultivation, and other activities that conflict with the long-term preservation and management of wetlands

(Francis, Philip, and Samuel, 2015). The majority of the community members who were interviewed admitted that their per capita income is low, they are impoverished, and they continue to be largely illiterate. Through a vicious loop, this causes overuse, abuse, and deterioration of wetland resources.

The study also investigated the occupation of the respondents, 68.3% of the respondents participated in farming activities, 23% participated in business activities, 2.4% were brick makers, 4.8% were involved in civil service and 1.6% involved themselves in politics. The majority of the study participants 68.3% were farmers while 1.6% involved themselves in politics. These findings were in agreement with Stuij, Baker and Oosterberg (2002) who asserted that subsistence-level groups close to wetlands commonly utilize livelihood strategies that combine subsistence agriculture with the exploitation of wetlands' resources. Because these communities are frequently less organized than other societal groups, they are not effectively represented at decision-making tables, and as a result, the economic benefits that wetlands deliver to these communities are not adequately reflected in national political development. Also, the political class lacks political will because they too benefit from the wetland. Furthermore, development projects that aim to relieve poverty may mistakenly exclude these poorer communities if this reliance on wetland resources is not recognized and taken into consideration during the planning and implementation of the project from the very beginning.

Biologically, age is a very important component of human capital in Sustainable Livelihood Approach. As shown in table 4.1 below, the majority of the study participants 32.5% were in the age of between 26-35 years while the minority 3.2% were less than 18 years of age. The mean age of the respondents was 33 years. The mean age of 33 years of the household respondents authenticated the results of this research given the Kenyan age of consent of above 18 years in the constitution of Kenya (GOK, 2010).

Table 4.1 Socio-Demographic Characteristics of the Respondents

Characteristics	Frequency	% age	Characteristics	Frequency	% age
Sex			Income per Month		
Male	83	65.9	< \$81	59	46.8
Female	43	34.1	\$81-162	26	20.6
Level of Education			\$162- 244	16	12.7
None	4	3.2	\$244-325	15	11.9
Primary	33	26.2	\$325-407	10	7.9
Secondary	57	45.2	Mean income	\$ 85.5	
Post primary	32	25.4	Number of Dependents		
Marital Status			0	13	10.3
Single	22	17.5	1-4	58	46.0
Divorced	1	0.8	5-10	52	41.3
Married	103	81.7	>11	3	2.4
Experience			Occupation		
0-5 years	38	30.2	Farming	86	68.3
6-10 years	9	7.1	Business	29	23.0
11-15 years	32	25.4	Brick making	3	2.4
16-20 years	13	10.3	Civil Service	6	4.8
>20 years	34	27.0	Politician	2	1.6
Mean experience	10 years		Age		
Distance of Wetland			<18 years	4	3.2
< 1 km	66	52.4	18-25 years	16	12.7
1-4 km	20	15.9	26-35 years	41	32.5
5-10 km	20	15.9	36-45 years	23	18.3
11-15 km	7	5.6	46-55 years	27	21.4
>15 km	13	10.3	56-65 years	15	11.9
Mean distance	1.3km				

Source: (Researcher, 2022)

4.3 Effects of Brick Making on Wetland De vegetation

The most significant processes in the brick-making process include removing soil from the earth's surface, kneading, shaping, and, finally, burning. Brick is commonly used for furnace ducts, flues, lining, and chimneys, as well as the foundations, walls, piers, buttresses, and arches of buildings and other structures (Encyclopedia Britannica, 2018). Because vegetation is left bare and exposed after the brick preparation process, brick manufacturing has the ability to significantly modify soil conditions and vegetation. This method, however, may be optional at times, depending on the current flora or the most recent land-use choice. In this sub-section, the researcher looked into how brick production affected Kingwal wetland in Nandi County, brick making activities, farmers' perception and knowledge on wetland vegetation in Kingwal area formed part of this study.

4.3.1 Awareness of Brick Making Activities

Making bricks is a source of income in many communities. The Kingwal Wetland encourages the growth and extension of brick manufacture due to the low startup costs and other costs. For individuals working in construction and building, bricks continues to be an affordable supply of building materials. However, the production of bricks poses a risk to the biophysical and socioeconomic environment. Brick-making operations led to the destruction of settlement and agricultural land, the disappearance of vegetation cover, the creation of holes troughs on the earth's surface, a decrease in fertility of the soil, and other environmental problems. The study respondents were asked to state whether or not they were aware of brick making activities. The study results are as shown in table 4.2 below.

Table 4.2 Awareness of Brick Making Activities

	Frequency	Percentage
Yes	85	67.5
No	41	32.5
Total	126	100

Source: (Researcher, 2022)

The respondents were asked to state whether they were aware of brick making activities being carried out in the swamp. The findings of the study revealed that 67.5% of the respondents were aware while 32.5% were not aware. The findings were in tandem with those of focused group discussions where the various group members agreed that brick making is taking place around the wetland. Those interviewed asserted that they were aware of the brick making activities taking place around the swamp.

Brick manufacture requires a variety of interconnected tasks and services, and the majority of brick makers were involved in a number of wetland activities such clay mining, baking or preparation, brick laying, drying, moving bricks, and setting up brick kilns. Others were engaged in brick marketing and blocking, as well as the buying and selling of firewood. Due to the necessity for wood fuel to burn the bricks and the usage of vegetation like papyrus reeds to cover brick kilns, this activity reduces agricultural land and settlement areas. The marsh is then vulnerable to soil erosion and burning of bricks cause soil and air pollution (Pariyar, Das and Ferdous, 2013).

Brick-making used to be considered a duty best left to the community's less educated or semi-skilled members (Pariyar, Das, and Ferdous, 2013). However, the activity has already

evolved into a profitable business with minimal human and material resources due to the growing market and high demand. In agreement with this study, USAID (2006) discovered that brick production has had a negative influence on Kenya's ecology because of unemployment and illiteracy. Settlement, agriculture, and brick manufacture are all categorized as environmental concerns (Momanyi and Ariya, 2015).

4.3.2 Source of Clay for the Bricks

One of the most common natural mineral compounds in the world is clay. Clay must have a variety of qualities and characteristics in order to be used in the production of bricks. These clays must be durable while wet and air dried to maintain their shape after production. They must also be flexible enough to allow for shaping or molding when combined with water. For the clay particles to combine, the proper temperatures must also exist. Given the aforementioned remark, it was essential for the researcher to determine the source of the clay used to make bricks. The study results are as presented in table 4.3 below.

Table 4.3 Source of Clay for Bricks

Source	Frequency	Percentage
Wetland Riparian Land	60	47.6
Agricultural land	29	23.0
Both	34	27.0
Others specify	3	2.4
Total	126	100

Source: (Researcher, 2022)

In relation to the question on where do you get the clay for the bricks, 47.6% indicated that they get clay from wetland riparian land, 23.0% agricultural land, 27% indicated that they get clay for the bricks from both wetland riparian land and agricultural land and 2.4% obtained clay from other sources. One of the most common natural mineral compounds in the world is clay. Clay must have a variety of qualities and characteristics in order to be used in the production of bricks. These clays must be durable while wet and air dried to maintain their shape after production. They must also be flexible enough to allow for shaping or molding when combined with water. The clay particles must also fuse together at the proper temperatures. Clay soil is preferred by the majority of brick makers because it retains water well; for instance, 1000 bricks require roughly 600 liters of water (Pariyar, Das, and Ferdous,

2013). This water is abundant in wetland; the respondents cited this as one among other reasons that make them source the clay for brick making from the wetland riparian.

4.3.3 Source of Wood Fuel around and Within Kingwal Wetland

The respondents were asked to state the source of wood fuel around and within Kingwal wetland in Nandi County where 94.4% of the respondents cited firewood as their source of wood fuel while 5.6% indicated that farm waste was their main source of wood fuel around and within Kingwal wetland. The sources used by brick makers in Kingwal are traditional kilns where bricks are arranged in rectangular kilns. They are poorly organized causing excessive use of woodfuel. This fuel emits 15% of carbon dioxide which pollutes the air (Uisso, 2015). While conducting the group discussion sessions those in charge of conservation asserted that there has been cutting down of trees by the brick makers to burn the bricks. One of the key informants categorically stated that “Firewood is the main source of burning the bricks, those who carry out these activities have been cutting down the trees to get the wood fuel”.

According to Draaisma (2009), it is possible to build bricks without burning, which reduces the requirement for wood fuel. He proposes making a strong brick out of cement, sand, and soil. This technology has aided in the preservation of the vegetation by reducing the amount of carbon dioxide emitted into the atmosphere when burning bricks. The project to update brick kilns would also be in accordance with environmental initiatives that seek to eradicate rural poverty and maintain economic expansion in order for future generations to benefit from a nation's environmental resources.

Table 4.4 Source of wood fuel around and within Kingwal wetland

	Frequency	Percentage
Firewood	119	94.4
Farmwaste	7	5.6
Total	126	100

Source: (Researcher, 2022)

4.3.4 Brick Making Site

The respondents were asked to indicate the place where brick making takes place. The data shows that 61.1% of the study participants indicated that it takes place in wetland while 38.9% said that it takes place outside the wetland.

Table 4.5 Brick Making Site

	Frequency	Percentage
Wetland	77	61.1
Outside wetland	49	38.9
Total	126	100

Source: (Researcher, 2022)

Wetlands have drawn a sizeable section of the human populations that rely on resource exploitation to survive, through various resource use activities that are frequently motivated by financial and economic considerations. Due to the fact that wetland has enough water and the right kind of clay for building bricks and that brick making is a source of revenue, brick makers evaluate the wetland's closeness to these resources when choosing where to do their work. Brick making being a source of income and wetland having sufficient water and the type of clay that is required for manufacturing bricks, the brick makers consider the proximity to these resource hence the reason why they carry out brick making in the wetland. In support of this statement, some of the respondents interviewed insinuated that they carry out brick making in the wetland due to availability of the raw materials such as soil type, grass and other materials for covering the brick before burnings. One of the respondents indicated that;

“We also do this activity since we are compelled by the residential developers who frequently ask for them. This creates a demand that has to be fulfilled”.



Plate 4.1: Brick making activities in Kingwal wetland, Nandi County

As shown in Plate 4.1 above, brick making takes place near the wetland. The materials from the wetland are used in brick production. Most of the soils near wetlands have clay soils, which are ideal for making bricks. The riparian wetland has been stripped bare. During rainy season pool of muddy water collects which act as breeding ground for mosquitoes, also bare soil and pits are left uncovered by the brick makers. With the rising demand for residential constructions, more bricks are required. According to NEMA official who are bestowed with

the responsibility of wetland inspection, brick production generally affects environment through clay extraction (open pits left uncovered), dust from material handling, and processing plus gas emission from fuel combustion. As evident in table 4.4, firewood is the most common source of fuel used in brick making enterprise; the woodfuel is obtained from trees cutting, which led to destruction of environment.

To lessen the hazard of brick production near wetlands, management solutions should take a participatory approach and incorporate neighborhood residents and professional groups interested in exploiting wetland resources. When developing participatory management, special attention should be paid to the social stratification, occupational structure, and apparent inter-boundary nature of certain wetlands.

4.3.5 Extent to Which Brick Making Process Affects Wetland Ecosystem

Participants in the study were asked to rate the impact of the brick-making process on the wetlands habitat. According to the study's findings in table 4.7, 57.1% of respondents believed that brick making affects wetland ecosystem to a very large extent, 23% considered it to a large extent, 9.5% moderate extent, 1.6% small extent, and 8.7% very small extent. The study found that the ecology of wetlands is greatly impacted by brick production. The destruction of the marsh and other plant life as a result of the harvesting of grass for brick covering and the felling of trees for the wood fuel required to burn the bricks and firewood is one of these repercussions. Burning activities also decreases soil fertility, and the removal of soil for brick-making cause's pits and gulleys to appear on the earths.

In support of these findings, the majority of those interviewed agreed that the wetland has been greatly affected by the brick making activities. The most evident was the pits left open after excavation of the clay, the clearing of vegetation to be used for covering the brick kilns when burning. The group's forums in charge of conservation firmly indicated that there has been encroachment of wetland as the brick makers continue with their activities.

Table 4.6 Extent to Which Brick Making Process Affects Wetland Ecosystem

	Frequency	Percentage
Very large extent	72	57.1
Large extent	29	23.0
Moderate extent	12	9.5
Small extent	2	1.6
Very Small Extent	11	8.7
Total	126	100

Source: (Researcher, 2022)

Supervised classification

With the help of unsupervised photos, supervised classification was carried out for the clipped images (Figures 4.1, 4.2, and 4.3) in ERDAS Imagine 2014. The pictures were from 2000, 2010 and 2020, respectively. Categories for land use changes in supervised categorization are defined in Table 4.7.

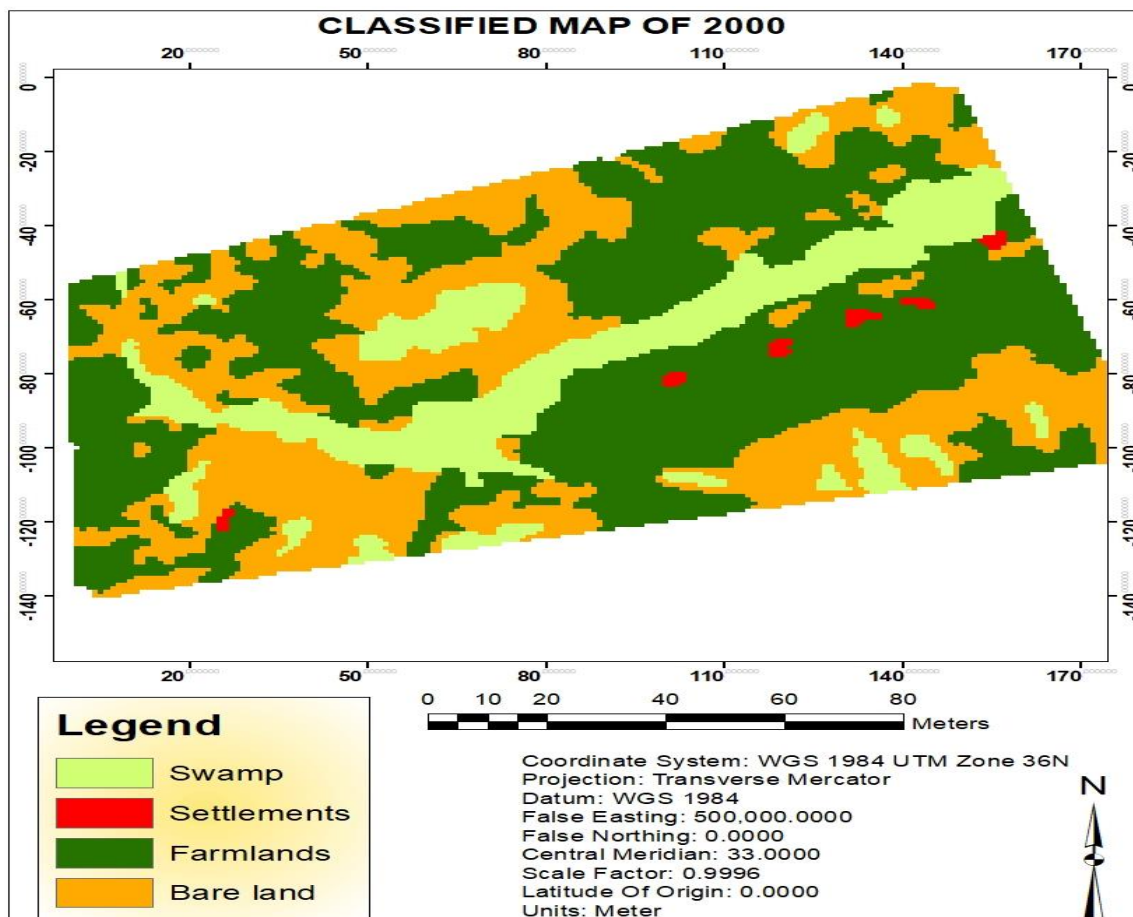


Figure 4.1 Supervised classifications of 2000 of Kingwal Wetland

Land use change is a process by which human activities transform the natural landscape, referring to how land has been used, usually emphasizing the functional role of land for economic activities. The researcher sought to describe the various types of land cover type as shown in Table 4.7.

Table 4.7 Explanations of Land Change Uses

Land Cover /Land Cover Type	Description
Swamp	Permanent and seasonal grasslands along lake, river, and streams, marshy land and swamps
Bare land	This category refers to land that is devoid of vegetation. This could be the result of degraded land, worn roads, and abandoned agricultural land.
Settlements	This class describes the land covered with buildings in rural and urban. It includes commercial, residential, industrial and transportation infrastructures.
Farmland	All agricultural lands, both cultivated and uncultivated, including farms, crop fields, fallow lands, and horticultural lands.

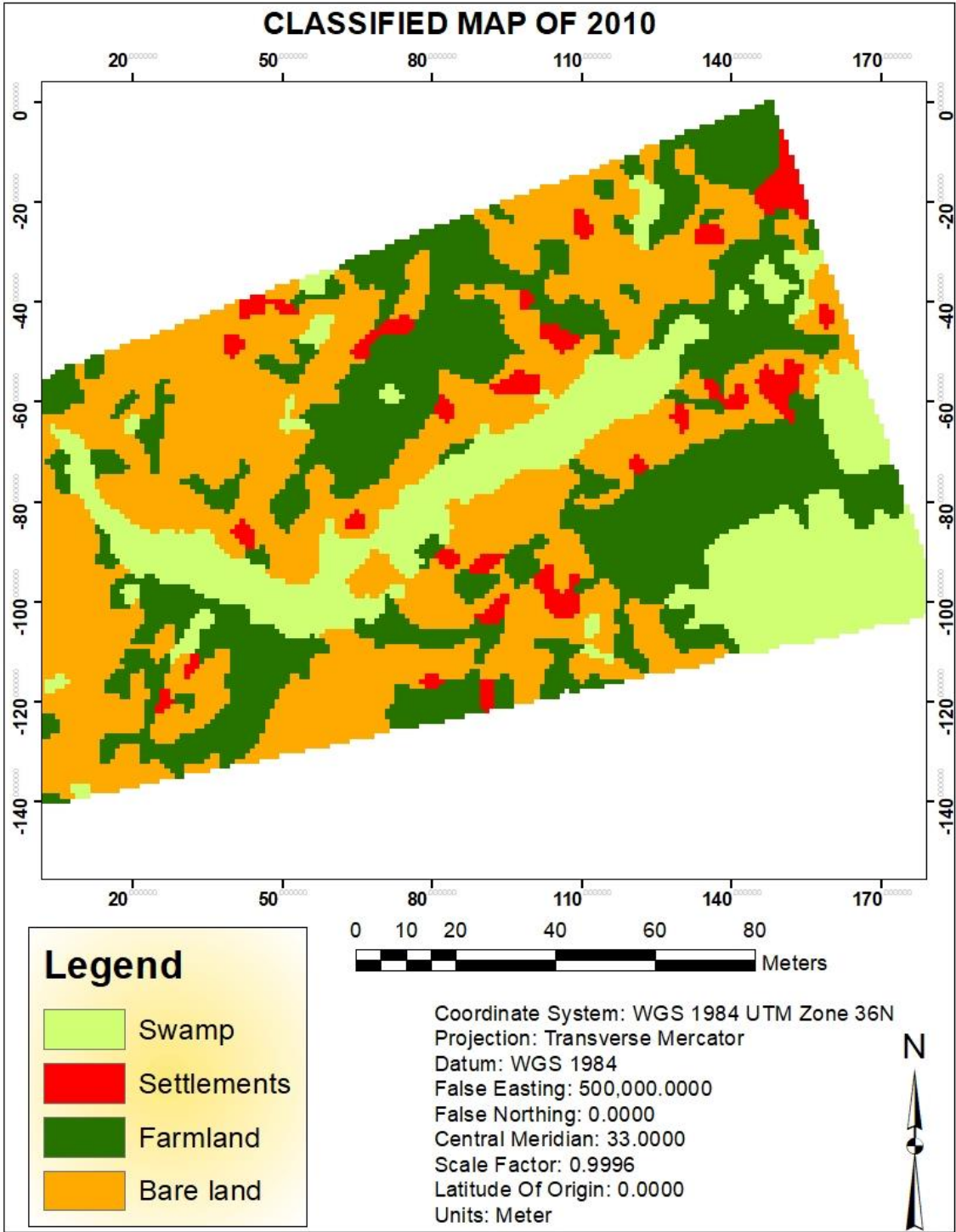


Figure 4.2 Supervised classifications of 2010 of Kingwal Wetland

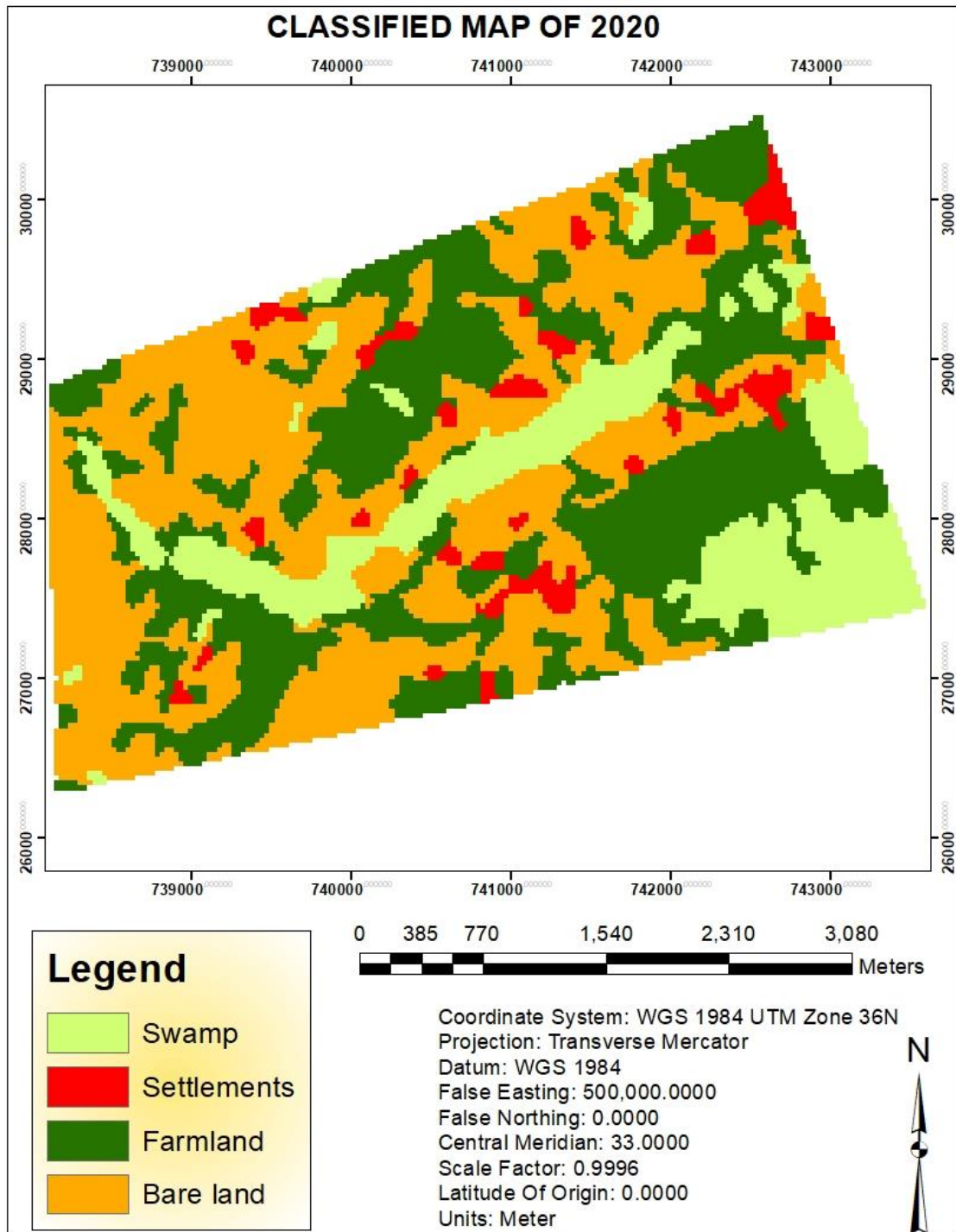


Figure 4.3 Supervised classifications of 2020 of Kingwal Wetland

In the research region, three classes of LULC were discovered. The wetland is distinguished by settlements, swamps, agriculture, and bareland, according to the classified Land Use Land Cover Changes (LULC) maps of 2000, 2010, and 2020 (figures 4.1, 4.2, and 4.3). In table 4.8, the rate of change over time for these three LULC classes has been calculated. The findings showed that settlements, farming, and other economic activity including brick

production had encroached into the wetland. Kingwal wetland use changed significantly between 2000 and 2010, which was caused by a steady rise in the amount of farms and agricultural land in the region. The swamp as a natural habitat has been severely impacted by the ongoing invasion of this resource. As shown in table 4.8, the change in wetland area between 2010 and 2020 was 10.953%, which was less than the change of 31.492% between 2000 and 2010. Mwangi (2021) claims that expanding settlements have both a direct influence on wetland regions by draining them in order to develop the land and an indirect impact through increased storm water and pollutants produced by land development. Wetland animal and plant communities become stressed as a result of modification.

Table 4.8 Rate of change (%) and Hectares of wetland

Description/ period	2000-2010		2010-2020	
	Rate of change (%)	Hectares (Ha)	Rate of change (%)	Hectares (Ha)
Swamp to swamp	54.653	0.1494	83.986	0.2722
Swamp to Farmland	31.492	0.0861	10.953	0.0355
Swamp to bareland	13.643	0.0373	4.782	0.0155

From 2000 to 2010, the rate of change from swamp to swamp was 54.653% (0.1494 ha) compared to from swamp to farmland (31.492%). The rate of change from swamp to swamp implies that the status of swamp overtime remained the same, increased or decreased.

From the year 2000 to 2010, the rate of change from swamp to bareland was 13.643% representing an area of 0.0373 while between 2010 and 2020; the rate of change was 4.782% representing an area of 0.0155ha. As indicated in figure 4.2 and 4.3, there has been an increase in the number of settlements from 2000 to 2010. This could be attributed to wetland change of 54.653%.

4.3.6 Effects of Brick Making Practices on Wetland De-Vegetation

Uncontrolled brick production can have a variety of negative environmental repercussions. These effects may include decreased crop output because brick building reduces soil fertility by removing the soil cover, loss of natural habitat for some animals that flourish in marshy

environments, and loss of soil fertility. Controlled brick production must be used to address all of these effects. Since time immemorial, man has used marshes as a reasonable resource to collect food, such as fish, and grass for thatching buildings. The researcher sought to investigate the effects of brick making on wetland vegetation, the study results as shown in Table 4.9 below.

Table 4.9 Effects of brick making practices on wetland de-vegetation

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean
Soil fertility is threatened	87(69%)	26(20.6%)	3(2.4%)	4(3.2%)	6(4.8%)	1.54
Source of income	65(51.6%)	37(29.4%)	0(0.0%)	13(10.3%)	11(8.7%)	1.95
Decline of agricultural yields	60(47.6%)	15(11.9%)	16(12.7%)	16(12.7%)	19(15.1%)	2.36
Compete with other demands.	58(46.0%)	19(15.1%)	19(15.1%)	12(9.5%)	18(14.3%)	2.31
Loss of moisture.	76(60.3%)	23(18.3%)	5(4.0%)	12(9.5%)	10(7.9%)	1.87
Destruction of wetland cover and land changes	90(71.4%)	17(13.5%)	2(1.6%)	3(2.4%)	14(11.1%)	1.68

Source: (Researcher, 2022)

The majority of the research participants (69%) strongly agreed with the statement that soil fertility is jeopardized when fertile topsoil is removed for brick making, while 2.4% who made up the minority, were neutral, meaning they neither agreed nor disagreed. We carry out Brick making as a source of income, based on this assertion, 51.6% who were the majority strongly agreed while 8.7% strongly disagreed. Changes in surface roughness are connected to the removal of vegetation. An increase in wind speed and subsequent moisture loss from the ground could occur from a decrease in surface roughness. In addition to adverse effects on homes, increased wind could also have direct detrimental effects on agriculture due to increased crop damage.

The majority of respondents (59.5%) agreed, 12.7% were neutral, and 27.8% disagreed that air pollution in the area where brick kilns are located had led to a certain drop in agricultural production. In order to bolster this claim, Asif *et al.* (2020) pointed out that throughout the

recent decades; increasing industrialization and urbanization have made air pollution a serious environmental stressor for crop plants. Sulfur dioxide (SO₂), nitrogen oxide (NO_x), carbon monoxide (CO), tropospheric ozone (O₃), heavy metals, and suspended particulate matter are among the most dangerous and extensively dispersed pollutants in brick kilns. The annual estimated indication of emission from brick industry was 80 tons of particulate matter, 30 tons of carbon, 7 tons of NO_x, and 5 tons of SO_x (Singh & Asgher, 2005). Plants that are immediately close to emission sources are more vulnerable. On whether increasing demand for bricks compete with demands for food and the environment, the study results revealed as follows; 61.1% of the respondents agreed, 15.1% appeared neutral and 23.8% disagreed with the statement that demand for bricks compete with demands for food and the environment.

The study's findings revealed that 78.6% of participants agreed, 4.0% expressed no opinion, and 17.4% disagreed with the proposition that the removal of vegetation through the brick-making processes has led to moisture loss and, as a result, reduced capacity for plant and vegetation growth. The removal of vegetation to make bricks has interfered with infiltration and prevented water from seeping into the soil. This could cause the soil to lose moisture. The presence of water pools may produce evaporation from the open waters as opposed to evapotranspiration from the vegetated surface. Such surface properties may alter changes in moisture flux, related to regional factors that control the distribution of rainfall.

The study results revealed that 84.9% of participants, or the majority, agreed that wetland loss and land changes were caused in part by brick-making activities near the wetland, while 1.6% were neutral and 13.5% disagreed. Clay mining itself is a major problem. After severely mining the clay, large trenches are left exposed, rendering the impacted region useless for any operation or clay excavations to take place. A wetland will often experience this, which will lower the water table and shrink the wetland's size. After drying, the clay products are then burnt, which causes them to become harder.

In an interview schedule with the official charged with the responsibility of conserving the wetland, majority of the respondents (78%) indicated that brick making has caused disturbance of soil structure, this occurs while searching for soil for brick making. They also stated that de-vegetation occurs when vegetation is cleared. The open pits left after digging the soil may act as breeding grounds for mosquitoes, this affects human health. In the burning of bricks, trees are cut to be used as firewood. The smoke from the kilns pollutes the air and

causes environmental deterioration. The FGDs indicated that the residents of King'wal are mostly aware of legislation that permits or prohibits the use of wetland. However, due to high incidences of poverty and the need to meet their livelihood demands, they sometimes exceed the allowable limits to maximize their returns. According to one of the FGD participants,

“.....as the people of King'wal, we experience droughts and floods which sometimes lasts for some months. Most of us have limited education and so we cannot go for formal employment, and even those with degree don't have jobs, we rely on the wetland for source of income, Agriculture and food for our children...”

The results of the questionnaire, FGDs and interview schedule were consistent with those of Wamithi (2018), who discovered that the removal of vegetation during the brick-making process caused a loss of moisture and, as a result, reduced the soil's capacity to support plant and vegetation growth. These have a negative impact on plant growth and development, resulting in less photosynthesis and fewer panicles in wetland plants, among other things. A major change in land use due to the brick-making process has led to alteration, encroachment, and inappropriate use of marginal lands, which has resulted in a rise in wetland de-vegetation. Increasing demand for bricks competes with demands for food and the environment. This results to the riparian community encroaching to the wetland for these necessities.

4.3.8 Relationship between Brick Making and Wetland De-Vegetation

A Pearson product moment correlation was computed to establish the relationship between brick making and wetland de-vegetation. The study results are as shown in Table 4.10 below.

Table 4.10 Relationship between Brick Making and Wetland De-Vegetation

		Brick making	Wetland de-vegetation
Brick making	Pearson Correlation	1	.218*
	Sign. (2 tailed)		.014
	N	126	126
Wetland de-vegetation	Pearson Correlation	.218*	1
	Sign. (2 tailed)	.014	
	N	126	126

*Correlation is significant at the 0.05 significance level (2-tailed)

According to Table 4.10 above, there was a statistically significant weak positive relationship between brick making and wetland de-vegetation ($r=.218$, $n=126$, $P=.014$). This finding demonstrates the tenuous link, if present, between brick making and wetland de-vegetation. A minor amount of marsh vegetation is impacted by brick-making activity.

According to Hashemi and Cruickshank (2015), mining in the unregulated brick business is a labor-intensive activity that requires removing vegetation and digging through dirt and overburden. The production of bricks has significantly altered the environment of the area, causing issues including desertification, deforestation, air pollution, Soil contamination, and the removal of fertile topsoil.

4.4 Effects of Farming on Biomes in King'wal Wetland

Maize farming is the main agricultural economic activity carried out from the top to the lower portion of the wetland, especially during the prolonged rains. The communities that live close to the swamp cultivate millet during short periods of rainfall. The other crop that is mainly grown there is tea. Using irrigation water, it is also possible to cultivate short-term crops such tomatoes, onions, *Solanum nigrum*, Sukuma wiki, cabbages, carrots, and irish potatoes. The second objective of the study was to ascertain how farming on biomes affects the Kingwal Wetland's vegetation. The amount of silt that collects there is expected to increase as a result

of farming along wetland boundaries that encroaches into those areas, which could shrink the wetland on overall. The study results are discussed in subsequent sections.

4.4.1 Farming Activities are carried out Within the Wetland

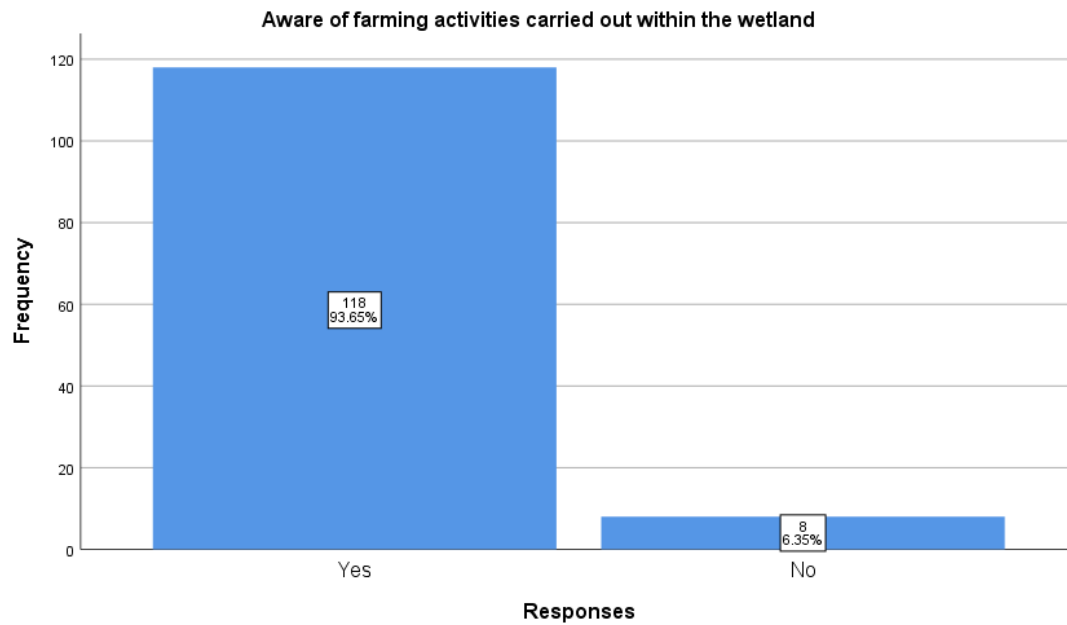


Figure 4.4 Farming activities are carried out within the wetland

The study participants were asked to state whether they were aware of farming activities carried out within the wetland where 93.65% indicated that they were aware of the farming activities carried out within the wetland while 6.35% said that they were not aware of the farming activities carried out within the wetland. In agreement with these findings, the researcher observed that the farming activities are carried out within the wetland. Plate 4.2 below shows some of the crops grown within the wetland.





Plate 4.2 A-D Crops mostly grown within the wetland.

As shown in plate 4.2, part A-D, the crops that were observed to be grown near the wetland are maize, as illustrated by stakes, tea, vegetables such as sukuma wiki, bananas, pineapples among others. The farmers in this area practiced subsistence and cash crop farming (tea). The FGDs complemented our observation by reporting that the households within and round the wetland derive several direct and indirect uses for their livelihoods. They identified that maize was the most common crop grown within and around the wetland. The discussion showed that maize, tea, beans were also grown within the wetland. The participants also reported that they grow trees for construction and vegetables such as kales, tomatoes, and onions. Other activities that take place within and around the wetland include irrigation, fishing (little extent), and fodder for livestock.

4.4.2 Common Crops grown near the wetland

Since agriculture requires flat, fertile land with a sufficient supply of water, wetlands are generally seen as potentially helpful agricultural resource globally. Widespread and well-established land-use practices have resulted from wetlands' capacity to retain moisture for long periods of time, frequently all year. The respondents were asked to list the crops grown in close proximity to wetlands. The study results are as shown in Table 4.12 below.

Table 4.12 Common Crops grown near the wetland

Crop type	Frequency	Percentage
Tomatoes	7	5.6
Tea	16	12.7
Millet	2	1.6
Maize	82	65.1
Greens	19	15.1
Total	126	100

Source: (Researcher, 2022)

The study results in relation to Table 4.12 revealed that the crops grown in the area are tomatoes (5.6%), tea (12.7%), millet (1.6%), maize (65.1%) and greens 15.1% (Cabbage, sukuma wiki, sagaa and black night shade). Based on the foregoing findings, it's evident that the most popular crops grown in the area is maize (65.1%) followed by greens 15.1% (Cabbage, Collards green commonly known as sukuma wiki, Spider plant commonly known as sagaa and black night shade), millet being the least popular crop grown in the area. King'wal Wetland's surroundings have rich soils that don't need much fertilizer. These soils are able to support a variety of crops, including maize and beans. Since the majority of residents invest in farming to cover their subsistence needs, farming operations do not necessitate professional knowledge. As a result, in addition to the favorable environmental circumstances in the region, people employ their traditional expertise to improve farming. These results are consistent with those of Nabahungu and Visser (2011), who claimed that crop growing is the primary activity supported by Rwanda's wetlands particularly during the dry seasons (Cyabayanga and Rugeramigozi, 2011).

The relevance of wetlands for agriculture in Africa has been emphasized by the Food and Agriculture Organization of the United Nations (FAO). However, past experience has shown that poorly planned development frequently leads to a loss of natural capital, adverse environmental effects, and detrimental effects on people's ability to support their families. Wetland agriculture can have a significant positive impact on food security, health, and income. The poorest and most vulnerable members of society frequently face the brunt of wetland agriculture's undesirable effects, while occasionally only a very small number of people gain from it (Woodhouse *et al.*, 2000).

4.4.3 Methods used in Land Cultivation

Approach utilized on land cultivation has the ability to degrade soil structure and increase soils' susceptibility to erosion and other types of deterioration. Inappropriate cultivation practices can lead to a number of negative outcomes, including a drop in soil organic matter and soil structure. The study results are shown in table 4.13 below.

Table 4.13 Methods used in Land cultivation

	Frequency	Percentage
Animal drawn power	18	14.3
Mechanized	18	14.3
Manual Tillage	72	57.1
Slash and burn	18	14.3
Total	126	100

Source: (Researcher, 2022)

In regards to the method used in land cultivation, 14.3% of the respondents said that they used animal drawn power in land cultivation and mechanized method, 57.1% used manual tillage and 14.3% adopted slash and burn to carry out land cultivation. Evidence from the study results shows that majority (57.1%) use manual tillage method in land cultivation. Manual tillage is commonly used near the wetland as the soil is wet, meaning that mechanized method of land cultivation can only be utilized during the dry periods. Wetlands have undergone significant ecological change as a result of intensive agricultural usage, as raising animals or growing crops requires reclamation techniques like drainage or tillage. King'wal biodiversity has frequently suffered serious harm, and large areas might not even be considered wetlands anymore. The wetland landscape may, however, display high levels of diversity where low-intensity agriculture is practiced in wetlands, involving a regime of extensive use without fertilizers or pesticides, despite the fact that the species composition and setting are very different from those in which they are found in their pristine state (Verhoven and Setter, 2009).

As shown in Plate 4.3 below, the main method of cultivation used by the farmers near the wetland is manual tillage. Jembes and forks are used in carrying out the tillage operations near the wetland. The FGDs indicated that manual tillage is carried out by the farmers during the dry season in order to plant short seasoned crops such as vegetables, tomatoes, and other crop in the wetland. This is done due to availability of plenty water which is used to irrigate these crops.



Plate: 4.3 Manual tillage

4.4.4 Management of Soil Fertility for the Crops

Soil fertility is the ability of the soil to naturally supply nutrients in sufficient quantities and in the right balance for the growth of crops. The growth of biomes depends on the management of soil fertility in the area surrounding the wetland. Table 4.14 below shows the analyzed results.

Table 4.14 Management of soil fertility for the crops

	Frequency	Percentage
Adding inorganic fertilizer	62	49.2
Animal manure	52	41.3
Poultry manure	1	0.8
Green manure	11	8.7
Total	126	100

Source: (Researcher, 2022)

The management of soil fertility is of paramount importance for the crops. The respondents were asked to state how they manage the fertility of their crops. From the results, 49.2% indicated that they add inorganic fertilizer to crops, 41.3% use animal manure, 0.8% use poultry manure and 8.7% used green manure. As evident from the study findings, the majority 49.2% apply inorganic fertilizer to manage soil fertility for the crops while 0.8% use poultry manure to manage soil fertility for the crops. Despite being easily accessible, animal dung, according to the responders, is insufficient to cover the entire field. Additionally, they mentioned how rapidly the nutrient-rich salts in the inorganic fertilizer dissolve and become

available to the plants, which depend on them for vital nutrients like nitrogen, phosphorus, and potassium. According to Mohammed (2018), Elephant grass (*Pennisetum sp.*) has colonized the Saiwa swamp and replaced the original Typha vegetation; this has been caused by intensive agriculture's exposure to fertilizer leaching and resulting eutrophication of the wetland.

The interview responses revealed that the most used soil fertility method was organic fertilizer because they dissolve and become available to plants easily. Most of the farmers indicated that they used animal manure because they are easily accessible. They often save money by properly using manure as a fertilizer.

For smallholder farmers, such as those who reside in transmigration zones, the expense of fertilizer purchases presents a challenge. The cost of purchasing enough chemical fertilizer is out of the smallholder farmers' reach. Practically, it is frequently suggested that in order to maintain agricultural output, good management practices should be used, including the addition of extra organic matter, liming, and the use of the necessary inorganic fertilizer (Fageria and Baligar, 2001; Yan *et al.*, 2007; Sukristiyonubowo and Tuherkih, 2009). Additionally, it was stated by Whitbread *et al.* (2003), Sukristiyonubowo 2007, and Whitbread *et al.* (2010) that a sustainable farming system necessitates stable soil fertility through balanced fertilization and crop residue management.

Since the turn of the century, the usage of nitrogen (N) fertilizers in agriculture has grown significantly, and most projections indicate that this trend will continue Schlesinger, Aneja, and Battye (2017). Rich in nutrients, agricultural runoff causes eutrophication and is a source of diffuse pollution. Wetlands were developed in recent decades to treat agricultural runoff, and they are currently employed to reduce N transport at watershed scales.

4.4.5 Reasons for Farming on the Wetland

There are various reasons as to why people prefer farming on wetland. Wetlands contain water throughout the year; this water is used for irrigation and domestic use. Wetlands are fertile lands initially considered as wastelands. Others may use the wetland as it is easily available. Table 4.15 below shows the results.

Table 4.15 Reasons for farming on wetland

	Frequency	Percentage
They are fertile	39	31.0
Availability of water	85	67.5
Easily Available	2	1.6
Total	126	100

Source: (Researcher, 2022)

As shown in Table 4.15, 31.0% of the respondents prefer farming on wetland since they are fertile, 67.5% prefer farming on wetland due to availability of water while 1.6% prefer farming on wetland because they are easily available. The majority 67.5% prefer farming on wetland due to availability of water, while the minority 1.6% prefers farming on wetland because it's easily available. The community living near the wetland prefers farming near the wetland due to soil fertility and availability of water for irrigation. Wetlands receive transported materials from adjacent uplands. These materials are usually fertile and have a high agricultural potential which makes it ideal for crop farming. The participants interviewed and the FGDs asserted that the local community heavily depends on wetland for agriculture because it is fertile and the water for irrigation is readily available. Those who lived far from the wetland lamented that the wetland was not serving their needs as they face difficulties accessing water for crops and irrigation; they mainly attributed this to an ineffective water allocation system and lack of adequate conditions to Implement Sustainable Water Resources Management (IWRM) strategies in the area.

The aforementioned findings are supported by Rodenburg *et al.* (2014), who found that lowlands with wetlands often have a high potential for agricultural output. Lowland soils are often productive because they get resources from surrounding uplands. In West Africa, lowland soil fertility characteristics have been observed. There doesn't seem to be much knowledge about Ondombes swamp, despite the fact that there have only been a few studies on the soil fertility of seasonally flooded wetlands (oshanas) (Watanabe *et al.*, 2016). The researcher also endeavored to find out the factors that have promoted farming near the wetland. Table 4.16 below shows the results.

The interviewed respondents indicated that the main reason why they carry out farming in wetland is because of the fertile soil and water availability for irrigation.

One of the participants categorically stated as follows;

“Farming in wetland has been rampant due to the fertility nature of its soil; the soils there do not require the use of fertilizer as they are very fertile”

4.4.6 Awareness on Effects Associated with Wetland Agriculture

By virtue of its natural existence, the King'wal wetland benefits the area in several ways, both directly and indirectly. However, it appears that the community mainly associates itself with the wetland's direct advantages and is oblivious of its indirect benefits. The wetland is currently used for farming, fish rearing, grass for mats, planting of vegetables for commercial use, brick-making, tourism, herbal medicine, trees for firewood and timber, and water for domestic purposes (washing, bathing, and drinking) by both people and livestock, cultural benefits, swimming/recreation, and improvement of scenic beauty in the landscape. The awareness effect is highlighted in Table 4.16 below.

Table 4.16 Awareness on effects associated with wetland agriculture

	Frequency	Percentage
Yes	96	76.2
No	30	23.8
Total	126	100

Source: (Researcher, 2022)

The intention of the researcher was to find out whether the respondents were aware of the effects associated with farming on wetland biomes. The study findings revealed that; 76.2% of the respondents were aware on effects associated with farming on wetland biomes while 23.8% were not aware on the effects associated with farming on wetland biomes.

The findings were in tandem with those of Focused Group Discussion, who indicated that the local community is aware of the detrimental effects of wetland agriculture. They notably emphasize the effects of the use of pesticides and other chemicals on salinization, eutrophication, erosion, and wetland contamination. The loss of wetlands has a number of detrimental effects including direct loss from draining and conversion to agricultural land, indirect loss from water withdrawal from rivers and streams for irrigation, loss from damming for water storage, loss from seasonal wetlands due to an altered hydrologic cycle, loss from Salinization, sediment deposition, erosion, and eutrophication, and pollution from pesticide use.

4.4.7 Effects of Farming on Biomes and Wetland Vegetation

The wetland environment is impacted by farming in wetland biomes in a variety of ways. For instance, the significant extinction of wetland species is caused by the clearing of wetlands

for farming or the usage of pesticides in wetlands. Wetlands are destroyed or used for other purposes, which restricts the availability of water filtration services and reduces chances for the poor to earn a living. The researcher investigated the effects of farming on biomes on wetland vegetation, the study responses are as shown in Table 4.17 below.

Table 4.17 Effects of farming on biomes and wetland vegetation

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean
Negatively affects natural tendency for retaining pollutants	75(59.5%)	2,5(19.8%)	2(1.6%)	22(17.5%)	2(1.6%)	1.82
Wetland loss	73(57.9%)	27(21.4%)	4(3.2%)	11(8.7%)	11(8.7%)	1.89
Water withdrawal for irrigation	67(53.2%)	24(19.0%)	8(6.3%)	13(10.3%)	14(11.1%)	2.07
Damming for water to be used during dry spell	69(54.8%)	19(15.1%)	3(2.4%)	17(13.5%)	18(14.3%)	2.17
Use of agrochemical and excessive leaching of nutrients to wetland	75(59.5%)	24(19.0%)	5(4.0%)	9(7.1%)	13(10.3%)	1.90

Source: (Researcher, 2022)

Based on the first claim that draining wetlands for agricultural production has negatively affected the environment's natural tendency to retain pollutants, the study's findings showed that 79.3% of participants agreed with the claim, 1.6% was neutral, and 19.1% disagreed. The erosive pressures of water movements are mitigated and maintained to some extent by the wetlands (Alavaisha, 2020). By diffusing the energy of the water, wetlands plants' root systems stabilize the soils and establish a buffer zone. During periods of rapid stream flow (or low water levels), vegetation helps the river slow down, maintain minimal water levels, and maintain speed. Additionally, wetlands near streams, lakes, and reservoirs may discharge stored water directly into these systems, aiding in their upkeep (Senkondo *et al.*, 2017; Smith, 2016). When this vegetation is lost through farming the ability of wetland to retain these pollutants is affected, hence negatively interfering with environment ability to naturally retain pollutants.

The study results established that most of wetland area has been degraded through intensive farming on wetland biomes, which has led to wetland loss, according to 79.3% of respondents agreed, 3.2% who were neutral, and 17.4% who disagreed. The existence and

productivity of the ecosystem are being threatened by the ongoing growth and extension of both large- and small-scale farming regions due to the loss of natural plant cover, biodiversity, upper soil cover, and fertility. Rapid agricultural expansion and an increase in animals are the main causes of these dangers (Alavaisha, 2020).

This wetland has been indirectly lost due to water withdrawal for irrigation of crops and other biomes, based on this statement, 72.2% of the study respondents agreed, 6.3% neither agreed nor disagreed and 21.4% disagreed. Due to unpredictable rainfall and drought in the highlands, irrigation farming is a frequent agricultural method in wetland areas. Irrigation can result in the buildup or loss of organic matter and nutrients, which can diminish or boost output, depending on the quantity of irrigation and the application of fertilizers (Livsey *et al.*, 2013). According to Livsey *et al.*, (2013) irrigation encourages absorption and mineralization, and an adequate amount of moisture provides a medium for microbial activity and speeds up the decomposition process. When moisture levels are either above or below a certain point, microbial activity is reduced and nutrients begin to accumulate (Livsey *et al.*, 2013).

In regards to the statement that damming for water storage to carry out irrigation during dry season has resulted to loss of biomes in wetland area, the study findings revealed as follows; 69.9% of the study participants agreed, 2.4% were neutral and 27.8% disagreed that damming for water storage to carry out irrigation during dry season has resulted to loss of biomes in wetland area.

On whether extensive farming on wetland vegetation by use of agrochemical and excessive leaching of nutrients has led to wetland degradation, the study findings revealed as follows; 78.5% agreed with the statement, 4.0% were neutral and 17.4% disagreed that extensive farming on wetland vegetation by use of agrochemical and excessive leaching of nutrients has led to wetland degradation.

During the focus group discussion and interview schedules, the respondents were asked to share their opinions on the de-vegetation in Kingwal wetland, which is likely to increase sediment deposition in the wetland and may result in the overall decrease in wetland size. About a third of the respondents said that crop cultivation was the main driver of wetland de-vegetation; local communities cited farming on biomes along the swamp as the main cause of vegetation removal, the resultant feature being exposure of soil to various agents hence soil erosion.

During the focus group discussions and interview with the local community, one of the respondents stated that "the local communities are overgrazing their animals in the swamp."

Overgrazing results in soil contraction, decreased water retention, increased salinity, and the loss of some nutrients, particularly nitrogen. Our study's conclusions indicate that the local population's excessive grazing, especially during the dry season, significantly contributes to the resource's depletion. The ability of the soil to endure water stress during the dry season is impacted by changes in vegetation condition, which are related to this. The respondents also addressed how the use of harmful pesticides affects the wetlands ecology. These insecticides are employed in the management of diseases and pests. During the wet season, excess water flows together with the chemicals into the wetland. This causes wetland pollution and kills living organisms in water.

Wetlands' diminished biological function, loss of habitat, and monoculture due to drainage for agricultural use. Regarding this, the vast majority of respondents concurred that the Kingwal wetland has partially disappeared as a result of the introduction of invasive techniques that have caused the swamp to dry up. According to Spence *et al.* (2019), which validated this claim, draining wetlands for future cultivation is a common agricultural practice that is motivated by the need to improve crop productivity and export agricultural products. Natural filters for pollutants and agricultural nutrients are wetland ecosystems. The inherent inclination of the ecosystem to retain contaminants is significantly impacted by the draining of these wetlands for agricultural production.

The findings in table 4.17 were in agreement with the works of Verhoeven and Setter (2010) who claimed that agricultural practices have destroyed wetland services and functions all over the world. Many wetlands are currently subject to extensive land uses, in which crop production is frequently combined with other functions like water quality improvement, flood detention, or biodiversity. These land uses include conventional water management methods, traditional agricultural growth methods without the use of artificial pesticides or fertilizers, and animal grazing strategies. These instruments are essential for assessing agricultural activities in wetlands because it has been discovered that some farming practices have a more detrimental effect on wetlands than others (Van Dam, Kipkemboi, and Denny, 2014).

4.4.8 Relationship between Farming on Biomes and Wetland De-Vegetation

A Pearson product moment correlation was computed to determine the relationship between farming on biomes and wetland de-vegetation. The study results are as shown in table 4.18 below.

Table 4.18 Relationships between Farming on Biomes and Wetland De-Vegetation

		Farming on Biomes	Wetland de-vegetation
Farming on biomes	Pearson correlation	1	.724
	Sign. (2-tailed)		.000
	N	126	126
Wetland de-vegetation	Pearson correlation	.724	1
	Sign. (2-tailed)	.000	
	N	126	126

*correlation is significant at the 0.05 significance level (2-tailed)

As shown in table 4.18, there existed a strong positive correlation between farming on biomes and wetland de-vegetation, which is statistically significant ($r=.724$, $n=126$, $P=.000$). This result shows that there is a relationship between farming on biomes and wetland de-vegetation. Farming on biomes to a great extent contributes to wetland de-vegetation.

Wetland de-vegetation is greatly compounded by farming on biomes. Several schools of thought have been developed about the compatibility of wetland farming with wetland ecosystem. One extreme is the pervasive notion that marsh farming results in reduced river flow during the dry season and general degradation. This school of thought was challenged because a recent study found no conclusive link between wetland cultivation and the supposed deterioration and reduced dry season river flow (Constantin *et al.*, 2015). Our findings established that there is a significant correlation between farming on biomes and wetland de-vegetation. Our results are at odds with the findings of the aforementioned literature. Our study established that there is a correlation between agricultural farming and wetland de-vegetation, but other studies have not discovered any solid evidence of this.

4.5 Community Perception of the Values of Kingwal Wetland

Any project should persuade the community to take part in the initiatives before it is put into action in order to fulfill the goals of effective and efficient wetland resource management and protection. Local users are both the exclusive owners and defenders of their resources. If wetland conservation programs don't bring in money for the community, users won't support them. The researcher wanted to gauge how well the local communities understood the value of the wetland resource. Responses from the respondents were requested. The results and findings are discussed in the subsequent sections

4.5.1 Involved in Wetland Use

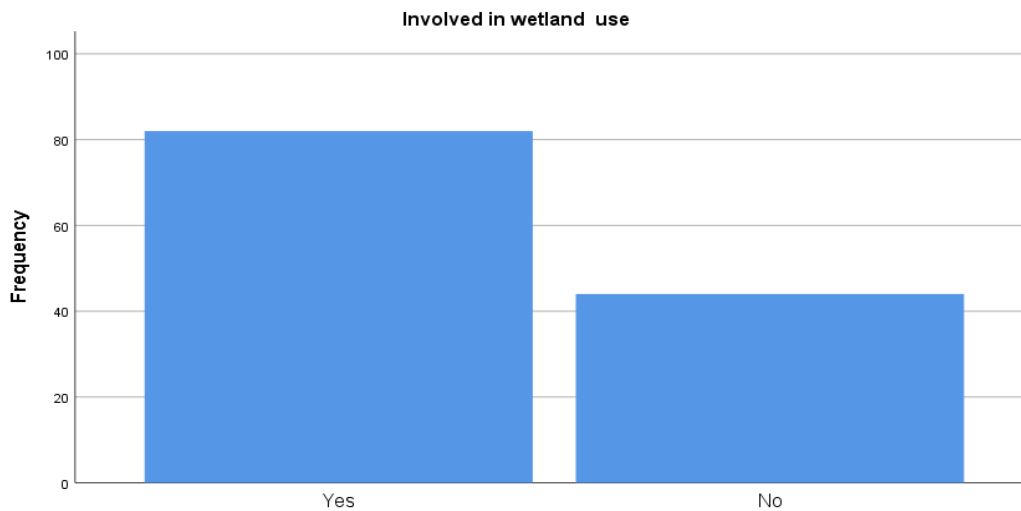


Figure 4.5 Respondents views on Involvement in wetland use

Figure 4.5 above illustrates that 63.5% of respondents said they use wetlands, compared to 39.5% who said they don't. This conclusion is supported by Shrestha's (2011) earlier research, which eloquently argued that community involvement in wetland use can play a leading role in many functions necessary for sustainability and equity. Only conservation programs should represent local communities for the consultation in any development phase. Additionally, as local populations make major use of resources, it is important to consider what they think about conservation. Wetlands have a lot of local stakeholders with a range of interests, thus they may play a big part in conservation.

4.5.2 Activities Carried Out in the Wetland

Once wetlands are recognized and valued as significant ecosystems, they are many things to many people. This knowledge is highly developed in Kenya, where wetlands are valued as ecosystems required for a variety of commercial and conservation endeavors. To be sure, wetlands are valued by many different facets of society and the government as sources of goods, services, and habitats. The purpose of this study was to learn more about the activities occurring in Kingwal Wetland. The results are highlighted in Table 4.19 below.

Table 4.19 Activities carried out in the wetland

Activities	Frequency	Percentage
Crop cultivation	78	61.9
Fishing	14	11.1
Papyrus harvesting	8	6.3
Hunting	8	6.3
Brick making	18	14.3
Total	126	100

Source: (Researcher, 2022)

The respondents were requested to state the activities carried out in King'wal wetland. The study findings revealed that; 61.9% are involved in crop cultivation, 11.1% carry out fishing, 6.3% do papyrus harvesting and hunting and 14.3% carry out brick making. Based on the study results, it's evident that the majority (61.9%) carry out crop cultivation in the wetland while 6.3% do papyrus harvesting and hunting respectively.

One of the primary activities carried out in Kingwal Swamp is wetlands farming, which is on the rise and represents the largest danger to the system, as indicated in Table 4.19. Other implications include a decrease in the amount of available drinking water, a deterioration of sensitive soil organic matter that is held under soggy circumstances, a decline in the wetland's capacity to hold and filter water, and more. This is consistent with research from other wetlands (Kirui, 2016).

4.5.3 Functions/Value of Wetland Resource

Wetland plays a major role in water purification, controlling flooding, source of water for domestic usage and irrigation. It is also a habitat of various species of wild animals and a source of income and employment. In view of these functions, the researcher purposed to know the function/value of wetland resource. The study findings are as shown in table 4.20 below.

Table 4.20 Functions/value of Wetland Resource

Statement	Most valued		Averagely valued		Least valued	
	f	%	f	%	f	%
Control of flooding and soil erosion	92	73	22	17.5	12	9.5
Habitat of various species of wild animals and plants	91	72.2	16	12.7	19	15.1
Water purification and nutrient retention	70	55.6	34	27.0	22	17.5
Source of agricultural produce	81	64.3	36	28.6	9	7.1
Reliable source of water for domestic usage and irrigation	106	84.1	17	13.5	3	2.4
Source of income and employment	83	65.9	26	20.6	17	13.5

Source: (Researcher, 2022)

As shown in table 4.20 above, 73% of the study participants indicated that the wetland is most valued in control of flooding and soil erosion, 72.2% said that wetland is most valued as an habitat of various species of wild animals and plants, 55.6% revealed that wetland is most valued in terms of water purification and nutrient retention function, 64.3% indicated that wetland is most valued as source of agricultural produce, 84.1% indicated that wetland is a reliable source of water for domestic usage and irrigation and 65.9% indicated that wetland serves as a source of income and employment for the local community.

In terms of ranking the function/value of wetland, majority of the community members ranked wetland as a reliable source of water for domestic usage and irrigation while water purification and nutrient retention function was ranked as the least important function.

In an interview schedule, the officials interviewed revealed the various wetland services/functions in Nandi County;

“Wetland act as water cleaning agent, water reservoirs, source of plants of medicinal value, and a home to wildlife especially endangered Sitatunga antelope.” (Nema official, Nandi County)

Another official interviewed revealed as follows;

“Wetland is used for grazing animals, sources of firewood, Bee keeping and it also helps to control ground recharge” (KWS official, Nandi County)

As you can see from the answers above, wetlands are a valuable natural resource with a variety of uses. One example is grass, which may be used for grazing, building and thatching, fuel, and mulching, among other things. This was expected to have an impact on management planning since, depending on the usage, a resource may face distinct risks, although other advantages from the same resource would not (Kingw'al Integrated Wetland Management Plan, 2014-2018).

4.5.4 Current Use of the Wetland

Wetlands can be used for various functions, such as grazing, papyrus harvesting, source for clay used for brick making, water for irrigation and domestic use among others. In our study, we established that the current use of Kingwal wetland is good. On the ratings on the current use of the wetland, 26.98% of the respondents rated the current use of wetland as very good, 39.68% rated the current use of wetland as being good, 15.87% rated the current use of wetland as bad while 17.46% rated the current use of wetland as being very bad. The current use of wetland was good. This was evident by 66.66% of the respondents who asserted that the community has tried its level best to use the wetland wisely.

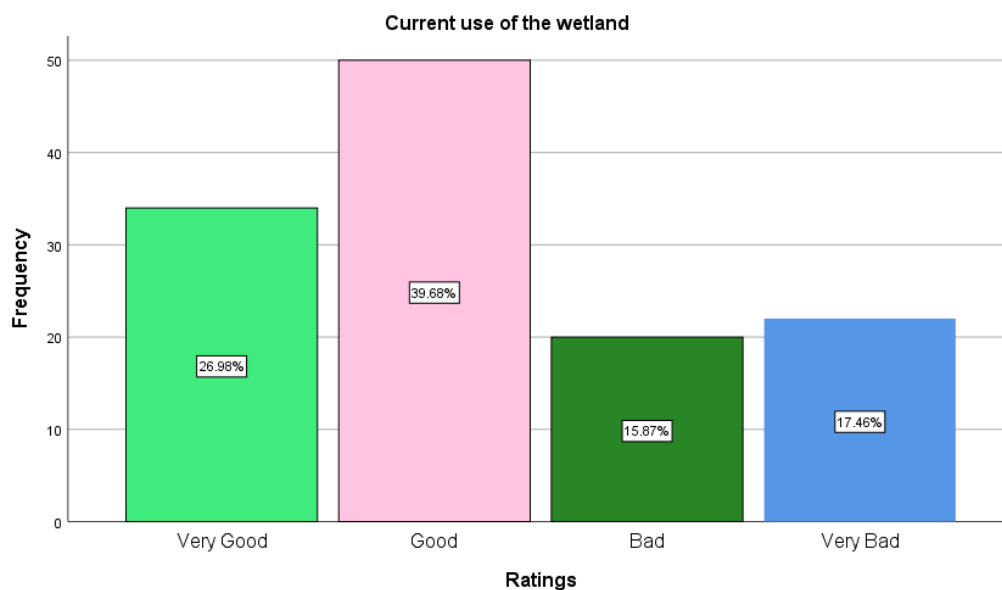


Figure 4.6 Ratings on the current use of the wetland

The FGDs sessions revealed that despite the fact that there has been an endeavor to manage the wetland for wise use. There are still numerous anthropogenic activities continue to destroy the integrity of Kingwal wetlands, rendering it incapable of carrying out its biological responsibilities. According to Raburu (2020) changes in water quality is brought on by

nutrient inputs from the watershed, such as nitrogen and phosphorus. This causes eutrophication and affects the utilization of wetland (Cole *et al.*, 2010). Also, according to Mulei *et al.* (2014), urbanization, pollution, and agricultural practices are other anthropogenic activities that have an impact on wetlands.

4.5.5 Community perception of the value of Wetland Conservation

The researcher requested the respondents to state their level of agreement on the awareness of wetland conservation. The likert scale was used where 1 represented strongly agree while 5 represented strongly disagreed. The study responses are tabulated below.

Table 4.21 Level of Awareness on Wetland Conservation

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean
control the level of flood	92(73%)	14(11.1%)	8(6.3%)	6(4.8%)	6(4.8%)	1.57
Government legislation and public support	95(75.4%)	21(16.7%)	6(4.8%)	4(3.2%)	0(0.0%)	1.36
Role of conservation	78(61.9%)	27(21.4%)	2(1.6%)	10(7.9%)	9(7.1%)	1.77
Threats to wetland reported to the relevant conservation bodies	70(55.6%)	23(18.3%)	8(6.3%)	14(11.1%)	11(8.7%)	1.99
We cooperate with management bodies in conservation	74(58.7%)	27(21.5%)	0(0.0%)	17(13.5%)	8(6.3%)	1.87

Source: (Researcher, 2022)

Based on the first statement that by preserving and restoring wetlands, we can control the level of flood, 84.1% agreed, 6.3% neither agreed nor disagreed and 9.6% disagreed that by preserving and restoring wetlands, we can control the level of flood.

Through appropriate government legislation and public support we can conserve wetlands, the study results revealed as follows; 92.1% agreed, 4.8% neither agreed nor disagreed and 3.2% disagreed that through appropriate government legislation and public support the wetland can be conserved.

The community living around the wetland plays a major role of conservation, the study findings revealed that; 83.3% agreed, 6.3% neither agreed nor disagreed and 19.8% disagreed that community living around the wetland plays a major role of conservation.

The study sought information regarding the threats posed to the wetland is reported to the relevant conservation bodies, the analyzed results revealed that; 73.9% of the respondents

agreed, 6.3% were neutral and 19.8% disagreed that information regarding the threats posed to the wetland is reported to the relevant conservation bodies.

On whether the community living around the wetland ecosystem cooperates with the environmental management bodies in conserving the wetland, the study results showed as follows; 80.2% agreed that community living around the wetland ecosystem cooperates with the environmental management bodies in conserving the wetland while 19.8% disagreed.

As shown in table 4.21, the respondents provided an honest assessment of their level of awareness regarding the conservation of wetlands; their findings were consistent with those of the World Agroforestry Center (2014), which found that wetlands play a significant role in regulating local water availability and quality as well as the global water cycle. They support the nutrient cycle, sediment transport, retention and export of nutrients, as well as water filtration, de-nitrification, and detoxification. Additionally, wetlands can filter waste water and guard against coastal and river flooding.

The respondents in an interview were questioned about whether they were aware of any human activity occurring in the marsh. Numerous arguments were made that included; farming, hunting, grazing, harvesting papyrus reeds for use in building houses, producing bricks, and beekeeping. They were also requested to elaborate on how these human activities affect the ecosystem's physical environment, specifically with regard to the Kingwal wetlands in Nandi County. The majority of study participants noted in their comments that this leads to deterioration, a loss of vegetation cover, and drainage, which causes the wetland to dry up. Other human activities that have an impact on the wetland environment include the construction of roads and homes. Building homesteads involves the use of clay soil which is extracted from the ground. This affects the soil structure and the vegetation is lost.

The concept between wetland and swamp was a hot debate during the discussion as the respondents considered swamp as “a place with the water and the reeds” and wetland as the “entire river where is being drained and where the vegetation exists”. From this finding, it's clear that the respondent's perception on swamp and wetland were fair.

On the usage of wetland, the respondents interviewed said as follows;

“Wetland was mainly used during the dry season for continuous supply of water all year round and now if we don't conserve what will happen?” said one of the respondents.

In regard to this statement, it's evident that the respondents were aware of the importance of wetland and its function. Wetland provides water to the local community all year round and more specifically during the dry spell. The local community attaches a lot of importance to it and this may be cited as the main reason why they conserve it.

Human wildlife conflict was the major setback that came forth in our discussion with the respondents, majority of them said that Sitatunga destroys their crops mainly beans, maize, sukuma wiki. KWS placed the animals in the swamp without prior consensus from the community. No civic education was done by the KWS prior to introduction of these animals. This has strained the relationship that exists between KWS and the community as there is no goodwill in the part of KWS official to discuss with them on how to keep off the animals off their farms.

4.5.6 Relationship between levels of awareness of the community and wetland de-vegetation

The researcher set out to evaluate the community's levels of knowledge of the value of wetlands. This association was evaluated using the Pearson product moment correlation. The study results are shown in Table 4.22 below.

Table 4.22 Relationship between level of awareness of the community and wetland de-vegetation

		Level of awareness	of Wetland de-vegetation
Level of awareness	Pearson correlation	1	-.299
	Sign. (2-tailed)		.001
	N	126	126
Wetland de-vegetation	Pearson correlation	-.299	1
	Sign. (2-tailed)	.001	
	N	126	126

*correlation is significant at the 0.05 significance level (2-tailed)

As shown in table 4.22, there was a weak negative correlation between level of awareness and wetland de-vegetation, which was statistically significant ($r=-.299$, $n=126$, $P=.001$). This result showed that there exist a relationship between level of awareness on the importance of wetland and wetland de-vegetation.

There are several benefits to genuine local participation in the management of wetland resources and decision-making processes. It primarily serves to increase public interest in and trust in wetland activities. Second, it promotes wetland management's legitimacy and openness. Thirdly, it lowers management expenses and wetland encroachment, which worsens the condition of the wetlands and boosts benefits to nearby people. Planning and negotiating resource usage in the Kingwal Wetland will enhance relationships between the

organizations tasked with managing the wetland and the local population and lessen the possibility of intentional wetland destruction. Our investigation showed that understanding the value of wetlands does not equate to their preservation. Most of the residents in Kingwal area were aware of the importance of wetland (Table 4.20) but that does not mean that they conserve it.

4.6 Conservation Measures Put in Place to Protect Kingwal Wetland Ecosystem

Article 3 of the Convention, which requires Contracting Parties to "formulate and implement their planning so as to promote the conservation" of listed and other wetlands in their territories, alludes to the necessity of national policy frameworks for the conservation and management of wetlands even though it does not use the word "policy" specifically. The responders were then asked to make a list of the steps taken to save the Kingwal wetland environment. The measures mentioned by the respondents were establishing legislation to restrict wetland use, controlling brick manufacture, cultivating native trees, having regular barazas, and implementing legislation on wetland encroachment, including placing NEMA, KWS, and county government surveillance.

Building local communities' and individuals' capacity to carry out conservation efforts is crucial for sustainable conservation and development (IUCN, 1996). In other words, local populations must "own" the programs from design to implementation if biodiversity conservation initiatives are to be successful. Success in conservation depends on proving that development and conservation are not hostile or mutually exclusive, and that biodiversity conservation can actually be a means to development. "Local communities must profit for conservation to be effective."

In order to stop the threat of wetland loss, the Local and National Governments must enforce the current regulations and create new ones. The wetland's ownership should be clearly delineated so that the neighborhood can understand its confines. The conservation organizations will benefit from this as they carry out their duties. Other conservation measures suggested by the locals include hiring locals as guards to protect the wetland and provide work for them to support their families, harsh penalties for farmers who operate nearby farms, rotating guards to keep an eye on the wetland, enforcing strict laws against poaching, and hiring more wardens to look after the wetland.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of the Findings

The study main objective was to investigate the effects of Human Activities on Wetland Perspectives from King'wal Wetland in Nandi County, Kenya. The study was guided by the following objectives; to establish how brick making causes wetland de-vegetation, to examine the effects of farming on the biomes of King'wal wetland in Nandi County and to assess the community perspective on the value of wetland conservation. The study was guided by Ecological Theory developed by Egerton (1973). The study was carried out in Kingwal wetland which is in Nandi County, Kenya. The researcher utilized questionnaires, interview schedules and focused discussion groups as data collection instruments. Quantitative data was analyzed using frequencies, percentages and mean. Pearson product moment correlation was used to show the association between the dependent and independent variables. Thematic data analysis was used to examine qualitative data.

Objective one sought to establish how brick making affect wetland vegetation in Kingwal Wetland, Nandi County. The study results established that there was a weak positive correlation between brick making and wetland de-vegetation, which was statistically significant ($r=.218$, $n=126$, $P= .014$). Majority of the respondents (67.5%) were aware that brick making activities takes place in the wetland, 57.1% said that brick making to a very large extent affects wetland vegetation, the main source of wood fuel was cited as the firewood. Further, Most of the respondents (61.1%) agreed that increasing demand for bricks compete with demands for food and the environment while 78.6% agreed that removal of vegetation through brick making process affects wetland vegetation and 84.9% ascertained that brick making activities around the wetland has contributed to the destruction of wetland cover and land changes.

Objective two: examined the effects of farming on the biomes of King'wal wetland in Nandi County, the study's findings showed a statistically significant positive link between farming on biomes and wetland de-vegetation ($r=.724$, $n=126$, $P= .000$). A high number of respondents (93.65%) indicated that they were aware of farming activities carried out within the wetland, most of them (67.5%) indicated that they highly practiced wetland agriculture, few of the respondents (38.1%) have been farming for between 3-4 years, 65.1% of the respondents indicated that the most popular crop grown in the area is maize and greens (Cabbage, sukuma wiki, sagaa and black night shade). In the cultivation of these crops,

57.1% of the farmers use manual tillage in land cultivation. In the management of the fertility of the crops, the majority of the respondents (49.2%) indicated that they apply inorganic fertilizer to manage soil fertility for the crops where 67.5% indicated that they prefer farming on wetland due to availability of water, majority of them (67.5%) ascertained that the fertility nature of wetlands has promoted wetland agriculture. A number of them (76.2%) were aware of effects associated with farming on wetland biomes.

The interviewed respondents asserted that most parts of wetland have been degraded through intensive farming on wetland biomes which has resulted to wetland loss, approximately 69.9% of the study participants agreed that wetland has been indirectly lost due to water withdrawal for irrigation (crops and other biomes). In most of the FGDs sessions the participants asserted that wetland degradation has occurred due to extensive farming on wetland vegetation by use of agrochemical and excessive leaching of nutrients. It was also recognized that, while certain problems can be effectively dealt with by dealing with the obvious major causes, it may be necessary to investigate the sources of the problems and pinpoint their root causes. For instance, it might not be possible to immediately address increasing rainfall if the cause of decreased agricultural production is decreased water availability. There was need to reestablish formerly drained wetland on farmlands.

Objective three: to assess the level of awareness of the community on the importance of wetlands in relation to their encroachment activities. The study findings revealed as follows, there was a weak negative correlation between level of awareness and wetland de-vegetation, which was statistically significant ($r=-.299$, $n=126$, $P= .001$). Most of the respondents (63.5%) indicated that they are involved in wetland use where majority 61.9% carries out crop cultivation in the wetland.

In terms of wetland functions/values, many of them (72.2%) said that wetland is most valued as an habitat of various species of wild animals and plants, water purification and nutrient retention function, and source of agricultural produce while a good number (84.1%) indicated that wetland is a reliable source of water for domestic usage and irrigation and serves as a source of income and employment for the local community.

In relation to the statements on the community level of awareness on wetland conservation; the majority 92.1% agreed that by preserving and restoring wetlands, we can control the level of flood; there is also need to strengthen the existing laws that support wetland conservation. The majority of the participants (83.3%) agreed that community living around the wetland plays a major role of conservation and 80.2% agreed that community living around the wetland ecosystem cooperates with the environmental management bodies in conserving the

wetland. This was evident by 73.9% of the respondents who agreed that threats posed to the wetland are reported to the relevant conservation bodies.

5.2 Conclusion

This study concludes that, brick making results from lack of employment/ source of income and increased demand of construction materials. The local community in Kingwal wetland was aware of the brick making activities taking place. These actions have significantly reduced marsh vegetation, left exposed holes that serve as mosquito breeding grounds, and the potential for mishaps like drowning due to the pits. The results of this study, when compared to other wetlands locally and internationally, show that unless steps are done to protect the wetland, there is a risk that wetland biomes would become extinct. Brick kilns are burned using firewood, which depletes the area's vegetation and pollutes the air where the activity took place.

Based on the second objective: “to examine the effects of farming on the biomes of King’wal wetland in Nandi County”. The study concludes that, the continued expansion of both small and large scale farming areas has threatened the presence and existence of the ecosystem. Some of the largest impacts are through drainage and conversion of King’wal wetland into cultivated land which have drastically reduced the land under wetland. The study also concludes that wetland degradation has occurred due to extensive farming on the wetland by use of agrochemical and excessive leaching of nutrients reducing soil nutrients level and affecting texture.

In relation to the third objective: “to assess community perception on the importance of Kingwal wetland”. Wetlands are highly productive ecosystems that offer a wide range of products and services to populations throughout the world who depend on them. The riparian community was generally aware of the importance of wetlands. Rarely were community gatherings with locals organized when they should have been instructed on how to prevent endangering Kingwal Wetland and the need of protecting it. KWS was criticized for failing to involve the local population in conservation-related issues; their connection with the community has not worked as a result of rising conflicts between people and animals that go unaddressed and as a result of the absence of alternative avenues of income-generating enterprises for the community. Respondents mentioned during focus group talks that KWS started its own initiatives of raising awareness without allowing local participation due to the ineffectiveness of education programs in Kingwal area. However, the neighborhood has requested an educational initiative to aid the government in protecting the wetland.

5.3 Recommendation

Based on the study findings and conclusion, the following recommendations are made;

- i. Locals should be encouraged to engage in sustainable activities such as making baskets, mats, and brooms to reduce human activity in the wetland, such as crop cultivation and brick production.
- ii. In order to make Kingwal Wetland a Ramsar conservation protected site, the government should negotiate with the neighborhood residents, fence it off, and pay those who own land there and relocate them, the ownership conflicts should be resolved.
- iii. To inform locals about the advantages of the Kingwal Wetland and how to extract them without endangering it, KWS, KFS, NEMA, and other conservation authorities should develop an active conservation-based education campaign.
- iv. The county administration of Nandi and the National government should develop and enforce laws to protect the Kingwal wetland and promote its sustainability for future generations.
- v. All conservation programs and bodies should be harmonized in order to yield more meaningful results.

5.4 Suggestions for Further Research

Further research should be undertaken on the following;

- I. Research into policy implementation and evaluation is important. Guidelines have been created and put into place for both small and large wetlands, therefore it's critical to evaluate their effects on riparian communities and the country as a whole.
- II. Research into how human activities have affected water quality and Content

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APPENDICES

APPENDIX I: LETTER OF INTRODUCTION

**MARGARET JEPKEMOI KIPSANG,
P.O BOX 51,
KAPSABET**

Dear sir/madam,

I am a postgraduate student pursuing a Master's Degree in Geography. To accomplish my master's thesis titled: *Effects of Human Activities on wetlands. Perspective of King'wal Wetland in Nandi County, Kenya*. I kindly request you to assist in providing the required information by answering all the questions in the questionnaire. Your views will be considered important to this study; your facilitation towards the success of this noble exercise will be highly appreciated. All the information provided will be treated with utmost confidence.

Thank you very much for your co-operation.

Yours sincerely,

Margaret Jepkemoi Kipsang

APPENDIX II: QUESTIONNAIRES FOR FARMERS AND BRICK MAKERS

Introduction

Please answer each question to the best of your knowledge. I guarantee that the responses provided will be kept private. We much appreciate your willingness to take part in this research.

Section A: Socio-Demographic Information

Please check the box (✓) that corresponds to your response to each question, and then type your response in the relevant space provided. Your information will be handled with the strictest of confidence.

Age	Sex	Education Level	Marital Status	Dependents	Job	Experience	Occupation	Distance from place of work
<18	M	None	Single	0	Permanent	0-5 years	Farmer	<1km
18-25	F	Primary	Divorced	1-4	Semi-permanent	6-10	Business person	2km
26-35		Secondary	Married	5-10	Piece-meal	11-15	Brick maker	3km
36-45		Post-secondary	Separated	>11	Jobless	16-20	Civil servant	4km
46-55						>20years	Others.....	5km
56-65								> 5km

Section B: Questions based on Study Objectives

How brick making causes wetland de-vegetation

6. Are you a part of or are you aware of the brick-making operations taking place in this wetland area? Please tick the correct response.

{ } Yes { } No

7. Use the scale below to rate the statements that show how brick manufacturing techniques affect wetlands' loss of vegetation. Use a tick 1= Strongly Agree; 2= Agree; 3= Neutral; 4= Disagree; 5= Strongly Disagree

Statement	1	2	3	4	5
By removing the fertile topsoil for brick production, soil fertility is threatened.					
Through brick making activities, there has been high amounts of biomass (mainly firewood) used in brick kilns which pollute the air.					
Brick making activities causes additional run off through creation of impervious areas and compaction of soils.					
We do brick making as a source of income					
Air pollution in the areas where brick kilns are located has contributed to certain decline of agricultural yields.					
Increasing demand for bricks compete with demands for food and the environment.					
Removal of vegetation through the brick making processes have led to loss of moisture and hence less ability to support plant and vegetation growth.					
Brick making activities around the wetland has contributed to the destruction of wetland cover and land changes.					
The removal of topsoil for brick making creates burrow pits and trenches on the wetland surface which are normally left uncovered contributing accidents to human life.					

Effects of farming on biomes

8. Do you participate in or are you aware of the farming on biomes activities taking place in this wetland area? Please tick the correct response.

Yes No

9. Use the scale below to rate the assertions that show how farming on biomes practices affects wetland de-vegetation. Use a tick

1= Strongly Agree; 2= Agree; 3= Neutral; 4= Disagree; 5= Strongly Disagree

Statements	1	2	3	4	5
I understand that through the use of agrochemicals such as pesticides and fertilizers water catchment area is polluted					
We can utilize wetland sustainably for agricultural Purposes without depleting the resource base.					
Through conversion of wetlands to agricultural land, there has been rapid soil erosion and hence losses of land cover in this region.					
Some areas of wetlands have been lost through drainage and conversion to agricultural land.					
This wetland has been indirectly lost due to water withdrawal for irrigation and crop cultivation.					
Damming of wetland for water storage to carry out irrigation during dry season has resulted to Loss of wetland area.					
Wetland de-vegetation in this area has occurred due to pollution resulting from use of pesticides and other chemicals					

Awareness among the communities on the importance of wetland resource

10. Are you involved in wetland usage?

(a) Yes (b) No

If yes, what activities do you carry out?

(a) Cultivation

(b) Fishing

(c) Sand mining

(d) Papyrus harvesting

- (e) Hunting
- (f) Brick making
- (g) Other specify.....

11. Which of the following functions/value of wetlands as a natural resource is valued in the area where you live? Rank the following attributes in order of significance. Where 1= the most valued, 2= averagely valued, and 3= the least valued

- Control of flooding and soil erosion
- Habitat of various species of wild animals and plants
- Water purification and nutrient retention
- Source of agricultural produce
- Reliable source of water for domestic usage and irrigation
- Source of income and employment

12. How would you rank this wetland's present use? Kindly Expound.

- i. Very good. ii. Good iii. Bad IV. Very bad

13. Do you benefit financially from the use of the wetland? Yes No

- a. If yes, expound?
- b. If no, expound?

14. Do you have to pay to access the wetlands? Yes No

- a. If yes, how do you pay and what amount?
- b. If no, expound.

15. Use the scale below to rate your opinion of the statements illustrating the degree of wetland conservation awareness. Use a tick where applicable 1= Strongly Agree; 2= Agree; 3= Neutral; 4= Disagree; 5= Strongly Disagree

Statements	1	2	3	4	5
By preserving and restoring wetlands together with other water retention, we can often control the level of flood					
Through wetland Protection, we can protect our safety and welfare.					
Through appropriate government legislation and public support we can conserve wetlands.					
As a community living around the wetland, we play a major role of conserving the wetland as it provides free goods and services to us.					

We disseminate the information regarding threats and dangers posed to wetland to different organization dealing with wetland management.					
We cooperate in environmental management programs that secure our right and gains.					

**APPENDIX III: INTERVIEW GUIDE FOR CHIEF, ASSISTANT CHIEFS, VILLAGE
ELDERS AND KWS OFFICIAL**

Name of Institution: _____

Department: _____

Location: _____

Name of Officer in Charge: _____

Designation of the Officer: _____

1. To what extent are you involved in wetland conservation activities?

.....
.....

1. What are the wetland services/ functions in Nandi County? Please discuss them?

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2. How does brick making causes wetland de-vegetation?

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3. How does farming on biomes causes wetland de-vegetation?

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4. Are you aware of any human activities carried out on these wetlands?

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Kindly mention the human activities carried out on these wetlands

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5. How do these human activities influence the physical environment in King'wal ecosystem, with specific reference to Wetlands in Nandi County?

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6. What are the conservation measures put in place to protect the King'wal wetland ecosystem?

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7. How can wetland use co-exist with the livelihood activities to achieve wetland conservation and management?

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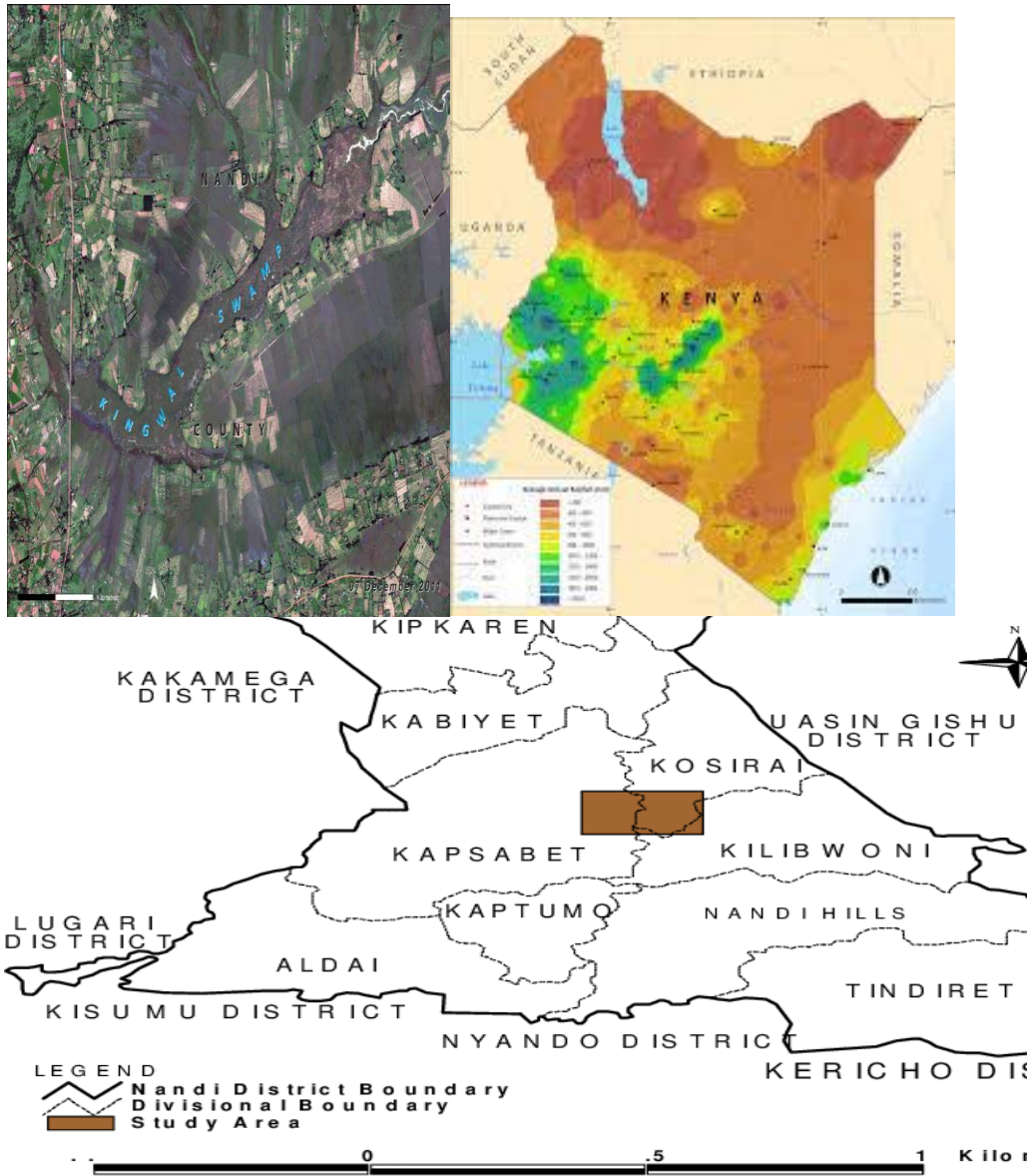
APPENDIX IV: FOCUS GROUP DISCUSSION GUIDE

Name of the location-----Date-----

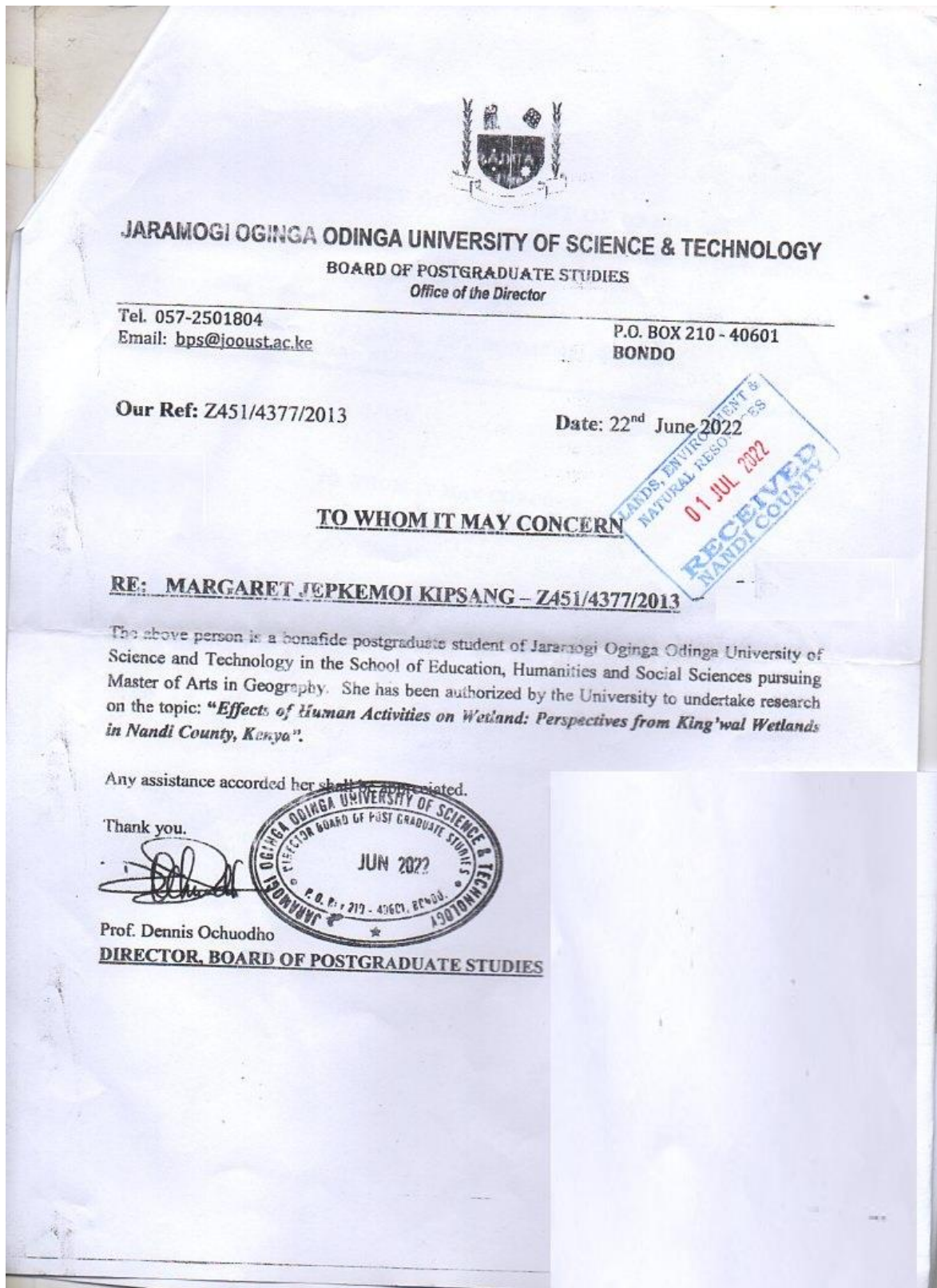
1. In your own view, do you think there is wetland de-vegetation in King'wal swamp?
Give reasons.
2. How does brick making cause wetland de-vegetation in King'wal swamp? Why do you think this brick making has caused wetland de-vegetation?
3. In what ways have the existence and or non-existence of brick making caused wetland de-vegetation?
4. How does farming on biomes cause wetland de-vegetation in King'wal swamp? Why do you think this farming on biomes has caused wetland de-vegetation?
5. In what ways has the existence and or non-existence of farming on biomes caused wetland de-vegetation?
6. In your opinion, are there measures undertaken to curb wetland de-vegetation in King'wal swamp? What are these measures?
7. What is the significance of King'wal swamp to your community?

We appreciate you taking the time to participate.

APPENDIX V: MAP SHOWING KING'WAL SWAMP




APPENDIX VI: RESEARCH AUTHORIZATION FROM THE UNIVERSITY



APPENDIX VII: APPROVAL FROM COUNTY GOVERNMENT OF NANDI

COUNTY GOVERNMENT OF NANDI

TELEPHONE 0535252355
Email: info@nandi.go.ke
Website: www.nandi.go.ke



Office of the Chief Officer
P.O. BOX 802-3030
KAPSABET.

**DEPARTMENT OF LANDS, ENVIRONMENT, WATER &
NATURAL RESOURCES**

CG/NDI/LENRCC/GC/VOL.II/146 1st July, 2022

TO WHOM IT MAY CONCERN

RE: MARGARET JEPKEMOI KIPSANG - Z451/4377/2013



The above subject matter refers;

The above is a postgraduate student of Jaramogi Oginga Odinga University of Science and Technology in the School of Education, Humanities and Social Science pursuing Masters of Arts in Geography.

She is undertaking research on the topic 'Effects of Human Activities on Wetland; Perspectives from Kingwal wetlands in Nandi, Kenya.


Permission is granted to her to undertake the research.

Thank you.




Solomon Mang'ira
Chief Officer- Lands, Environment and Climate Change

APPENDIX VIII: RESEARCH PERMIT FROM NACOSTI



REPUBLIC OF KENYA




**NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY & INNOVATION**

Ref No: **914064**

Date of Issue: **28/July/2022**

RESEARCH LICENSE




This is to Certify that Ms. MARGARET JEPKEMOI KIPSANG of Jaramogi Oginga Odinga University of Science and Technology, has been licensed to conduct research in Nandi on the topic: EFFECTS OF HUMAN ACTIVITIES ON WETLAND: PERSPECTIVES FROM KING'WAL WETLAND IN NANDI COUNTY, KENYA for the period ending : 28/July/2023.

License No: **NACOSTI/P/22/19402**


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**NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY &
INNOVATION**

Verification QR Code



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APPENDIX IX: PARTICIPANTS LIST

No	Name	Age	Place	

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