AN ASSESSMENT OF HUMAN-INDUCED IMPACTS ON URBAN WETLANDS: A CASE STUDY OF THE NAIROBI DAM.

By

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DECLARATION

This project report is my own original work and has not been submitted for examination at any other university or institution.

……. …….

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This project report has been submitted for examination with our approval as university supervisors.

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DEDICATION

To my beloved husband and children, Myles and Charisa who are my great source of encouragement, motivation, support and strength.

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ABSTRACT

Wetlands are among the most productive ecosystems on earth. They support millions of people and provide environmental goods and services including but not limited to reducing impact of floods, regulating water flow, mitigating impacts of drought, recharging ground and surface water bodies, supply and storing of drinking water among others.

This project investigated human-induced impacts on urban wetlands, using a case study of Nairobi Dam, an urban manmade wetland whose history dates back from the year 1953. A UNEP study which was done in 2003 showed that the Nairobi Dam was heavily polluted and the dam's ecosystem was undergoing serious deterioration due to human activities. The UNEP report proposed measures that were to be put in place to mitigate and avoid pollution of the dam. The specific objectives of this study were to determine the chemical elements which lead to pollution loads in the water entering Nairobi dam. The research also examined the socio-economic benefits of Nairobi dam; the study investigated some of the human activities leading to continuous pollution which may not be soon stopped if long term measures are not taken. The study also assessed the implementation by the relevant government institutions of the environmental policy and laws relating to pollution. The study further discussed the effectiveness of rehabilitation and management measures undertaken to conserve the Nairobi Dam. The samples of water from inlet, outlet and also from within the dam were collected. These water samples were transported to Public Health Engineering Laboratory and preserved in a cold room for a night.

Cluster sampling was done based on administrative areas (7 locations).The seven locations which were used as cluster areas included; Kibera, Lang'ata, Karen, Mugumoini, Nairobi West, Laini Saba and Sarang'ombe. The clusters were based on the seven locations of the study area. The clusters had demographic and ecological characteristics. The seven clustered points were numbered and by use random sampling, the researcher came up with three locations which were used for this study. The three locations included; Laini Saba, Sarang'ombe and Kibera. Since the population was large, the sample size was determined using a equation developed by Cochran (1963).A list of residents was obtained from area administrative officers, the selection of an element was based on equal intervals, starting with randomly selected element on a population list. A total of 85 questionnaires were administered to the residents for data collection.

Primary data was obtained from the field through questionnaires, interview schedules and observation schedules. The questionnaires were administered to the sampled residents of the Nairobi Dam and its surroundings. Quantitative data collected using questionnaires were analyzed using bar graphs and pie charts. With the help of the Statistical Package for Social Sciences software, the quantitative data was analyzed. The UNDP 2007 data base research which was conducted was used to compare with the findings of this research.

The results showed that chemical pollution loads in the dam water varied from Lead to Copper for organic and inorganic chemicals respectively. These pollution loads were attributed to human activities around the dam and the use of its water. In particular, interviews, observations and literature linked organics to human activities while inorganic were linked to agricultural sources, especially runoff water from surrounding farmlands where inorganic fertilizers are used. The research found out that the environmental policy dealing with pollution was applied selectively and this was the main reason pollution was a friendly activity to the residents. From the findings the study recommended that the policies need to be harmonised if we are to achieve a socio-economic development and wetlands management required multi-disciplinary or multi-sectoral approach. The last recommendation was that the biggest challenge of socio-economic development was corruption and there was need to be dealt with strongly because this vice overlooks implementation of programs.

ACRONYMS AND ABBREVIATIONS

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DPSIR	Driving force-Pressure-State-Impact-Response
EMCA	Environmental Management and Coordination Act
GK	Government of Kenya
KWS	Kenya Wildlife Service
MEAs	Multilateral Environmental Agreements
MOE	Ministry of Environment
NEMA	National Environment Management Authority
NRBP	Nairobi River Basin Programme
OECD	Organization of Economic Co-operation and Development,
PSR	Pressure-state-response
RAMSAR	Convention on Wetlands of International Importance especially as habitat for waterfowl (RAMSAR, 1971)
SD	Sustainable development
SDI	Sustainable Development Indices.
SPSS	Statistical Package for Social Sciences
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USEPA	United Nations Environmental Protection Agency
WARMA	Water Resource Management Authority
WEF	World Economic Forum
WRUA	Water Resource User Association

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Wetlands are distributed all over the world and cover about 6% of some 5.7 million km^2 of the earth's surface (Maltby, 1986). Wetlands were the first ecosystem to receive international attention through the Convention on Wetlands of International Importance, opened for signature at Ramsar, Iran, in February 1971 (Lambert, 2003). The convention defines wetlands as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary" with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Ramsar,2006).

Wetland ecosystems provide essential services to society, such as water storage, purification and supply, flood mitigation and erosion control, and stabilization of local climate conditions (Ramsar, 2006). Wetlands support millions of people and provide environmental goods and services to the world even outside the wetlands themselves. They are considered to act as custodians of valuable water resources. They act as "banks" from where water may be drawn and ground water replenished (Lambert, 2003).

Wetlands are also important storehouses of genetic materials but of most importance is the ecosystem functionality role, which they play through the biogeochemical, biophysical and biological processes (Lambert, 2003). Well managed wetlands have many benefits to the society in various ways such as; reducing floods impact, regulating water flow and drought effects, recharging ground water, supply and storing drinking water, retaining carbon, treating waste water, controlling erosion and sediment, exporting biomass, serving as habitat for wildlife, recreational and eco-tourism centres, source of pasture, wood fuel, retaining nutrients and toxins, building and craft materials and clay among others (Ramsar, 2006).These areas may incorporate riparian and coastal zones adjacent to the wetlands and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands. The Ramsar classification of wetland types is intended as a means for fast identification of the main types of wetlands for the purposes of the Ramsar Convention.

Kenya has wide regulation of the Environmental Management and co-ordination (Wetland, River banks, lake shore and sea shore management) Regulations, 2009, defined wetland to mean areas permanently or seasonally flooded by water where plants and animals have become adapted; and include swamps, areas of marsh, peat land, mountain bogs, bank of rivers, vegetation, areas of impeded drainage or brackish, salt or alkaline; including areas of marine water the depth of which at low tide does not exceed 6 maters. It also incorporates riparian and coastal zones adjacent to the wetlands" (G.o.K, 2009: pg 86).

Kenya has a variety of wetlands that stretch from coastal and marine wetlands to inland freshwater lakes, rivers, dams and swamps as well as the saline lakes of the Rift Valley system, constructed wetlands in the irrigation schemes, sewerage treatment systems and the mountain bogs, peat and glacier lakes. Some of these wetlands are recognized as important conservation areas such as National parks, National reserves, Ramsar sites, Important Bird Areas and World Heritage Sites. Degradation is the reducing of the initial value of the wetland whether it is social, ecological or economical in kind (Warren, 1971).

Despite the many uses from the wetlands, such ecosystems are at a threat mainly because of increasing population subsequently resulting to increase in demand of fresh water. With continued of population trends some wetlands are at a risk of becoming extinct if efforts to solve the problems do not work or are poorly implemented (Warren, 1971). The costs of failure to protect wetlands are too severe to contemplate in terms of economic and the environment. Some of the problems associated with endangered wetland range from loss of earnings to the local community and the country, destruction of flora and fauna hence loss of biodiversity. With the increase in population and technological advancement, pollution of the ecosystem, consciously or unconsciously, by man's activities have continued to grow at alarming rates (Warren, 1971).

According to Ramsar Convetion (2006), there are five categories of wetlands namely; marine (coastal wetlands including coastal lagoons, rocky shores, and coral reefs); Estuarine (including deltas, tidal marshes, and mangrove swamps); Lacustrine (wetlands associated with lakes); Riverine (wetlands along rivers and streams); and Palustrine (meaning "marshy" - marshes, swamps and bogs).

Raburu, (2005) discussed some of the ways in which Kenyan rivers in general and Nairobi Dam in particular has not been spared from the cruel hands of degradation. Nairobi Rivers are increasingly choking with uncollected garbage; human waste from informal settlements such as Kibera; industrial waste in the form of gaseous emissions, liquid effluence and solid wastes; agro-chemicals, and other wastes especially petrol-chemicals and metals from micro-enterprises – the "Jua-kali" and over-flowing sewers. This situation has occasioned the spread of water-borne diseases, loss of sustainable livelihoods, loss of biodiversity, reduced availability and access to safe potable water and the insidious effects of toxic substances and heavy metal poisoning which affects human productivity.

The Nairobi Dam was constructed in 1953 by the Public Works Department of the British colonial government in Kenya in conjunction with the Uganda Railways and Harbours Service and holds a reservoir with a storage capacity of 98,000m^3, surface area of 350,000 m^3 and an average depth of 176 m. It was to provide potable water for the residents of Nairobi City. It attracted major recreational, sporting, fishing and bird watching activities in turn being a destination for both foreign and domestic tourists. Over the years intensive encroachment of human settlements, agricultural activities, draining of raw sewer and dumping of garbage led to eutrophication and infestation of hyacinth rendering the dam unusable. The dam receives its inflow from the Mutoine River, rainfall and waste water from the unsewered Kibera settlement and the outflow is mainly through evaporation and over the spillway into the Ngong River (Odipo, 1987).

Currently, the dam is heavily silted and most areas have been reclaimed for agriculture as a result of dumped solid waste. The degraded state of dam has necessitated plans to restore it by the Nairobi Dam Trust Initiative through a Nairobi River Basin project funded by United Nations Environment Programme (UNDP). The process of restoration of the dam's ecosystem integrity will essentially involve removal of the water hyacinth, solid waste as well as pulling down the encroaching settlement from the Kibera slums. In view of the foregoing, the purpose of this study is to establish the human-induced impacts resulting from the degradation of the Nairobi Dam. On establishing human-induced impacts on the dam, the study proposed for the restoration and sustainable management of the dam ecosystem.

1.2 Statement of the problem

Nairobi Dam ceased living its purpose which was mainly tourist attraction and recreation due to degradation which has been as a result of factors including water hyacinth, waste from the Kibera slums, other human settlement encroaching on the foundations of the dam such as the recent construction of a residential estate tampering with the walls of the dam (Adhiambo, 2009). According to UNDP report (2007), the human-induced activities led to the degradation of the Nairobi dam. The leading human activity was farming activities alongside the dam.

Wetlands are not wastelands or idle pieces of land; hence they should not be drained and converted to what is perceived as more rewarding and useful activities (Muhati, 2005).According to Adhiambo (2009), Nairobi Dam is a valuable ecosystem provides a wide range of vital services including hosting a range of flora and fauna species. Over the years the Nairobi Dam has experienced a range of challenges which include; pollution from uncontrolled domestic discharges and contamination that threaten the dam's biodiversity. Invasive alien species are another factor contributing to the deterioration of the dam's ecosystem (Mwenda, 2012). Invasive alien species are a global threat to fresh water habitats and biodiversity because they suffocate, replace and thereafter result in the extinction of indigenous species (Ghabo 2007). Other factors contributing to the deterioration of the dam include poverty, rapid population growth (Beadle, 1974). The wetland is also used as a farmland where food crops like cassava and a variety of vegetables are cultivated by residents of the sprawling Kibera slum (Dugan, 1993, Ghabo, 2007).

Despite the existence of a legal and institutional framework, human activities continue unabated to the extent of threatening survival of the Nairobi dam and its resources (Issaias, 2000). Lack of harmonised and integrated conservation mechanisms involving all stakeholders has opened up a gap of inter-sectoral inconsistencies leading to further loss of the country's natural resources including wetlands (Ndunge, 1999). It is imperative that the Nairobi Dam has immense significance necessitating its prompt regeneration so as to conserve and manage the Dam for sustainable development (Muchiri, 2012).

1.3 Objectives of the study

1.3.1 Main objective

The overall objective of this study was to assess the human-induced impacts on wetlands, specifically the Nairobi Dam.

1.3.2 Specific objectives

The specific objectives were to:

(i) To determine chemical pollution loads in water content of Nairobi dam.

(ii) To examine the socio-economic benefits of Nairobi dam.

(iii) To investigate the human activities leading to degradation of Nairobi dam.

(iv) To examine socio-economic activities around the dam as a basis for understanding the source of human impacts on the dam.

(v) Examine perceptions of dam neighbourhood communities on the effectiveness of existing regulatory frameworks (policies, laws, institutions) with respect to the dam.

1.4 Research Questions

The following research questions guided the study:

(i) What pollution elements contained in the waters entering Nairobi dam, in it and the water leaving the dam?

(ii) What is the benefit of Nairobi dam to the surrounding community?

(iii) Which human activities mostly pollute the Nairobi dam?

(iv) Which socio-economic activities which are carried around the dam?

(v) What is the perception of the surrounding community in relation to conservation of Nairobi dam in relation to policy implementation?

1.5 Hypothesis

The study will test the following hypothesis:

(i) H_o: There is no significant relationship between pollution elements and water contamination of water in Nairobi dam.

H_1: There is significant relationship between pollution elements and water contamination of water in Nairobi dam.

(ii) $H_{o:}$ There is no significant relationship between social and economic gains to the

Nairobi dam.

$H_{1:}$ There is significant relationship between social and economic gains to Nairobi dam.

(iii) $H_{o:}$ There is no significant relationship between human activities and degradation of Nairobi dam.

$H_{1:}$ There is significant relationship between human activities and degradation of Nairobi dam.

1.6 Justification of the study

The Nairobi dam is one of the few wetlands remaining in the neighbourhood of Nairobi County, the Capital City of Kenya. The dam serves a myriad of functions and provides values and services including income generation. It is also an important area of biodiversity and was being used for sailing which is a source of income. This study intended to sensitize all stakeholders on the negative effects of human activities on the wetland and also front for sustainable co-existence and conservation practices.

There is very high potential of reaping socio-economic benefits of having wetlands in our societies. It was envisaged that this study will contribute towards the natural wetland policy framework, which is expected to promote conservation and prudent management of Kenya's wetlands in order to sustain their ecological and socio-economic functions now and in future. The results would also sensitize and promote awareness among local communities on the value to be accrued from becoming partners in all efforts gearing towards preserving wetlands.

1.7 Scope of the study

The study area was limited to Nairobi Dam and its surrounding five estates in Nairobi County. The study focused on the various human induced impacts that have contributed to the degradation of the Nairobi Dam, including human activities conducted on the dam by local residents. These activities have been found to be the leading cause of degradation of the wetland despite the existence of the environmental policies, laws and bodies such as NEMA and WRMA and their proposed measures and strategies of rehabilitating and conserving the dam.

The study appreciated that various factors affecting the various wetlands in Nairobi are more or less similar but specifically focused on the factors that affect the Nairobi dam. The study covered the entire catchments area of Nairobi dam. The study was covered three social groups namely, local residents, government officials and the managers of the Nairobi sailing club who will form part of the sample. The scope of the study was on the Nairobi Dam since there seemed to be no progress after numerous recommendations have been made. The study focused on the human-induced impacts on conservation of wetlands that have contributed to the degradation of the Nairobi Dam.

1.8 Operational definition of terms and concepts

Biodiversity: It refers to the wide variety of ecosystems and living organisms: animals, plants, their habitats and their genes

Chemical pollution- the organic and inorganic elements which lead to degration of a resource in a negative way

Community- the population which lives along a resource

Conservation: to preserve, protect or prevent something from damage. In this case it refers to environmental preservation.

Environment: It is the biophysical and socio-economic and cultural factors that surround and influence the life of an organism.

Environmental awareness: having knowledge or cognisance to protect the quality and continuity of life through conservation of natural resources.

Environmental degradation: the act or process of declining to a lower condition, quality or level. In this case it refers to the deterioration of the environment through destruction of the Nairobi dam.

Human activities: It refers to activities that would not occur in natural environments without man-made influence or something that people do or cause to happen such as agriculture and construction.

Impact- refers to the effect of a subsequent

Loads- the effluents carried by water**.**

Over-exploitation: refers to the uncontrolled use and over utilization of natural resources until there is little left or to the point of diminishing levels of natural resources.

Pollution: This is the presence in the environment (air, water and land) of contaminants in quantities, characteristics and duration such as to be injurious to human, plant and animal life or property or which unreasonably interfere with the comfortable enjoyment of life and property.

Sewage: Waste matter especially faeces and other waste products from the human body, waste matter of factories that flows in underground pipes or other passages to a treatment plant or elsewhere, like a septic tank.

Sustainable use: in ecology the word describes how biological systems remain diverse and productive over time in this case, referring to wetlands.

Toxic materials: Those with the ability to cause damage to living tissues, impairment of the central nervous system, severe illness or in some cases death, when injected or absorbed by living things like plants and animals.

Wetlands: Refers to an area of land whose soil is saturated with moisture either permanently or seasonally. Such areas may also be covered partially or completely by shallow pools of water. Wetlands include swamps, marshes and bogs.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

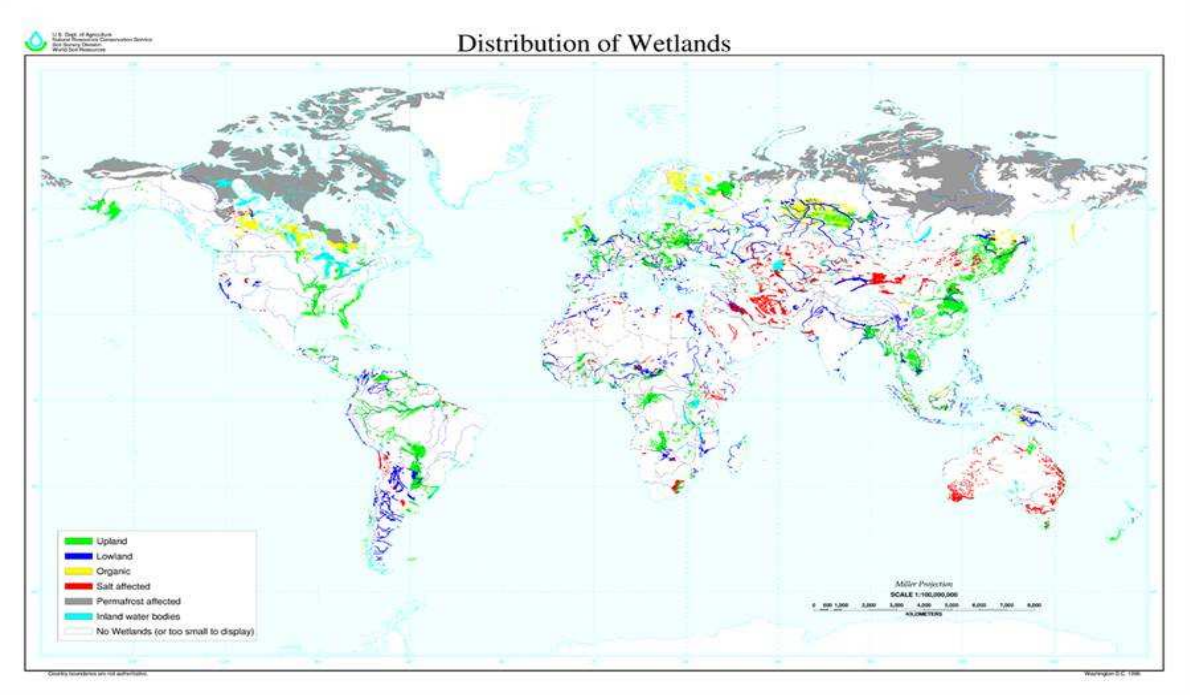
This chapter focused on the past researches that have been done relevant to this research study on human activities on the conservation of wetlands. The chapter explored relevant information from the past researches so as to narrow the gaps within the existing literature, methodologies and past findings with the aim of filling them. This chapter helped in gaining a better understanding of the research under study in terms of the theoretical and empirical literature. The literature review focused on the importance of wetlands at a Global, Continental, National and Regional level. The chapter also explored the policies formulated with respect to conservation of wetlands and the socio-economic importance of wetlands.

2.2 Global perspective on wetlands

Wetlands occupy about 6% of the world's land surface. Global levels studies including consultative meetings such as Ramsar convention of 1971 are spotlights showing previous initiatives which have been undertaken in recognition of the value and importance of wetland resources (Ramsar report, 1971). The report categorises wetlands as regions of both land ecosystems that are strongly influenced by water and aquatic ecosystems with special characteristics due to shallowness and proximity to land. Although various different classifications of wetlands exist, a useful approach is one provided by the Ramsar Convention on Wetlands. It divides wetlands into three main categories of wetland habitats: marine or coastal wetlands; inland wetlands and man-made wetlands.

According to Rongei (2013), the marine and coastal wetlands include estuaries, inter-tidal marshes, brackish, saline and freshwater lagoons, mangrove swamps, as well as coral reefs and rocky marine shores such as sea cliffs. Inland wetlands refer to such areas as lakes, rivers, streams and creeks, waterfalls, marshes, peat lands and flooded meadows. Man-made wetlands include canals, aquaculture ponds, water storage areas and even wastewater treatment areas. Figure 2.1 shows the distribution of wetlands around the world (Kirsten, 2001).

Figure 2.1 Global Distributions of wetlands



Source: US Department of Agriculture, Natural Resources conservation Services, 1997(p.27)

Wetlands occur naturally on every continent except Antarctica. The largest wetlands in the world include the Amazon River basin and the West Siberian Plain. Another large wetland is the Pantanal, which straddles Brazil, Bolivia, and Paraguay in South America (Fraser,2005).The UN Millennium Ecosystem Assessment determined that environmental degradation is more prominent within wetland systems than any other ecosystem on Earth. International conservation efforts are being used in conjunction with the development of rapid assessment tools to inform people about wetland issues (Stephen, eta al 2000**).**

2.2.1 The Ramsar Convention

The Ramsar Convention on wetlands is a treaty that embodies the commitments of its member States to maintain the ecological character of their wetlands by providing a framework for national action and international cooperation for the conservation and wise use of these fragile ecosystems and their resources. The Ramsar Convention on wetlands was adopted in the Iranian city of Ramsar in 1971 on the shores of the Caspian Sea, and the Convention's member countries cover all geographic regions of the planet.

The Convention uses a broad definition of the types of wetlands covered in its mission, including lakes and rivers, swamps and marshes, wet grasslands and peat lands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans. The Convention has formulated “three pillars” of action through which member States should seek to deliver their commitments to wetland conservation and wise use, the pillars are;

(a) Wise Use

This entails working through a wide range of actions and processes with an aim of contributing to the well-being of human beings, including such things as water, food security and poverty alleviation, for purposes of ensuring sustainable wetlands and river basin management. It involves efficient water allocation, establishing national wetland policies and plans such as reviewing and harmonizing the framework of laws and financial instruments affecting wetlands, undertaking inventory and assessment; integrating wetlands into the sustainable development process, ensuring public participation in wetland management and the maintenance of cultural values by local communities and indigenous people. It is the process of promoting communication, education and public awareness; increasing private sector involvement and harmonizing implementation of the Ramsar Convention with other Multilateral Environmental Agreements (MEAs).

(b) Designation of sites of international importance (Ramsar Sites)

Member States are required to engage in further identifying, designating and managing sites of International Importance (Ramsar sites), as a contribution to the establishment of a global ecological network. Countries should also ensure effective management and monitoring of such sites.

(c) International cooperation

The pillar on International cooperation focuses on management of trans-boundary water resources and wetlands and shared wetland species. Collaboration with other Conventions and International Organizations, sharing information and expertise as well as increase of flow of financial resources and relevant technologies to developing countries and countries where transition is encouraged.

2.3 Continental Management of wetlands

In dry land Africa the economic importance of wetlands is of great importance. Sometimes this fact is lost amidst concerns about the development problems and needs of dry lands and the vision of huge benefits in the future is usually pressumed if wetlands are developed Mavuti (1981). However, even without such development, wetland areas have an important place in the economy of many African countries. This could include direct production of surplus food or other commodities or simply providing sound and sustainable incomes in good and bad years for fairly large numbers of people. The Niger Inland Delta, for example, supports some 550,000 people, and in the dry season provides grazing for about one million cattle and two million sheep and goats. There are some 80,000 fishermen, and the Delta supports some 17,000 hectares of rice, half the total area of rice in Mali (Adam, 1993).

The management of wetlands in Kenya, Uganda and Tanzania are still under various evolutionary regimes whose activities and objectives are largely uncoordinated, overlaps and are even conflicting each other Government agencies under whose jurisdiction the wetlands presently occur are responsible for their conservation and management and are limited in harmonized approach and capabilities (Kamugisha, 1993). Similar to South America, there is an extreme lack of published quantitative studies on wetland loss in Africa (Moser et al 1996).

Dugan (1993) report on the causes of wetland loss in Africa and on the progress in protection and more sustainable use of wetlands in some areas, but no estimates were given. In west and central Africa there has been substantial loss and degradation of natural ecosystems due to population increase and other pressures over the last 80 years (Dugan 1993).

In Ghana for example, Gopal and Wetzel (1995), noted that there has been poor documentation and research of contamination by domestic and municipal wastes, agrochemical pollution of rivers and groundwater and effects of land degradation on water resources. Major water bodies receiving such pollutants include the Volta, Birim, and Densu, Ofin and Ankobra rivers and Korle Lagoon. River waters and sediments in mining areas contain high concentrations of cyanide and arsenic.

In Tunisia, an overall loss of 15% of wetland area is reported and 84% loss of wetlands in the Medjerdah catchment (Moser et al 1996). Dams have been built on the three major rivers flowing into Lake Ichkeul, causing progressive siltation and decline in vegetation. Marshes surrounding the lake are dwindling due to drainage for agriculture. Other regions in Tunisia have been considerably altered due to agriculture, including the hilly areas, where jessours (terrace-like dams) cover 400 000 ha (Gopal and Wetzel 1995).

In southern Africa, wetland loss figures are available for Natal, provided by Taylor et al (1995) in a review of wetland inventories in the region. In parts of the Tugela Basin over 90% of the wetland resources have been lost, and in the Mfolozi catchment 58% of the original wetland area has been lost (Taylor et al 1995, Moser et al 1996). Denny (1985) provides information on African wetlands which have been degraded by aquatic weeds.

Lake Chad for instance, fluctuates in size from 600 000 ha to 2.5 million ha. but has been severely impacted by aquatic weeds which cover 200 000 ha and interfere with transport and fishing on the lake. It is possible for such degraded wetlands to recover as in the discussed by Denny (1985) on Lake Kariba which was infested with 75 000 ha of the aquatic weed *Salviniamolesta*in in the 1960s. Biological control measures were successful and the weed infestation decreased, stabilizing at approximately 7700 ha. A study which was carried out by Scott (1995) noted that large-scale wetland degradation is occurring in the Middle East for various reasons including deforestation, overgrazing, reclamation, water diversion for irrigation, increased salinity, expanded urban and coastal development, overfishing, oil and other pollution and war damage.

2.3.1 Middle East

As in other regions, the fact that rivers such as the Jordan, Tigris and Euphrates flow independently of national borders means that proposed irrigation schemes in countries upstream can greatly impact upon water quality and scarce water supplies of the river and other remaining wetlands downstream (Ghabo, 2007). Almost all of the original freshwater wetlands in Syria, Lebanon and Israel were drained for agriculture in the early 1900s (Dugan 1993). Drainage of marshes continues, one such example being the systematic drainage of the Al Huweizah marshes in a 30 000 km^2 (3 million ha) area of southern Iraq. Water diversion through dykes and a drainage canal has decreased the area of marshes by 50% since 1972

(INC 1998). Over a seven-year period (1985–1992), the area of permanent lakes and marshes, and seasonal and temporary marshes in Lower Mesopotamia had been reduced by over 25%, from 1.94 million ha to 1.44 million ha. To date, much of the Haur Al Hammar marshes and the greater part of the Central Marshes have been drained, with disastrous ecological, social and human consequences for the region (Scott 1995).

Few countries in the Middle East have made any serious attempt to conserve dwindling wetland resources (Dugan 1993). Yet water demand in the region has also led to the formation of a large number of artificial wetlands, including water storage reservoirs, sewage treatment ponds and artificial lagoons for containment of urban and industrial waste water. These artificial wetlands have become important habitats for wildlife, including migratory birds (Dugan 1993, al Wetaid and Faizi 1993).

2.4 National perspectives on wetlands

Kenya has been touted as the 'Land of Splendor', with a rich historical background, great diversity of physical features, pleasant climate, diverse people, and magnificent wilderness areas. (Ministry of Environment and Natural Resources, 2000).

More recently, it has been praised as a model for environmental progress in the region following enactment of a new Constitution which contains specific measures for environmental management. Kenya became a signatory to the Ramsar Convention in 1990 with the Kenya Wildlife Service (KWS) as the focal administrative authority for the convention in Kenya. So far, Kenya has designated five Ramsar sites including; Lake Nakuru designated on 5th June 1990 with an acreage of 18, 800 ha; Lake Naivasha designated on 10th April 1995 with an acreage of 30,000 ha.

Lake Bogoria designated on 27th August 2001 with an acreage of 10,700 ha; Lake Baringo designated on 10th January 2002 with an acreage of 31, 469 ha; Lake Elementaita designated on 5th September 2005with an acreage of 10, 880 ha (UNEP,2008).According to UNEP(2008) country wide programme, other sites proposed for designation as Ramsar sites include: Tana Delta, Yala swamp, Sio-Siteko and Saiwa swamp**.** As a Contracting Party to the Ramsar Convention, Kenya committed itself to the obligations under the Convention. It is

explicitly stated under the convention a general obligation for the Contracting Parties is to include wetland conservation considerations within the national land use planning.
Kenya is required to formulate and implement this planning so as to promote as far as possible, the wise use of wetlands in the country.A second obligation is to designate sites of International importance that meet the criteria for inclusion in the Ramsar list. Kenya is also obliged to promote the conservation of wetlands in the country through the establishment of nature reserves, and promote training in wetlands research, management (Adhiambo, 2009). In addition management plans for Ramsar sites and non Ramsar should be developed. Kenya has so far developed management plans for Lakes Nakuru, Naivasha, Bogoria, Baringo, Jipe, Ol Bolo sat among others. However the implementation of the Lake Naivasha Management Plan was challenged in court rendering it ineffective.

In Kenya, studies have been conducted and recommendations released touching on importance and values of wetland resources (Mwaura, 2005). The Government of Kenya drafted national session paper of 2007 and this was a clear sign of government's endeavours to put in place legislative guidelines for sustainable use and conservation of such resources all over the country. It has been noted that in the absence of proper land management, degradation of wetlands, occurs (Mwaura, 2005). Population growth and development activities have led to pressure on the wetland and hence the resources as well as the benefits derived from the wetland are threatened by normal activities around the wetland (Gichuki, 1998).

According to development journal (2012), sustainable and wise use of wetland resources is far from being achieved. This explains why Nairobi Dam has been damaged by human activities. Though conservation strategies have been recommended by past studies, positive results are far from being realized. This study intended to assess effects of human activities on wetlands and establish the possible results of harmonized approach in all existing legislative frameworks, policies and community based initiative towards conservation and sustainable use of Nairobi Dam. Human use of wetlands in Africa for instance Sahel is highly significant economically (Adams, 1993).

The Kenya Vision 2030 is a national long-term development blue-print to create a globally competitive and prosperous nation with a high quality of life by 2030 that aims to transform

Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment (G.O.K, 2011).

Article 42 of the Constitution provides that every person has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69 and to have obligations relating to the environment fulfilled under Article 70 (The constitution, 2010).

2.4.1 The Nairobi River Basin Programme

The best practices for environmental conservation for the Nairobi River Basin Programme launched in 1999 was a multi-stakeholder initiative including the GoK, the UNEP, the UN-Habitat, the UNDP, Private sector and the civil society organizations, whose main objective was to restore, rehabilitate and maintain good water quality of river system passing through Nairobi with a view of reducing environmental risk for the urban population. The programme had three phases running between 1999 to 2009. Essentially the first and second phases established benchmarks and identified opportunities for productive interventions that were required to be made with regard to water and sanitation. This also involved mobilizing the community. The assessment of the upstream of the motoine/ngong' river was undertaken. The programme also explored options for dealing with pollution of the Nairobi rivers generally and the manner in which the Nairobi river would be restored.

According to Kenya National Cleaner Production Centre, the Nairobi River Basin is home to 80% of Kenya's manufacturing and service enterprises and is the most polluted river basin in the country (UNEP, 2003). Several industrial sectors are represented but the exact number and location in the basin have been poorly understood in the past. In addition to contributions of raw sewage from informal settlements, several of these enterprises discharge untreated or partially treated waste into the Nairobi River (UNEP, 2003).

2.4.2 Previous Nairobi Dam Chemical Water Analysis

In 2003, UNEP and the Government of Kenya, under the Nairobi River Basin Project Phases 1 and 11 undertook field investigations supported by laboratory analyses of samples obtained -from 20 monitoring stations along the Motoine/Ngong' river to identify major point sources of pollution (UNEP, 2003).

The study found that the river water was heavily polluted with both organic and inorganic loadings although it could not point out the contribution from each of the point industrial sources. The Biodiversity oxygen deficiency (BOD) of the river varied from a minimum of 12.5 mg/l in the wet season to 640 mg/l during the dry weather. The maximum average Chemical oxygen deficiency (COD) was 1317 mg/l. The dissolved oxygen levels in the river were up to 0.1 mg/l.

The heavy metals of concern in the river waters were cadmium, chromium, zinc and copper. The study showed that along the industrial area, the river water had concentrations of copper of 0.8 mg/l; chromium was detected at levels of 01- 0.2 mg/l whilst zinc was detected in concentrations of 0.1-0.7 mg/l. The heavy metal pollution was strongly associated with the industries located along the river. The study recommended that industrial discharges should be stopped through efforts by industries to take measures to curb pollution emanating from their facilities. Some technical and financial support should be considered in developing technologies to prevent, minimize and to treat discharges from industries within their premises, and cleaner production systems. There was need to look at the existing legislation in relation to environmental performance of companies. The “polluter pays principle” should be implemented to change behaviour of industries towards less polluting practices (MacKenzie, 2004). It is necessary to initiate efforts of assessment of pollution, community sensitization and clean up action plan for the Nairobi River and its three tributaries of the Ngong/Motoine-Nairobi River systems (UNEP, 2013).

As a way forward, the study recommended initiation of capacity building on legislation on pollution prevention and penalties as well as engineering solutions to the cleanup efforts. Phase III of this program has been set up and was to run from 2005-2008. This phase was to promote the concept of integrated river basin management through a number of activities, outputs and outcomes. The implementing agencies include: UNEP, UN-HABITAT, UNDP and the then Ministry of Environment and Natural Resources (UNEP, 2013).
In view of the UNEP and UNDP programmes, this research used the reports as a baseline study and in particular the results on the water pollution loads were used to investigate whether indeed the programme had an effect in regards to the restoration of the Nairobi dam.

2.5 Legislative frameworks for wetland conservation and management in Kenya

Chapter five of the Constitution relates to land and environment. In particular, Part 2 of Chapter five deals with environment and natural resources. Article 69 of the Constitution provides for the obligations of the state in respect of the environment to ensure sustainable - exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits; eliminate processes and activities that are likely to endanger the environment. It also places an obligation to every person to cooperate with state organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

Where a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may, by virtue of Article 70 of the Constitution, apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.

The court may make any order, or give any directions, it considers appropriate to prevent, stop or discontinue any act or omission that is harmful to the environment, compel any public officer to take measures to prevent or discontinue any act or omission that is harmful to the environment or provide compensation for any victim of a violation of the right to a clean and healthy environment. Notably an applicant does not have to demonstrate that any person has incurred loss or suffered injury.

Section 72 of the EMCA provides for water pollution and specifically states that a person, who discharges or applies any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permits any person to dump or discharge such matter into the aquatic environment in contravention of water pollution control standards shall be guilty of an offence and liable to imprisonment for a term not exceeding two years or to a fine not exceeding one million shillings or to both such imprisonment and fine.

A person found guilty of water pollution shall, in addition to any sentence or fine imposed on him, pay the cost of the removal of any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants, including the costs of restoration of the damaged environment, which may be incurred by a Government agency or organ in that respect and

pay third parties reparation, cost of restoration, restitution or compensation as may be determined by a court of law on application by such third parties.

Section 142 of the Act provides for offences relating to pollution generally. It specifically provides that-

142. (1) any person who –

(a) discharges any dangerous materials, substances, oil, oil mixtures into land, water, air, or aquatic environment contrary to the provisions of this Act;
(b) pollutes the environment contrary to the provisions of this Act;
(c) discharges any pollutant into the environment contrary to the provisions of this Act;

Commits an offence and shall on conviction, be liable to a fine not exceeding five hundred thousand shillings. In addition to any sentence that the Court may impose upon a polluter the Court may direct that person to –

(a) pay the full cost of cleaning up polluted environment and of removing the pollution;
(b) Clean up the polluted environment and remove the effects of pollution to the satisfaction of the Authority.

Further, the court may direct the polluter to meet the cost of the pollution to any third parties through adequate compensation, restoration or restitution.

Section 72 and 142 of EMCA are of particular importance in the management and conservation of water bodies and specifically the Nairobi dam. The provisions prohibit water pollution and imposes a hefty penalty to any person who discharges any pollutant .However, despite the provisions this study seeks to establish whether EMCA has been successful in implementing these provision or the extent in which the provisions of section 72 and 142 has been applied.

2.5.1 The Environmental Management and Co-ordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations, 2009

Regulation 14 of the Environmental Management and Co-ordination (Wetlands, River banks, Lake Shores and Sea shore management) Regulations, 2009 provides for the duty of land owners users and occupiers. Every owner, occupier or user of land which is adjacent or contiguous to a wetland shall, with advice from the Authority, have a duty to prevent the

degradation or destruction of the wetland, and shall maintain the ecological and other functions of the wetland. A person who fails neglects or refuses to protect a wetland commits an offence.

Regulation 21of the Environmental Management and Co-ordination (Wetlands, River banks, Lake shores and Sea shore management) Regulations, 2009 requires a developer intending to a undertake a project which may have a significant impact on a wetland, river bank, lake shore or the sea shore shall carry out an environmental impact assessment in accordance with the provisions of EMCA. The developer shall carry out an environmental audit as provided for by EMCA, and the Authority to monitor such activities in accordance with EMCA.
The Director – General may issue Environmental Restoration orders pursuant to the provisions of EMCA in order to allow a wetland, riverbank, lake shore or the sea shore area which has been degraded to regenerate as provided under Regulation 22 of the Environmental Management and Co-ordination (Wetlands, River banks, Lake shores and Sea shore management).Regulations (2009) any person who contravenes the provisions of the Environmental Management and Co-ordination (Wetlands, River banks, Lake shores and Sea shore management) Regulations, 2009 commits an offence and shall be liable on conviction to imprisonment for such term and such fine as are provided for in EMCA.

2.5.2 Highlights of Water Quality Regulations, 2006 (Legal Notice No. 121 of 2006)

The objective of the Water Quality Regulations, 2006 is mainly to protect human health and the environment by prescribing the standards for each category or class in which water is required. The Regulations provide for the standards required for water that is used for domestic, industrial, agricultural and recreational purposes, water used for fisheries and wildlife purposes and water used for other purposes. Different standards apply to different modes of usage. In addition the Regulations provide for the protection of sources of water such as lakes, rivers, streams, springs, wells and other water sources.

The effective enforcement of the water quality Regulations shall result to a marked reduction of water-borne diseases and hence a reduction in the health budget. The Regulations also provide guidelines and standards for the discharge of poisons, toxins, noxious, radioactive waste or other pollutants into the aquatic environment in line with the Third Schedule of the Regulations. The standards for discharge of effluent into the sewer and aquatic environment

are also provided in the said Regulations. While it is the responsibility of the sewerage service providers to regulate discharges into sewer lines based on the given specifications, NEMA regulates discharge of all effluent into the aquatic environment.

The regulations provide for the creation of a buffer zone for irrigation schemes of at least fifty metres in width between the irrigation scheme and the natural water body. Standards for irrigation water are provided in the schedule nine of the regulations. All firms or persons discharging effluent into the aquatic environment are required to submit quarterly discharge monitoring records to NEMA based on prescribed procedures of sampling and analysis. Everyone is required to refrain from any actions, which directly or indirectly cause water pollution, whether or not the water resource was polluted before the enactment of the Environmental Management and Coordination Act (EMCA) gazetted in 1999. It is an offence to contravene the provisions of these regulations with a fine not exceeding five hundred thousand shillings.

2.6 Challenges and Threats of wetlands

In the 1600's, over 220 million acres of wetlands existed in the lower forty eight states (Dahl and Johnson 1991). Since then, extensive losses have occurred, with many of the original wetlands drained and converted to farmland. Currently, less than half of the nation's original wetlands remain. Activities resulting in wetlands loss and degradation include: agriculture; commercial and residential development; road construction; impoundment; resource extraction; industrial sitting, processes, and waste; dredge disposal; silvi culture; and mosquito control (USEPA 1994b; USEPA 1993a). The primary pollutants causing degradation are sediment, nutrients, pesticides, salinity, heavy metals, weeds, low dissolved oxygen, pH, and selenium (USEPA 1994). Twenty-two states have lost at least 50 percent of their original wetlands. Indiana, Illinois, Missouri, Kentucky, and Ohio have lost more than 80 percent of their original wetlands and California and Iowa have lost nearly 99 percent (USEPA 1995). Since the 1970's, the most extensive losses of wetland acreages have occurred in Louisiana, Mississippi, Arkansas, Florida, South Carolina, and North Carolina (Dahl and Johnson 1991).

Between the mid-1970's and the mid-1980's, approximately 4.4 million acres of inland freshwater wetlands (-4%) and 71,000 acres (-1.5%) of coastal wetlands were destroyed

(Dahl and Johnson 1991). Inland forested wetlands were impacted the most during the mid-1970's to the mid-1980's, with a loss of 3.4 million acres (-6.2%), primarily in the Southeast (Dahl and Johnson 1991). Approximately 900,000 acres were converted from forested wetlands to other wetland types. Conversion to agricultural usage of land was responsible for 54 percent of the losses of both freshwater and coastal wetlands; drainage for urban development for 5 percent and "unspecified usage" (planned development) was responsible for 41 percent of the losses. This is in contrast to the mid-1950 to mid-1970, when agricultural drainage of wetlands was responsible for 87 percent of the losses and urban development for 8 percent (Dahl and Johnson 1991).

While wetlands have the potential of contributing significantly to the socio-economic development of countries, they face diverse and severe threats. These threats include among others inappropriate human activities within the catchments and in the wetlands, lack of coordinated and holistic policy guidelines, and climate change. Threats have induced changes that have eroded the ecological and socio-economic values and services derived from wetlands. The underlying threat remains lack of recognition of the importance of wetlands and the role they play in both the national economy and community livelihoods. Earlier studies show that unchecked interplay between agricultural and other human activities and the environment has dire consequences on wetlands (UNEP, 2003).

2.7 Social-economic factors resulting to degradation of wetlands

Poverty is another key contributor to wetland degradation. Most riparian communities engage in destructive farming practices, draining of wetlands and cutting of trees to make charcoal. Poverty and wetland degradation are intertwined and any step towards conservation must address poverty reduction Ndunge (1999). According to the study Ndunge (1999), Poverty related issues tend to increase rate of extraction of environmental goods such as firewood, building materials and fodder for animals. Activities such as cutting down of the trees by local communities to create room for agriculture to mitigate high cost of basic commodities manufactured and retailed in supermarkets is also common. The poor and hungry will often destroy their immediate environment in order to survive. Population growth is seen as a critical factor because it diminishes farm sizes in densely settled areas and creates pressure for people to push into fragile areas such as wetlands.

Releases of agrochemicals, which are lethal to fauna and flora, into the wetland and the rivers have complicated the situation even further. Increased nutrient loads have led to eutrophication and episodes of algal blooms in wetlands near major settlements (UNEP'2013).

In certain areas excessive abstraction of fresh waters, diversions, and catchments degradation, have led to increased salinity. Construction of high rise residential buildings near the wetland has also been on the increase. In the absence of sewer system, this situation is likely to accelerate ground seepage of nutrients into Nairobi Dam from septic tanks.Environmental impact assessment (EIA) of projects affecting wetlands directly, or impacting their support systems such as groundwater, river flow, or migratory species, is essential to sound environmental management and the sustainable utilization of wetland resources. The review of literature has shown that there is inadequate research conducted on why Nairobi Dam resources have continued being degraded despite the existence of environmental policies and custodian bodies such NEMA. This is the gap this research has filled (Issaias, I. 2000).Kirsten, (2005),as addressed the economic values of global wetlands. Case studies of economic values of wetlands in each continent have been used to illustrate this economic value. Drawing on the results of a valuation literature of 89 cases, estimates have been derived for wetlands globally by geographical region and by wetland function.

It was shown that, based on the sample of 89 case studies, un-vegetated sediment wetlands like the Dutch Warden Sea and the Rufiji Delta in Tanzania have the highest economic values at a median economic value of $374 per hectare per year. Furthermore, the provision by wetlands of recreational opportunities and amenities, and flood control and storm buffering are the wetland functions with the highest median economic values at $492 and $464 per hectare per year respectively. The economic value of wetlands per geographical region was also estimated, which showed that based on the sample of 89 cases, Asian wetlands have the highest economic values at $1.8 billion per year. Kirsten focus was on the economic value of wetlands and did not evaluate factors that contribute to degradation of wetlands which the study evaluated.

2.8 Critical Reviews

Macharia (2000) conducted a study on the impact of water hyacinth (*Eichorniacrassipes*) in a manmade wetland: a case study of Nairobi dam. He recommended that since it has been established that eradicating the weed will not be fully possible through utilization, it is imperative that sustainable utilization of water hyacinth be based on both the varied environmental and economical costs which include reducing the water hyacinth to manageable levels. Macharias' study did not consider other factors like the socio-economic pressure that contribute to the degradation of the Nairobi River which this study established.

Mburu (1999), carried out a study on the "Environmental degradation of a freshwater ecosystem: a case study of Nairobi river", he analysed the status of the Nairobi river as a fresh water ecosystem and how much it had been affected by people's activities, particularly due to high rate of urbanization. The study found out that Nairobi fresh water dam had been polluted by some of the human activities in relation to settlement and land inadequacy. It is clear that this study evaluated on the general factors not just human factors that contribute to degradation of the Nairobi dam which Mburu did not address in his study as his focus was on the Nairobi River.Barraclough (1997), argue that environmental degradations is a social concept which involves value judgment about an eco-system's long term potential for contributing to human welfare. Environmental degradation processes are usually associated with local level proximate causes such as careless natural resource management, inappropriate technologies, poverty, demographic changes, local power structures and natural processes which are environmentally disastrous. They are also linked with policies and institutions that may be national or global in scope and origin.

The study found out that mismanagement was the key factor in resource management. This study missed some of the key conservational measures like policy and even community participation in resource use which we will discuss fully. Paul (2000), summarizes collected data on biological impacts that could result from wetland alterations. It is an update to "Impacts on Quality of Inland Wetlands of the United States..." which covers literature prior to 1990. It is organized according to seven organism assemblages; each chapter addresses ten human- related stressors. The stressors were discussed fully but there was no research conducted to find out how each of them affected resource use.

Stephen (2000), ,made a comprehensive compilation of information on how specific stressors in Florida's inland freshwater wetlands affect various species assemblages. This study is designed to assist Florida agencies in developing biological assessment programs and will help identify appropriate assemblages, methods and metrics for future studies. Responses of wetland organisms to environmental stressors by Paul (1998), It summarizes literature prior to 1990.The author had undertaken a survey of the main water systems in tropical Africa and of their particular problems. The author pointed out that the relevance of limnology to tropical public health is very close since important tropical infections of man and animals are caused by water-borne organisms or are transmitted by animals that are partly or entirely aquatic (*e.g*. water-borne bacterial infections or malaria, schistosomiasis, liver-fluke, onchocerciasis, filariasis and several virus infections).

It provides a discussion and review of the historical background to scientific exploration, geological and climatic history and present climates, aquatic ecosystems, productivity, the mineral composition of tropical African fresh waters in relation to ecology, water circulation and stratification in tropical lakes, primary production in tropical lakes, and the evaluation and distribution of the African inland water fauna. This research had focused on the importance of clean water in avoidance of diseases which were perceived as stressors.

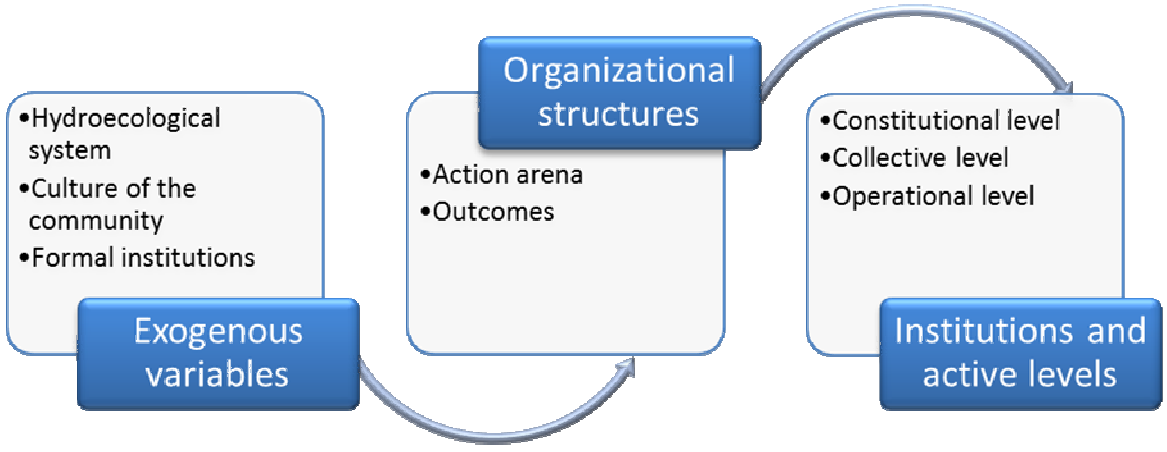
Mironga (2005), examined farmers' knowledge of the environmental effect of agricultural expansion to wetlands in Kisii. The study found out that land size and the increasing populations were some of the pressures which led to wetlands encroachment. He concluded that absence of knowledge of characteristics of farming activities and the attitudes of farmers with respect to planning mechanisms that might be used to support wetland protection in the area contributed to degradation of wetlands in now known as Kisii county.Rongei (2013), focused on Nyando wetland on the eastern shores of Lake Victoria, Kenya. Three sites in the wetland were identified for assessment of history and current status. The study assed the changes during the past fifty years were assessed through participatory exercises with local communities and a review of published work. Results showed that the wetland is important for hydrological and also ecological functions, which depend on the connectivity of the wetland with river and lake.

Muchiri (2012) investigated the impact of human activities on the Ondiri natural resources in Kikuyu District of Kiambu County. The study assessed the impact of human activities on Ondiri wetland at a time; both legislative institutions such as National Environment Management Authority (NEMA) and Non-Governmental Organizations (NGOs) have been put in place to spearhead environmental conservation programs in Kenya. This research therefore sought to investigate human induced activities on Nairobi dam as opposed to the Ondiri dam which Muchiri investigated on. In view of the above critical review it is imperative that this research investigated an area which has not been previously researched on.

2.9 Theoretical framework

The study is based on the Institutional Analysis and Development framework, applied to the Doñana water socio-ecosystem (Ostrom et al. 1994).

Figure 2.2 Analysis and Development framework



Source: Ostrom et al. 1994

Propositional conceptualization of rigid institutional regimes for the purpose of the analysis presented here, which has an exploratory and systemic character, institutional regimes were conceptualized as the on-the-ground matrix of institutions, organizational structures, and epistemological domains that define policy formation, decision-making procedures and

required action or outcomes for the accomplishment of a certain societal function, in this case, WRM and WC (based on Gunderson et al. 1995, Holling and Meffe 1996, Ostrom 2005, Hotimsky et al. 2006, Pahl-Wostl 2007, Fischer- Kowalski and Rotmans 2009).

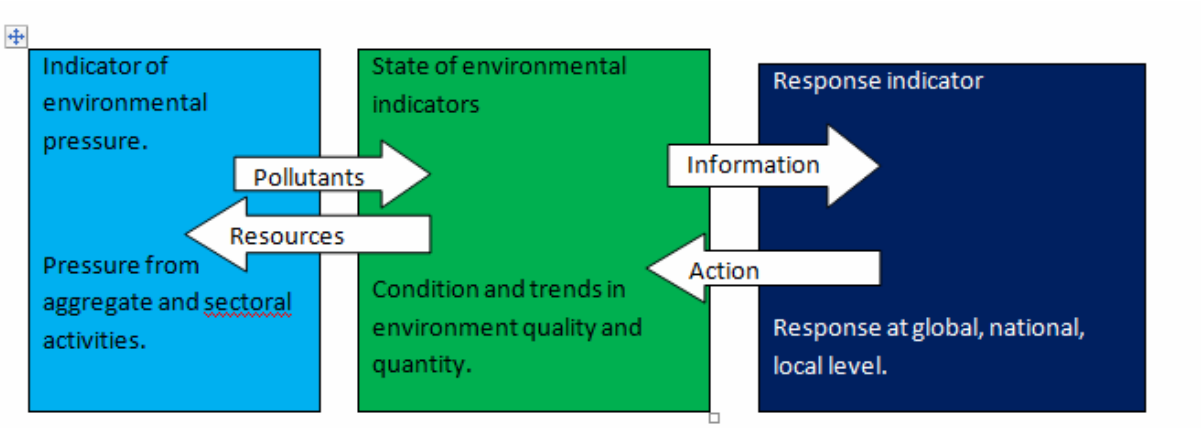
According to it, institutions are the formal and informal prescriptions (rules-in-use) about what actions or states of the world are required, prohibited, or permitted. Actors use these prescriptions to organize repetitive and structured interactions while participating in action situations within the regime's action arenas, at three different levels.

Institutions are considered as an exogenous variable of the arena; other exogenous variables include the biophysical system being acted upon, in this case Doñana's hydro ecological system, and the culture of the community (Ostrom 2005). The latter is a very broad and relevant concept, considered as an institution itself by sociological disciplines.

2.9.2 Causal Theoretical Framework

The causal framework introduces the concept of cause and effect relationships among diagnostic variables (i.e. indicators). Pressure-state-response (PSR) framework is such a conceptual approach widely used in SDI initiatives. 'Pressure' indicators represent human activities, processes, and patterns that impact on SD either positively or negatively. 'State' indicators provide a reading on the present state of affairs, while 'response' indicators represent societal actions aimed at pursuing SD. The PSR framework was developed and popularized by OECD (2003).

Figure 2.3 Pressure-States -Response (PSR) Framework

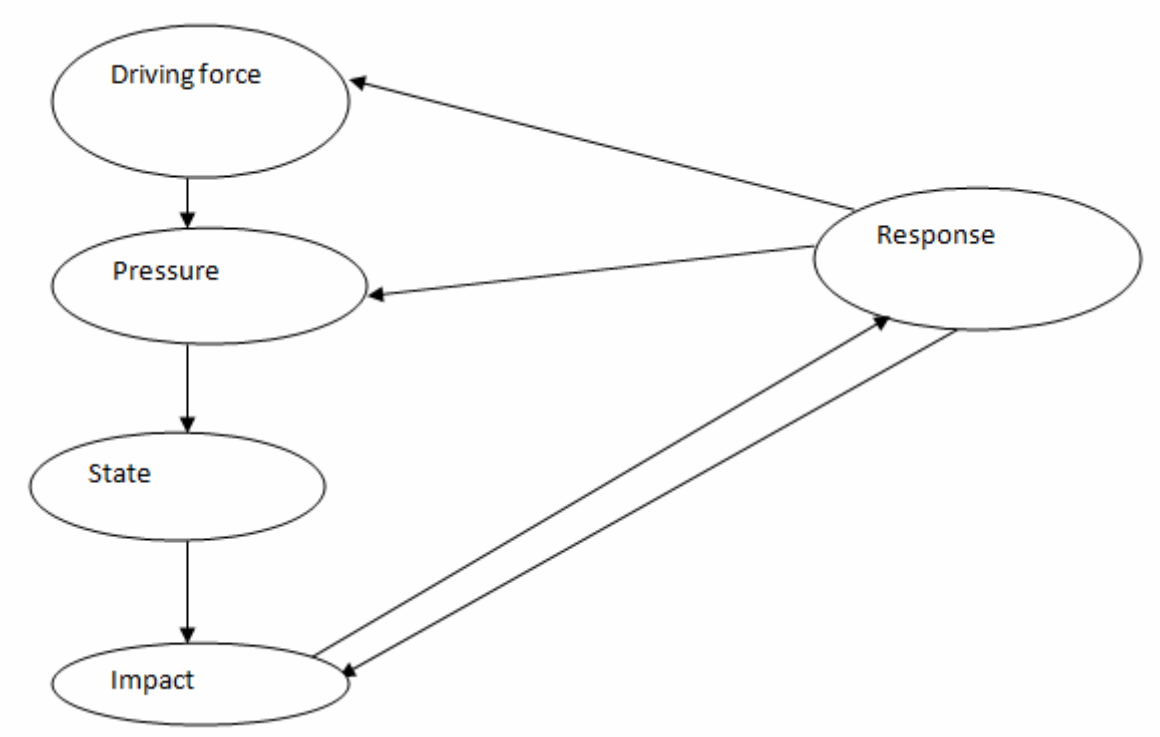


Source : Eurostat, 1997

As shown above, PSR framework groups indicators, related to human pressures on the environment, actual states of the environment, and the responses, 12 which may be undertaken to alleviate the damage. This also provides linkages among indicators through cause–effect relationships. One of the advantages of PSR framework is its attention to responses to environmental problems which are often neglected in the area in indicator studies (Australia, 1998). This model has been widely used, both locally and internationally. A modified version of PSR is used in Environment Sustainability Index (ESI), developed by the World Economic Forum (WEF) where apart from PSR two additional components were added, human vulnerability and global Stewardship (WEF, 2005).

Driving force-pressure-state-impact-response (DPSIR) framework, which is an extended version of PSR framework, has been adopted by the European Environmental Agency (EEA) and the European Statistical Office (Eurostat, 1997). Driving forces are the underline causes of pressure where as impacts are the effect of the observed changes in the state of the environment.

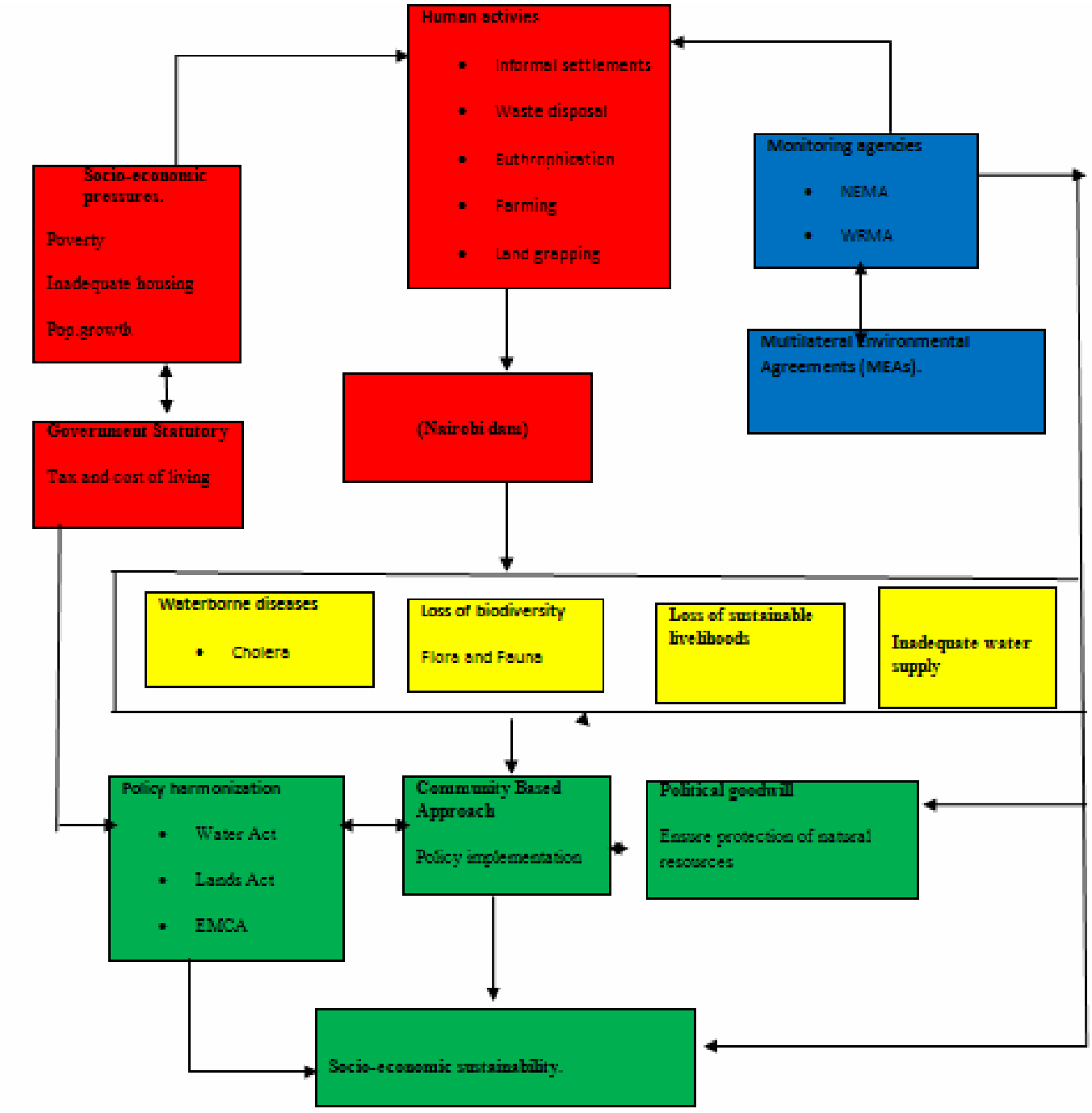
Figure 2.4 Driving Force-Pressure-State-Impact-Response



Source: Dhakal, 2002

Driving Force-Pressure-State-Impact-Response (DPSIR) Framework like PSR, DPSIR framework has also been used in variety of its forms by omitting one or more components or adding components to the original (Dhakal, 2002).There are two major limitations in the underlying foundation on which the causal framework is based. Firstly, it is difficult to categorize an indicator as a pressure or a state or a response, because the focus of the viewer may change depending on the underlying objective. The indicator, which is a pressure in one perspective, may be a state in another and a response in a third (Australia, 1998). For example, poverty and finance, which is a pressure indicator for population, is a state indicator is poaching and trading of illegal businesses domain and is a response for the source of income to find something to eat.

Figure 2.5 Conceptual framework



Source: Modified from Ostrom, 2005.

The figure 2.5 illustrates, the underlying threat remains lack of recognition of the importance of wetlands and the role they play in both the national economy and community livelihoods. Socio-economic pressures have induced changes that have eroded the ecological and socio-economic values and services derived from wetlands. Poverty is another key contributor to wetland degradation. Most riparian communities engage in destructive farming practices, draining of wetlands and cutting of trees to make charcoal. Poverty and wetland degradation are intertwined and any step at conservation must address poverty reductionNdunge (1999).

Poverty related issues tend to increase rate of extraction of environmental goods such as firewood, building materials and fodder for animals. Activities such as cutting down of the trees by local communities to create room for agriculture to mitigate high cost of basic commodities manufactured and retailed in supermarkets is also common. The poor and hungry will often destroy their immediate environment in order to survive. Population growth is seen as a critical factor because it diminishes farm sizes in densely settled areas and creates pressure for people to push into fragile areas such as wetlands. Human activities continue to be a menace when it comes to conservation.

The pressures cause the degradation of Nairobi dam. The effects can be felt in advance in terms of diseases, shortage of freshwater and even loss of livelihoods. If we want to achieve socio-economic development then we should involve the community, policy, government and non-governmental institutions.

CHAPTER THREE

STUDY AREA

3.1 Introduction

The chapter described the major elements of the study environmental area, encompassing the physical, biological and social environment as well as the state of Nairobi dam. The information obtained was presented in this section based on observation and desktop research of the study area.

3.2 Location and topography

The Nairobi Dam is located in Nairobi City County of Kenya (see map 3.1). It lies between latitudes 1019' South and longitude 360 48' East and at an altitude of 1700 meters above sea level. The Nairobi City County itself lies at an elevation range of 2,300m to the west and 1500m to the east. Bordering the north eastern side of the Nairobi Dam is Nyayo High-rise estate, on the southern side is the Nairobi Sailing club and Nairobi Dam Estate, on the Northern side is Laini Saba area of Kibera slums and Kibera High rise estate while on the western side are Ngei, Otiende, Southlands, Uhuru and Onyonka estates and on the eastern shore is the Langata Women's Prison (see Map 3.1).

Figure 3.1 Map of Kenya showing study area (Nairobi dam)

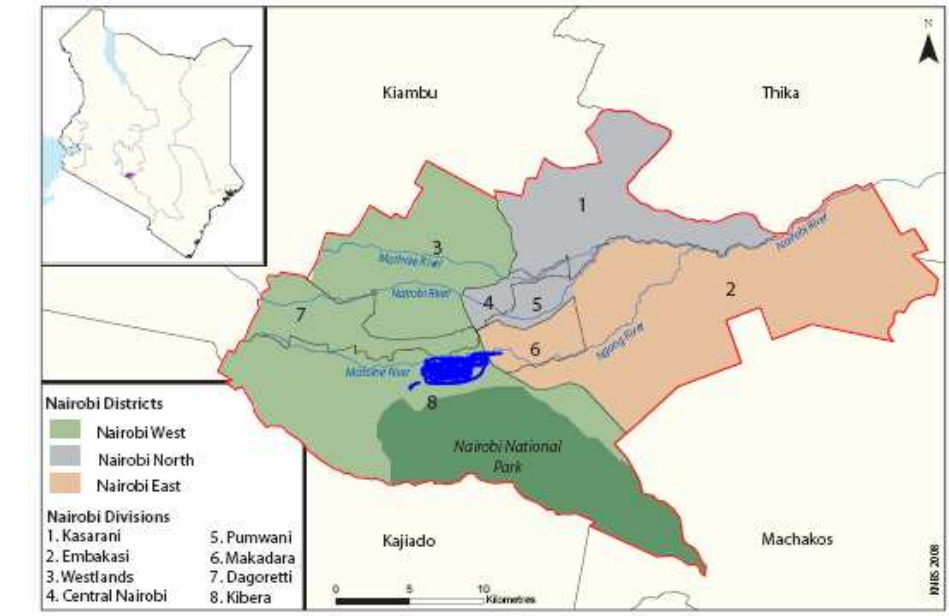
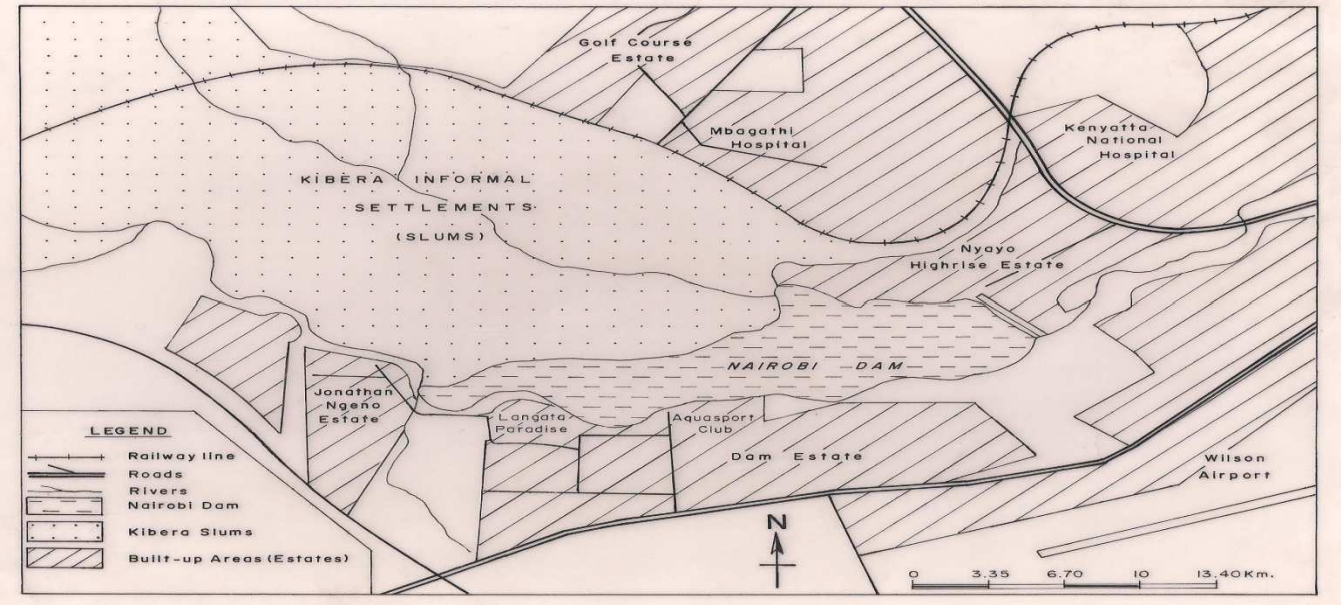


Figure 3.1 Map of the study area



Source: Cartography Unit, Department of Geography and Environmental Studies, University of Nairobi, 2012.

3.3 Rainfall and climate

Nairobi County area is characterized by two rain seasons, a long rain season that occurs between March and May and a short rain season that occurs between September and November (Kahara, 2002) .The mean annual rainfall is within the range of 500-1500mm(UNEP,2003). During the long rains, the storm water mostly disappears as run-off due to the poorly drained cotton soil and the paved land resulting in flooding. Temperature ranges between a high of 30°C to a low of 12°C have been recorded depending on the season of the year (UNEP, 2003). The humidity ranges between 40% and 97%.

3.4 Geology, soils and hydrogeology

Geologically, Nairobi City County is close to the Eastern border of the East African Rift Valley and is on a large depression filled with volcanic rocks and sediments Cainozoic times, which lie on basement complex rocks. This volcanic rocks and sediments of Cainozoic times, dominate Nairobi's geology. The volcanic rocks (phonolites) have gentle slope flowing eastwards from the rift Valley (Kahara, 2002).

The lava flow in the project area is considered hard and impervious while the tuffs and trachytes are relatively permeable allowing for water percolation (UNDP, 2007). Most of the

Nairobi area is underlain by volcanic and volcano clastic rocks of Pliocene age, which has bearing on the area's hydrology. Regarding ground water, Nairobi is underlain by volcanic rocks of Pliocene age, which have bearing on ground water. Major aquifers in the area are usually beneath the confining and deeply seated Upper Athi series. The Upper Athi series comprises of a heterogeneous combination of lakebed, re-worked sediments, air-fall tuffs, ashes and occasional intercalated lava flows (UNDP, 2007).

3.5 Hydrological Characteristics

The Nairobi Dam gets its water from the Motoine River while Ngong River is the outlet from the dam. Both Motoine and Ngong River systems are sub catchments of the Nairobi River Basin. The Motoine River rises from Ngong hills and flows through the Dagoretti forest, before pouring its waters into the Nairobi Dam, about 4 kilometres away from the source waters. The presence of clay sandy soils is derived from volcanic activities which result in good infiltration. Ngong stream rises from just above Jamuhuri International Trade Fair grounds at about 1,850 meters and drains into the Jamuhuri Dam (Kahara, 2002).Other five streams namely: Gatwereka, Olympic, Banker, Golf Course and Undungu, flow into the Nairobi dam through the Kibera slums (Primoz, 2010). Numerous natural water springs also contribute significant quantities of water into the dam.

3.6 Biophysical environment

Most of the indigenous vegetation that survives near the reservoir is of the dry semi-deciduous type (Trump, 1967).The dominant species are Croton megalocarpus and caledendrumcapense.

They include Themedatriandra, Eragrostrispynostachys, panicummaximu,setariaplicatalis and other scattered bushes and stunted trees, including the Barleriamicrantha, Grewiasimlis and Acacia species particularly on the western side. The Nairobi Dam is covered by Water hyacinth which is invasive species that thrive on the eutrophication of the dam caused by pollution from the surrounding area. However, it is important to mention that the hyacinth also plays a role in purification of the water before it drains into the Ngong River.

3.7 Human Geography

The human activities carried out in the study area that renders to the degradation are as discussed in Chapter 5 under the subheading 5.7 and is also aptly illustrated in plate 3.1 which shows how increasing population has rendered to the informal settlement of the kibera slum that encroach on the Nairobi dam.

Plate 3.1: View of Kibera slum from the dam.

Researcher 2013(26/12/2013)

CHAPTER FOUR
RESEARCH METHOLOGY

4.1 Introduction

This chapter discussed about the methods employed during data collection and data analysis and how the data was communicated to the interested parties. The research was undertaken in the regions surrounding the Nairobi dam.

4.2 Research design

The study employed a number of techniques and approaches which included field survey, case study and statistical analysis which enabled collection of relevant data for testing the research hypothesis. The study targeted various stakeholders who included residents living around the Nairobi dam, government agencies and non-governmental organisations which were in the study area.

4.3 Target population

The population from which the sample was drawn consisted of residents settled in the neighbourhood of the Nairobi (three locations out of the seven) dam which include: Langata Paradise Apartments, Dam Estate, Jonathan Ngeno estate, and High rise Estate and Kibera Laini Saba slums. Other persons interviewed included government officers from NEMA and WRMA. Random sampling method was used to ensure that each member of the target population had an equal and independent chance of being included in the sample.

Table 4.2: Population distribution and settlement pattern in Nairobi West (2009)

Division	**Pop 2009**	**Density 2009**
Kibera(five estates)	355,188	1,592

Source; Kenya Population and Housing Census (Population Census, 2009).

4.4 Sample Size and Sampling Procedures

The total population of the study area was 355,188. This population included all the five estates which included; Langata Paradise Apartments, Dam Estate, Jonathan Ngeno estate, and High rise Estate and Kibera Laini Saba slums. Cluster sampling was done based on administrative areas (7 locations).The seven locations which were used as cluster areas included; Kibera, Lang'ata, Karen, Mugumoini, Nairobi West, Laini Saba and Sarang'ombe. The clusters were based on the seven locations of the study area. The clusters had demographic and ecological characteristics. The seven clustered points were numbered and by use random sampling, the researcher came up with three divisions which were used for this study. The three locations included; Laini Saba, Sarang'ombe and Kibera. Since the population was large, the sample size was determined using a formula developed by Cochran (1963);

$$no = \frac{Z2pq}{e2}$$

Where:

$\mathbf{n_o}$ is the sample size

$\mathbf{Z^2}$ is the abscisca of the normal curve that cuts off an area at the tails (1- the desired confidence level).

e is the desired level of precision(sampling error)

P is the estimated proportion of an attribute that is present in a population.

Using the above formula, the assumed ***p***- value = 5 at a 95% confidence level.

A total of 385 residents were selected to be the sample of the study. Then the selection of an element was based on equal intervals, starting with randomly selected element on a population list which was collected from the areas provincial and presidents' administrative camp (chief).The questionnaires were administered to the 85 area residents who were selected randomly.

The samples of water from inlet, outlet and also from within the dam were collected. These water samples were transported to chemical laboratory and preserved with 1.5ml/L analar Conc. HNO3. The water samples were digested in Conc.3HNO3:HCl. Absorption spectrophotometer (AA-630) was used in the determinations of heavy metals (Pb, Cu, Cd, Ni).

4.5 Data collection procedure and instruments

Primary data was obtained from the field through questionnaires, interview schedules; observation and photos. The questionnaires were administered to the sampled residents of the Nairobi Dam and its surroundings. Questionnaires were also administered to government officers working at the Ministry of Environment, NEMA and WRMA.

The study used close ended questionnaires, as well as structured interviews which consisted of a number of questions done in a defined manner . Secondary data was collected through library research from such sources as academic journals, books, print and electronic media and also from unpublished works. Reports from conferences organized by various stakeholders and any other publications from them were utilized.

A lot of information was retrieved from government documents and International instruments such as the Kenya vision 2030, Ramsar Convention reports, and Population census of 2009 document.

4.5.1 Data on chemical pollution loads

The field method of collecting data was by use of a two litre container which was sterilised and rinsed with distilled water at the site. The water was collected on the mutoine river before joining the dam and in the dam before the water flowed out of the dam.

The methods used to test the various parameters specified in the results provided on table 5.6 the methods used to test the various parameters were as follows:

(a) For the BOD which tested the amount of oxygen required by bacteria while breaking down decomposable organic matter under aerobic conditions the procedure used was a bioassay-type procedure which measures the dissolved oxygen consumed by bacteria and other microbial life before and after the sample is diluted and incubated for a period of 5 days. The reduction of the BOD concentration during the incubation period was the measure used to calculate BOD. Calculation of the results was done using the azide modification method whose formula is as follows:

DO,mg/l= ml of tritrant used under the required conditions

$BOD=(D_1-D_2)/P$

Where:

D_1=DO in diluted sample before incubation

D_2=DO in diluted sample after incubation

P=decimal fraction of the sample in the BOD bottle

(b) In calculating the COD which test is a measure of the quantity of oxygen required to oxidise the organic matter in a waste water sample under specific conditions of oxidising agent, tenparature and time. During the determination of COD, organic matter was converted to carbon dioxide and water, amino nitrogen and organic nitrogen in higher oxidation. As a result COD values were greater than BOD values as indicated in the matrix containing the results. The formula used was as follows:

$$COD = \frac{(a-b) \times N \times 8000}{\text{Ml of sample}}$$

Where:

a=ml of tritant used for the blank

b=ml of tritant used for the sample

N=normality of tritant.

(c) The method used to test the Nitrate was the Nitrate method 3, where a solution of brucine, in concentrated sulphuric acid, is nitrated by nitrates to give a deep red colour fading to reddish-yellow;

(d) Fluoride was tested using the fluoride meter where the sample placed in an instrument was placed in a cuvet and the results were read;

(e) Sulphates was tested using various apparatus and reagents such as the magnetic stirrer, photometer, spectrophotometer, filter photometer, condition reagents, barium chloride and standard sulphate solution. The method for calculation used was:

$$SO_{4=} \frac{SO_{4} \times 1{,}000}{\text{sample}}$$

(f) In testing Hardness, total hardness and calcium hardness were calculated as follows:

Total hardness as mg $CaCo_3$/l (=ml EDTA x 20) where standard N/50 EDTA solution was used

Calcium hardness as mg CaC_3/l (= ml EDTA x 20) 4N sodium hydroxide

(g) Alkalinity 100ml of the sample was dropped in a phenolphthalein indicator solution. Phenolphthalein alkalinity is calculated as CaC_3/l by multiplying the volume of acid used to the end point by a factor of 10 and the total alkalinity is calculated using the total acid used.

(h) Solids such as the dissolved, suspended solids were calculated using the filter paper the fomular used to calculate was as follows:

TSS in mg/l=(wt obtained from (7) – wt obtained from (3) x 1000

ML of SAMPLE FILTERED

(i) The test for the Iron was conducted by diluting 5 ml of sample, 1ml of dilute hydrochloric acid and 2 drops of potassium permanganate solution into a separating funnel.5ml ammonium thiocyanate solution and 10ml of amyl acetate alcoholic solution is added and shaken thoroughly. The upper layer is transferred to a comparator cell and the process was repeated using distilled water instead of sample then calculated using the formula:

mg Fe/l(disc reading x 20)

(j) The pH or hydrogen iron concentration was tested using a pH meter;

(k) turbidity was measured by allowing the sample to warm up for about 110 minutes. The Formazin turbidity Units (FTU) ranges and a light shield were used.

(l) Chloride determination was done by adding 100ml sample and 1ml potassium chromate solution to a conical flask. The formula used:

Mg/l chloride (=ml silver x 10).

4.6 Data analysis techniques

The collected data ware analysed with a view to meeting the main objective of this study which was to assess the human impacts and their contribution to the degradation of the Nairobi Dam. Primary data was analysed using quantitative methods of environmental research. Presentation of the data was done descriptively using bar graphs, pie charts and even line graphs.

The nature of the data collected prompted the use of simple regression analysis. This was because regression analysis is used when two variables that are considered to be systematically connected by a linear relationship. Degradation of Nairobi dam was as a result of human activities as they are systematically connected by a linear relationship. The dependent variable was denoted as y while the independent variables were denoted as x. The relation between x and y was given by;

$$y = b_0 + b_1 x + e$$

Where y= is the dependent variable value

Finding the regression line: the method of “ordinary least squares” was done. Beginning with assumed values for b_0 and b_1 and it was proposed that the relation between x (human activities) and y (degradation of Nairobi dam) was given by;

$y = b_0 + b_1x$; some b_0’s and b_1’s gave us better fits than others

$y = a + b_xi$ the value of y was estimated by the regression equation when x had the value x_i; then if y_i was identified.

Analysis was done with the help of using data analysis software known as Statistical Package for Social Sciences (SPSS). The data collected was used to test the null hypotheses. The nature of the data which was collected prompted the use of regression analysis. This was because regression analysis is used when two or more variables are thought to be systematically connected by a linear relationship. Example is that there is a relationship between human activities (farming for example) and the degradation of Nairobi dam. The R value was calculated and R^2.Analysis of variance (ANOVA) was carried out and the calculated value was compared with the tabulated value.

Reading from critical values of students T- table was tested at 95% significance level (p = 0.05), in 49 degrees of freedom (n-1).The hypothesis was tested using the value that was calculated. The calculated value was higher than the tabulated value hence the null hypothesis was rejected.

CHAPTER FIVE
RESULTS AND DISCUSSION OF FINDINGS

5.1 Introduction

This chapter presents responses obtained from various participants in the research project. The responses that were obtained from various participants in the research project were analysed. The data was presented in tables, bar graphs and the hypothesis was tested.

5.2 Analysis of Data Collected

In Chapter one, an assumption was made that there are human impacts affecting the conservation of wetland. To test this study problem, data was collected from household residents neighbouring Nairobi Dam. The questionnaires were analyzed and the results were used to test the Hypothesis. The data collected through a questionnaire consisted of five sections. The first section of the questionnaire obtained data on general information of the respondents. The second section was about the functions of the wetlands. The third section looked into the environmental policy and its influence on environmental conservation. The fourth section assessed how different human activities can hinder the conservational efforts. And lastly the fifth section evaluated the measures that can be adopted to conserve the wetlands.

5.3 Response rate

A total of 85 questionnaires were distributed to the residents of Kibera region mainly the three locations which were Sarang'ombe, Kibera and Laini saba locations. The questionnaires that were collected back were 50 which was attributed to the fact that the some respondents did not return the remaining questionnaires. This represented 59% response rate. This was the sample size of the study area.

5.4 General information

This section presents information on the demographic data that was collected from the field. This includes data on gender, occupation and educational level of the respondents.

5.4.1 Gender

Information on gender distribution of the respondents was presented in the Table 5.1 shown

Table 5.1: Respondents by Gender

Gender	Frequency	Percent
Male	29	58.0
Female	21	42.0
Total	50	100.0

Source: Field research 2013

Data on gender in Table 5.1shows that majority (58%) of the participants were male while the female respondents were rated at (42%) based on the willingness and availability of the respondents. This portrays a relatively gender balanced sample population of the individuals who took part in the study. Male were more involved in the study because they did not shy away from being part of the study whose outcome would be used to salvage the wetland. This kind of disparity was not expected to bring any difference to the study as it was not the main area of concern by the research.

5.4.2 Occupation

The study sought information on the respondents' livelihood activities or economic occupation. The response was presented in table 5.2.

Table 5.2: Respondents Occupation

Occupation	Frequency	Percentage
Civil servant	15	30.0
Farmer	4	8.0
Wage earner	7	14.0
Business/investor	14	28.0
Others	10	20.0
Total	**50**	**100.0**

Source: Field research 2013

Table 5.2 generally shows that 70% of the respondents were in the category of individuals engaged in the informal sector while 30% were persons working in various sectors of the public service and residing around the Nairobi dam. In particular, 30% of the respondents

were civil servants, while 28% were business investors, the farmers and wage earners were represented by 8% and 14% respectively.

5.4.3 Level of Education

The respondents were asked to indicate their level of education. Their responses were presented in table 5.3.

Table 5.3: Level of Education

Level of Education	**Frequency**	**Percent**
Primary	9	18%.0
Secondary	17	34%.0
Tertiary	17	34%.0
University	7	14%.0
Total	**50**	**100%.0**

Source: Field research 2013

The study found that those who had acquired secondary and tertiary levels of education were rated at 34 % in each case. They we followed by those who had only the elementary education at 18% while 14% had university education level. This implies that all the respondents had substantial academic education which enabled them to interpret the effects of uncontrolled human activities on any environmental natural resource. Their higher literacy levels enabled them to participate and provide useful information through data collection instructions. This situation helped the researcher to obtain responses which were easier to analyse.

5.5 Chemical pollution loads in the dam water

In order to ascertain if the water contained some of the polluted mineral elements and to achieve the objective of water analysis, the researcher collected some water samples took them to the laboratory for testing.

The study found that the river water was heavily polluted with both organic and inorganic loadings and mainly due to household discharge into the river which flows into the dam and as a result pollutes the dam.

Table 5.4: Water quality analysis for water samples

Parameter	Result of the River Before Joining the Dam	Result of the Water in the Dam	Threshhold Value
pH	7.98	7.41	6.5-8.5
Apparent colour ^{o}H	320	150	-
True Colour ^{o}H	300	140	15
Conductivity µ/S/CM,mg/l	1068	922	
Turbidity, F.T.U	7.0	5.5	5.0
Calcium hardness AS $CaCo_3$,mg/l	142	102	
Total hardness AS $CaCo_3$,mg/l	224	112	500
Carbonate Alkalinity,mg/l	0	0	
Iron, mg/l	0.8	0.4	0.3
Fluorides, mg/l	0	1.3	1.5
Sulphates, mg/l	0	2	500
Nitrates	0.9	0.5	10
Chlorides, mg/l	301	200	250
Dissolved solids, mg/l	690	260	1500
Suspended solids	40	10	nil
Total solids, mg/l	730	270	1500
Biochemical Oxygen Demand, mg/l	240	29	30
Chemical Oxygen Demand	392	48	50

Source: Field research data 2013 (20/12/2013).

The result from table 5.6 shows the various parameters such as the biochemical oxygen demand of the river which joins into the Nairobi dam was 240 mg/l against the threshold of 30mg/l. This was a clear sign of pollution on the rivers before even the river entered the Nairobi dam. The chemical oxygen demand (COD) was 392 mg/l for the river and 48mg/l for the dam against a threshold of 50mg/l. The COD of the river was higher than the COD of the Nairobi dam. This can be explained in terms of water dormancy and the fact that the aquatic life in the dam may be purifying the water in the dam. When water enters the dam the chemical oxygen demand content reduces. In comparison with the UNEP (2003), the BOD was 640 mg/l during the wet season and the maximum average COD was 1317 mg/l. Therefore the level of pollution had considerably reduced though not to the required threshold as specified in the Fourth Column of the matrix containing the results. This was a clear indication that the water joining the dam was not as per the NEMA required standards for the water used for recreational purposes.

The data collection procedures and instruments are as contained in Chapter 4 under the subheading 4.5 on data collection procedures and instruments.

Plate 5.2: Motoini river before joining the Nairobi dam

Source: Researcher 2013(26/12/2013).

The dissolved solids at the river was 690 while at the dam itself it was 260 against the threshold of 1500.This showed that there was a lot of dumping of wastes along the river

before it entered the Nairobi dam. Also some of the solid wastes which were let into the stream may have contributed to these results.

5.6 Key socio-economic functions of Nairobi dam

The researcher sought to establish whether the water from the Nairobi Dam was of value to the community and the purpose for which the water was used. Some of the options given included; the response was given in the table 5.5 below.

Table 5.5: Key socio-economic functions of Nairobi dam

Is Nairobi Dam of any value to our society?		How do you use Nairobi Dam?			Total
		Farming	Recreation	Missing data	
	Yes	14	1	11	25
	No	0	0	24	25
Total		**14**	**1**	**35**	**50**

Source: Researcher 2013.

The table 5.7 shows that 50% (25) of the respondents considered the Nairobi dam to be of value to the society and similarly an equal proportion of 50% (25) of the respondents considered the dam to be of no value as shown. For those who felt that they derived some value from the dam, 28% (14) indicated that they used the dam for farming activities while another 2% (1) used it for irrigation. Those who find the dam useful are planting crops (maize and beans), vegetables, tomatoes and tree nurseries along the dam side to sustain their economic well being.

The respondents were asked to rank the functions/ value of Nairobi dam in their areas of residence. The ranking clusters were, 1- for most valued, 2- for averagely valued and 3 – least valued. The response was presented in table 5.7: According to the response given on table 5.7, the dam is least valued for holding religious and cultural functions at 100%. It is least used as a tourists attraction and cannot be used for recreational purposes at 98%, a source of fish and ineffective in ecosystems for carbon storage at 94% in each case. It is not used for purification of water and nutrients retention at 92%, the discharge and charge of water at

86%, habitation of biodiversity at 80% and controlling flooding arid soil erosion at 64%.However the dam was valued as a reliable source of water for domestic usage and irrigation at 80%, as an extra land for human settlement at 64%.

5.7 Human activities leading to degradation

The research sought to analyse some of the human activities leading to degradation of Nairobi dam.

Table 5.6 Valued Functions of the dam to the residents

Valued Functions of the dam to the residents	1	2	3
Control of flooding arid soil erosion	4%	32%	64%
Discharge and charge of water	-	14%	86%
Habitat of biodiversity		20%	80%
Effective ecosystems for carbon storage		6%	94%
Water Purification and Nutrient retention		8%	92%
Source of agricultural produce, fish, building materials, fuel wood, wildlife products	8%	52%	40%
Reliable source of water for domestic usage and irrigation	80%	20%	-
Source of income and employment	40%	54%	6%
Source of fish	-	6%	94%
Source of charcoals/timber/papyrus/Firewood	25	22%	76%
Good for Tourism and Recreation attraction	-	2%	98%
Holds Religious and Cultural Significance	-	-	100%
Provide forage for livestock	8%	58%	34%
Ideal and extra land for farming	58%	38%	4%
Dumping site for domestic and industrial waste	44%	50%	6%
Extra land for human settlement	12%	64%	24%

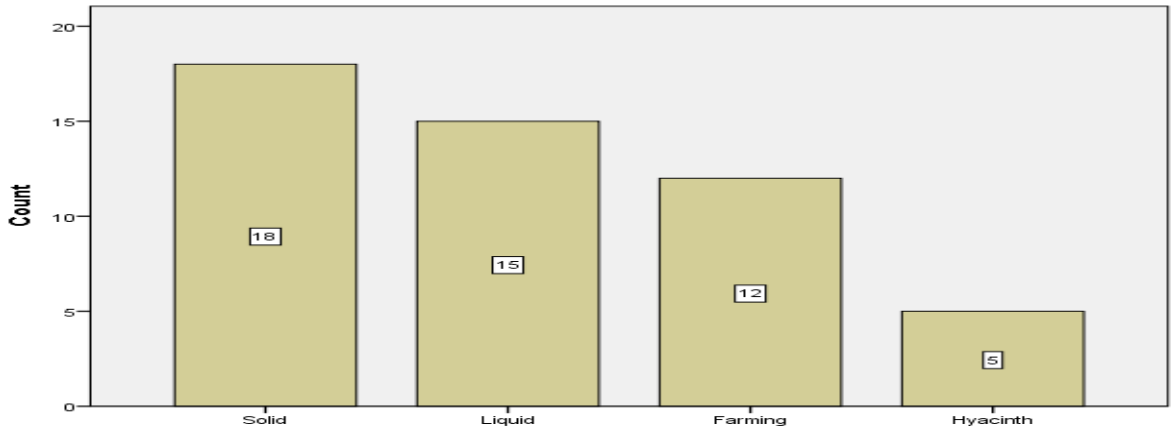
Source: Researcher 2013.

From table 5.8,the residents were asked to suggest the importance of the dam according to their perceptions. 64% strongly agreed that the dam's function was to Control of flooding arid soil

erosion. While 86% strongly agreed that its value was discharge and charge of water. The greatest value the community proposed was 100% for religious spiritual values.

The information as to whether there were any indications of encroachment and extraction of resources around the dam and those who were most involved in the encroachment and extraction. The response was presented as shown in figure below.

Figure 5.1: Indicators of encroachment and extraction of resources around Nairobi Dam



Source: Researcher, 2013

It was found that there is a very high level of encroachment into the Nairobi Dam mainly through dumping of wastes and expansion of settlement schemes by the communities living around the dam at a response rate of 36% (18). The dumping of liquid wastes and poor harvesting of waters from the dam was rated at 30% (15) where as small scale farming activities and the expansion of the hyacinth weed were ranked at 24% (12) and 10% respectively.

It shows that one of the greatest challenges to effective survival of the Nairobi dam is the expansion programmes to provided for more housing for the communities living around the dam and poor waste management where most nearly all the waste from the communities around the dam are dumped next to dam or eventually find their way into the dam through surface movement of dirty or rain water. Unfortunately, all these forms of encroachments were blamed on the residents around the dam.

5.7.1 Pollution from effluent discharges

The researcher undertook field investigations supported by laboratory analyses of sample obtained from the Motoine /Ngong River which joins into the dam and from the water in the dam. From the laboratory test it became clear that untreated waste water from the Kibera slum households is discharged into the river which flows into the dam and as a result pollutes the dam.

This is evident from the BOD level of the water in the river before it joins the dam which was 240mg/land the BOD level of the water in the dam which is 29 mg/l indicates that the water is polluted whereas the threshold value is 30mg/l. Waste water from houses being directed into the Nairobi dam is because there is no proper waste drainage system in the locality.

There was a variation in the level of pollution between the waters from the rivers and the water in the Dam. From the findings, the result shows that much of the waters from the rivers have deposits of garbage in the process of decomposition. The garbage is already rotten making the dam waters more toxic and darker in colour. While the waters in the dam are more clear and clean. Plate shows water from river before discharging into the dam.

The UNEP (2003) study report found out that the water samples collected from Motoine river, were stored and were analyzed for heavy metals: copper (Cu), Cadmium (Cd) and Nickel (Ni) concentration was done using atomic absorption spectrometer (APHA).The report found out that the water dam heavy metals were as follows; Lead was leading in percentage and the least was Nickel. Comparing with the current research the current study, the inorganic chemical elements have increased.

Plate 5.3: Water that has been discharged in the dam

Source: Researcher 2013 (26/12/2013).

Plate 5.4 shows the water in Nairobi dam. The water is contaminated and contains pollutional chemical elements. Also in the diagram the water hyacinth can be seen floating on the water.

5.7.2 Poor solid waste disposal around and within the dam

The findings shows a deplorable state of areas that surround the river as most of the waste are scattered within and around the dam without any proper disposal plan. These wastes continues to pile around the dam and there structures in place to dispose them further after they have been dumped along the dam. Plate 5.4 shows waste disposal within and around the dam.

Plate 5.4: Waste Disposal within and around the dam

Source: Researcher 2013

5.7.3 Presence of Water Hyacinth within the dam

The other greatest contributor to water degradation at the Nairobi dam is the invasion of the dam by the water hyacinth. The presence of water hyacinth along the dam has been presented in plate 5.5: The water hyacinth is strongly brought by the eutrophication processes which are part of the human activities leading to degradation of the dam. Eutrophication is frequently a result of nutrient pollution such as the release of sewage effluent and run-off from fertilizers into natural waters although it may also occur naturally in situations where nutrients accumulate (e.g. depositional environments) or where they flow into systems on an ephemeral basis. Eutrophication generally promotes excessive plant growth and decay, favours certain weedy species over others, and is likely to cause severe reductions in water quality.

Plate 5.5: Plate showing the extent to which water hyacinth has infested the Nairobi Dam.

Source: Researcher 2013 (26/12/2013)

5.7.4 Population Encroachment on the Dam

There is a very high level of human interference within the eco-system around the dam. Most of the people living around the dam are expanding their structures into the dam side blocking some of the rivers flowing into and from the dam and even constructing structures less than 20 meters from the dam. This is an indication that the level of human encroachment is on going and may reduce the distance further. Some structures are even constructed on top of some of the rivers separated by bridges. Figure 5.6 shows one of the settlement around the dam.

Plate 5.6: Photo showing human settlement next to dam

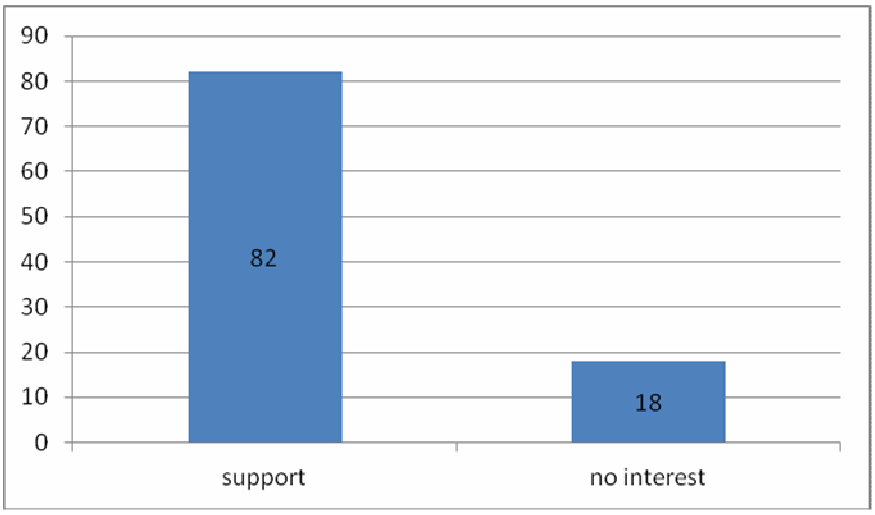
Source: Researcher 2013.

Policy dealing with pollution

The research sought to understand why the degradation of Nairobi dam continued and yet the Government and the non-government organisations were aware of the same. The players in the rehabilitation and conservation of the Nairobi dam include the local residents, the government agencies and the Non-governmental organizations. Figure 5.3 illustrates that 70% of the respondents agreed strongly that partnerships between government agencies and the local residents would be a worthwhile approach in the rehabilitation and conservation of the dam, 30% were of the opinion that there was poor structures in place and only 10% of the respondents had reservations on such partnerships.

The researcher sought to know if they were aware of any partnership in implementing conservation policy.

Figure 5.2: Support for Protection and Conservation strategies



Source: Researcher 2013.

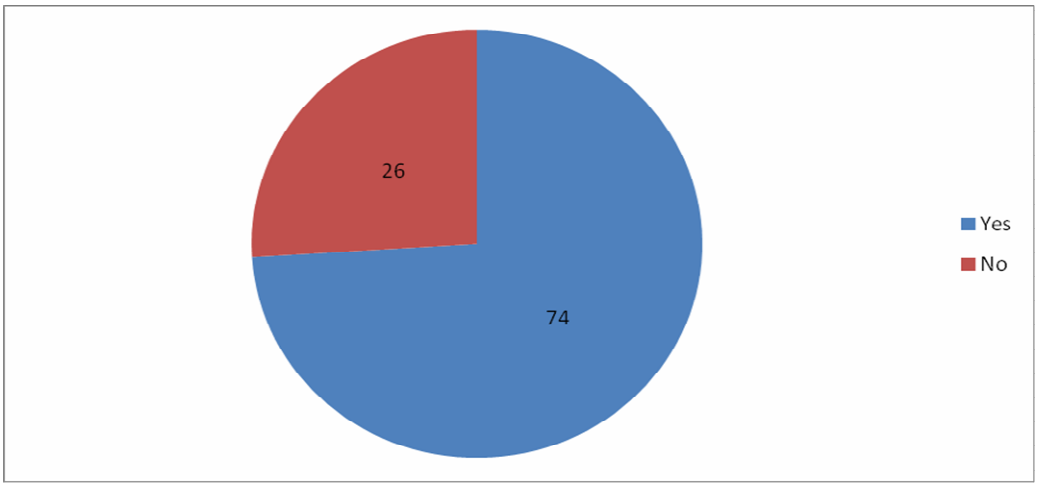
From the results shown above on 82% of the residents strongly were in agreement to support conservational measures of Nairobi dam. While some residents 18% were not interested with conservational measures because the facility had no meaning to them.

5.8 Harmonization of various sector policies and legal frameworks concerned with conservation programs.

From figure 5.7 harmonization of various policies and legal frameworks towards conservation, was indicated to be worthwhile, more enriching and would yield better results by 74% of the respondents. Only 14% of the respondents indicated they were not sure that the results of such harmonized efforts.

Figure 5.3: Harmonization of policies

The research sought to find out if there was harmony in the policy implementation



Source: Researcher 2013.

It can be deduced that harmonised effort would bring all stakeholders on board and they will own the process. The interviews gathered information that harmonised approach would also avoid the current costly duplication of activities but rather create better coordination in resource mobilization efforts, sharing ideas, opinions and views on the best way forward towards sustainable use of the Nairobi dam. Respondents preferred one co-ordinating body to spear head all the activities geared towards conservation and sustainable use of the wetland. Such a body would also be involved in publicity and sensitization campaign on responsible use of the wetland. Respondents were of the view that there is conflict and lack of common understanding among the government agencies WRMA and NEMA regarding the rehabilitation and conservation of the dam.

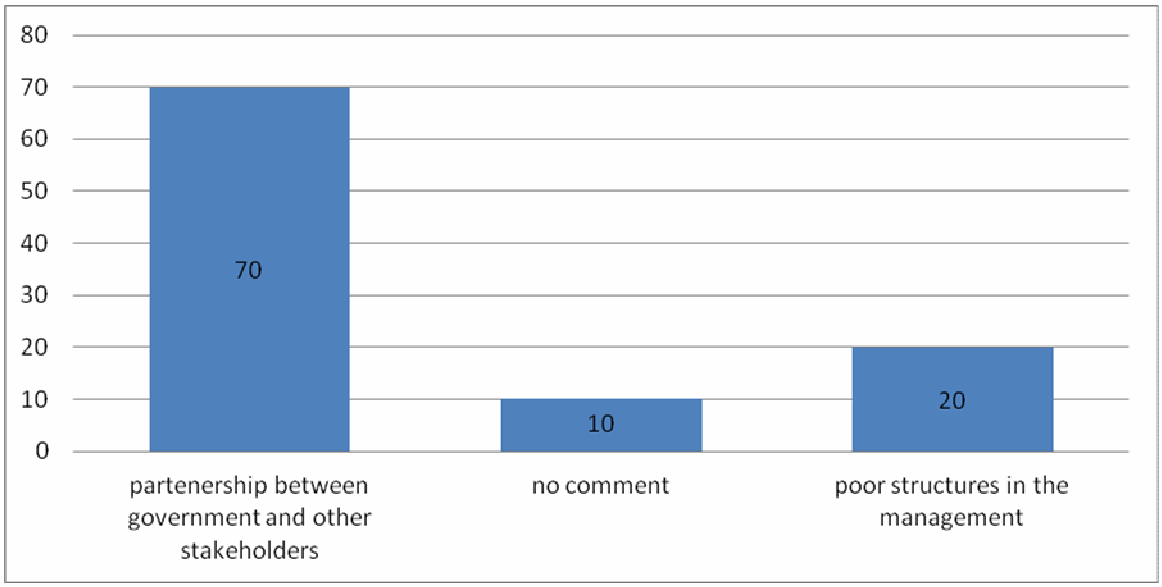
In view of the above 52% of the respondents were of the view that NGOs should coordinate harmonization of conservation strategies of the Nairobi dam and 26% felt that the government agencies should be the coordinators of the process of rehabilitation and conservation of the dam as shown in figure 5.14. Lack of harmonized approach was singled out as the prime responsible factor for current unsuccessful efforts in conservation measures. Inadequate environmental conservation sensitization and awareness, ineffective conservation and enforcement programs also emerged as other key issues which may hinder conservation efforts that may be conducted. From the findings, it also emerged that residents were not able

to comprehend the operations of the organizations which have been involved in conservation activities for the Nairobi dam .In general, respondents were of the view that harmonization of the conservation activities into one common front would stop the current ad hoc and haphazard policies which were used to be guzzling funds without results.

5.9 Rehabilitation and management measures

This objective sought to understand if there was some activity going on to curb the already deteriorating dam facility. The study sought to establish the measures used in the conservation and sustainable utilization of the Nairobi dam by asking the respondents whether people seek permission for extracting the natural resources around the dam. The response was presented in table below.

Figure 5.4: Rehabilitation and management measures



Source: Researcher 2013.

The players in the rehabilitation and conservation of the Nairobi dam include the local residents, the government agencies and the Non-governmental organizations. Fig 5.12 illustrates that 70% of the respondents agreed strongly that partnerships between government agencies and the local residents would be a worthwhile approach in the rehabilitation and conservation of the dam, 30% were of the opinion that there was poor structures in place and only 10% of the respondents had reservations on such partnerships.

Table 5.7: Measures for conservation of Nairobi Dam

Measures taken for conservation of the dam	Yes	Not sure	No
Seeking permission to extract resources around the dam	-	18	82
Existence of rules and regulations to guide against exploitation of the dam	-	22	78
Whether dam is lying idle and could be converted to better economical activities for the residents	94	-	6
Whether the dam has remained stable and secure over the years	6	-	94
Changes caused by human activities around the dam	100	-	-

Source: Researcher 2013.

The human activities within and around the dam have been the greatest threat to its survival at observed by all (100%) the respondents. The respondents indicated that it has been hard for the dam to remain secure and stable over the years due to poor urban planning and the ever growing population in Nairobi at 94%made worse by lack of control on the levels extraction and encroachment into the dam by the residents because they do not seek for permission before extraction at a response rate of 82%. At the same time 78 % of the respondents indicated that there are no rules and regulations to guide exploitation of the resources within and around the dam and therefore 94% of the respondents were of the opinion that the dam could be transformed into a more economical use instead of leaving it lying idle where as it is located in a very strategic position within Nairobi town.

5.10 Measures for conservation of Nairobi Dam

The residents were asked to give their views about the management of the dam.

Table 5.8: Measures for conservation of Nairobi Dam

Measures taken for conservation of the dam	Yes	Not sure	No
Seeking permission to extract resources around the dam	-	18%	82%
Existence of rules and regulations to guide against exploitation of the dam	-	22%	78%
Whether dam is was idle and could be converted to better economical activities for the residents	94%	-	6%
Whether the dam has remained stable and secure over the years	6%	-	94%

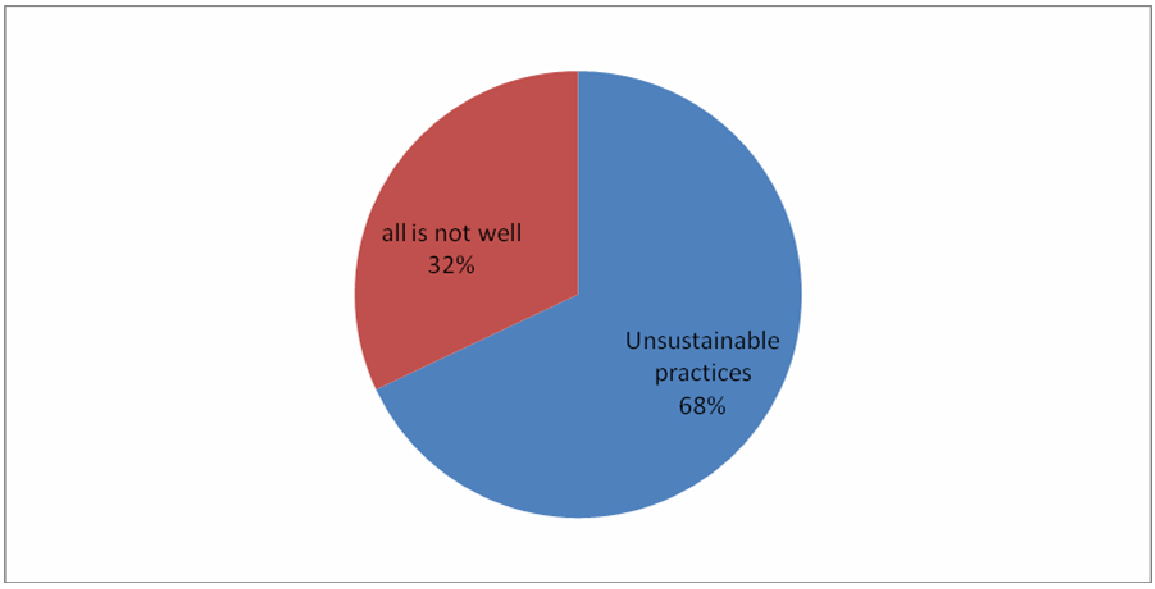
Source: Researcher 2013.

The human activities within and around the dam have been the greatest threat to its survival at observed by all (100%) the respondents. The respondents indicated that it has been hard for the dam to remain secure and stable over the years due to poor urban planning and the ever growing population in Nairobi at 94%made worse by lack of control on the levels extraction and encroachment into the dam by the residents because they do not seek for permission before extraction at a response rate of 82%. At the same time 78 % of the respondents indicated that there are no rules and regulations to guide exploitation of the resources within and around the dam and therefore 94% of the respondents were of the opinion that the dam could be transformed into a more economical use instead of leaving it lying idle where as it is located in a very strategic position within Nairobi town.

5.11 Existence of Monitoring Unit to authorize usage

When asked if there exist a monitoring unit to authorise any form of extraction or usage of the Nairobi dam, from Figure 5.7, only 26% of the respondents answered in the affirmative while 38% indicated that they were not sure of such a unit. 36% indicated that no such unit was in existence.

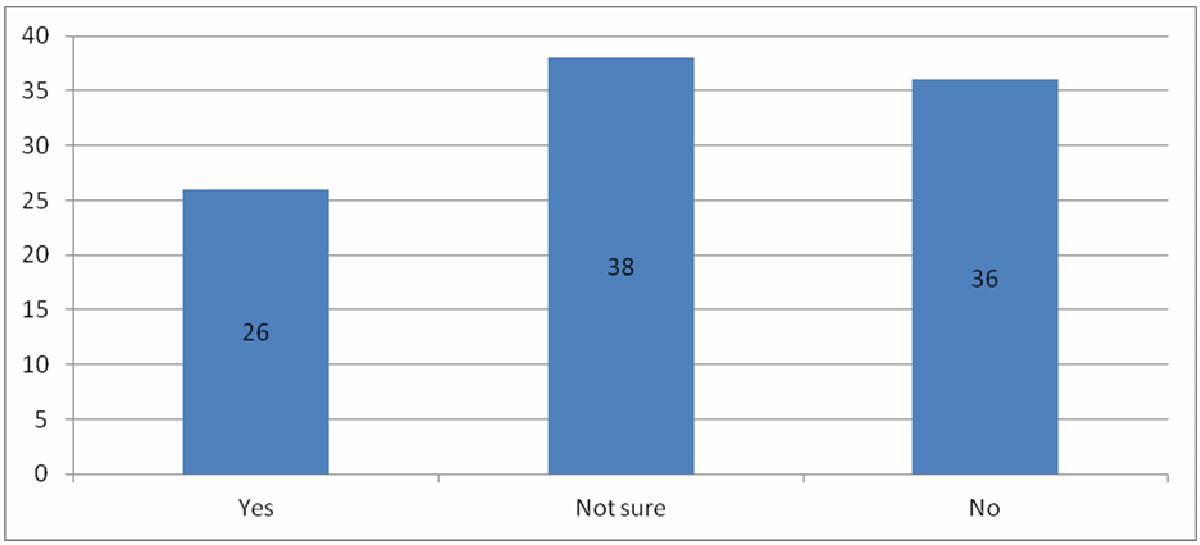
Figure 5.5: whether the dam is used in a sustainable manner



Source: Researcher 2013.

The interview recorded similar sentiments regarding the damage the wetland resources were experiencing if the current human activities were to remain unchecked and uncontrolled

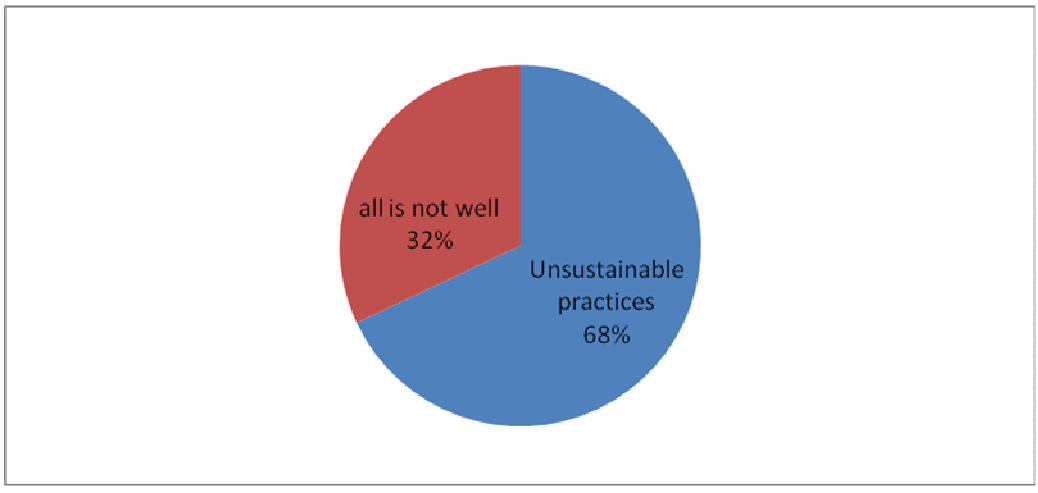
Figure 5.6: Existence of Monitoring Unit to authorize usage



Source: Researcher 2013.

In the interviews, NEMA WRMA and the Sailing club were mentioned as agencies which have failed to provide monitoring units to authorize any access to the wetlands. Both the questionnaires and the interviews established from the respondents that no monitoring agencies was effective in controlling the misuse of the wetland resource, yet NEMA is charged with the responsibility of implementing all policies relating to environment in the country. When asked if the Nairobi dam was being used in a sustainable manner, 32% of the respondents were of the opinion that all was not well while 68% indicated that unsustainable practices were visibly being conducted by the local residents such as the current uncontrolled human activities were a threat to the survival of the Nairobi dam as shown in figure 5.6.

Figure 5.7:Dam is used in a sustainable manner



Source: Researcher 2013.

The interview recorded similar sentiments regarding the damage the wetland resources were experiencing if the current human activities were to remain unchecked and controlled.

5.12 Awareness conservation campaign

Findings also established that the following factors were also contributing to delayed progress in conservation of the Nairobi dam. These include inadequate funding, lack of goodwill and support from the local residents, ineffective and inefficient conservation monitoring and law enforcement programs. The study found out that the residents were willing to be involved in any programs geared towards sustainable and wise use of the Nairobi dam. Respondents indicated they would participate in activities such as creating environmental conservation awareness in the community. Other stated that they were ready to practice sustainable utilizations of wetland at both individual and communal level to avert further damage of the Nairobi dam.

5.13 Hypothesis testing

5.13.1 Regression Analysis

The null hypothesis that was tested was as follows;

$H_{o:}$ There is no significance relationship between human activities and degradation of Nairobi dam.

$H_{o:}$ There is significance relationship between human activities and degradation of Nairobi dam.

The major hypothesis was tested to ascertain if there was correlation between the independent variables and the dependent variable. Regression analysis was chosen as the method of analysis because of the nature of the data that was collected. The variables showed some linear correlation.

In testing the hypothesis the researcher picked on the major factors of degradation around the dam. These were; pollution by industries, sewage and solid waste, water hyacinth, over-extraction of water for household and industrial use, agricultural encroachment and land reclamation due to population pressure and tested them against the dam management activities around the dam. The output was presented as follows.

Table 5.9: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.526	.777	.176	.180

a. Predictors: (Constant); is pollution by industries, sewage and solid wastes the most serious, water hyacinth, over-extraction of water for H/hold & industrial use, agricultural encroachment the most serious, is disposal of agro-chemical ssubstances the most serious, land reclamation due to population pressure .This variables were used as the independent variables

b. Dependent variable; degradation of Nairobi dam.

The R value shows a relative strong correlation 0.53 between human activities and degradation of Nairobi dam. The R squared shows the variations between thehuman activities and degradation of Nairobi dam.

It shows that 77.7 % of degradation around the dam can be accounted for bythe presence of effluents from industries, sewage and solid wastes, water hyacinth, over-extraction of water by households and industries, agricultural encroachment and settlement by the communities living around the dam. The other percentage (33.3%) can be accounted for other factors not considered in this test. This shows a very strong relationship between human activities and degradation of Nairobi dam.

Table 5.10: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.532	6	.089	2.747	.024
	Residual	1.388	43	.032		
	Total	1.920	49			

Source: Researcher 2013.

The ANOVA table shows the level of significance of the model. From the table the R value is 0.532, and the calculated total value is 1.920.Reading from the critical values of students T-table tested at 95% significance level (p = 0.05), in 49 degrees of freedom (n-1).The tabulated value was 1.68.Since the calculate value (1.920) was higher than the tabulated value (1.68),then we reject the null hypothesis and conclude that degradation of water in Nairobi dam is as a result of the human activities.

CHAPTER SIX
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

In this chapter, the most crucial points of concern highlighted in the previous chapters were summarized together with a number of conclusions. Recommendations have also been discussed. The problem statement under investigation in the study was to assess the impacts of human-induced activities on degradation of the Nairobi dam.

6.2 Summary of findings

It is clear that there are various forms of degradation of the Nairobi Dam. One is the discharge of liquid waste on the river flowing into the dam where the BOD of the Motoine river before entering the dam. The other cause of degradation of the Nairobi dam was the deposition of solid waste and household effluents on the dam which are generated by the residents of the Kibera, Sarang'ombe and Laini Saba slums. The water hyacinth and encroachment by human activities such as farming of cassava on the dam are other factors of degradation of the dam.

From the interviews it was clear that the farming on and around the Nairobi dam is the leading cause of degradation while the main purpose that Nairobi dam was meant for which was mainly for recreational purposes was the least valued. This meant that Nairobi dam was no longer used for its original purpose. Majority of the respondents indicated their awareness on matters relating to conservation and sustainable use of the Nairobi dam. The respondents affirmed that they would support and protect conservation strategies which would allow rehabilitation of the Nairobi dam and its ecological functions.

In addition, from the research the respondents strongly agreed that partnerships between government agencies and the local residents would be a worthwhile approach in the rehabilitation and conservation of the dam. However, only a few respondents had reservations on such partnerships. Harmonization of various policies and legal frameworks towards conservation was indicated to be of value.

6.3 Conclusion

In conclusion, from the findings it has been established that the human activities and policy issues and implementation contribute to the degradation of the Nairobi dam. Respondents acknowledged their participation in the continuous degradation of the Nairobi dam which was as a result of anthropogenic activities which resulted to the degradation thereof. Respondents noted that the numerous uncoordinated efforts to conserve the Dam by the different players have not yielded the desired results harmonization of the conservation activities into one common front which in effect has resulted wastage of resources. However, they were amenable to partner with the government or other persons in order to improve the condition of the dam and hence improve their livelihood.

6.4 Recommendations

The study has made efforts in recommending various measures which require to be undertaken to ensure that Nairobi dam regains its place in the socio-economic development of Nairobi and Kenya at large. Nairobi dam can be protected and regain its past glory as a major sporting, fishing and recreational facilities within the city precinct but this will require concerted efforts by all stakeholders and particularly the community living around the dam. The benefits of a clean dam will not only be enjoyed by people who live around the dam rather by more than 15 million people within the Athi river basin. The measures are as outlined below:

Planting trees and cleaning the river at the upstream in order to ensure that it is clean and free from contamination. Demolition of all the structures within the riparian reserve of the dam to and replace it with a green park which can be used for recreational facilities. The park shall enhance the aesthetics of the dam while ensuring compatibility of land-uses. Dredging of the dam to remove marshes and compacted solid waste within the dam shall ensure that the dam retains its pristine state and increases its capacity. Solid waste management should be developed with much emphasis on the Recycle Re-use and Reduce to ensure that the waste does not contaminate the dam. It is also envisaged to create employment.

Efforts to upgrade slum and provide sustainable housing will be a remarkable effort towards cleaning the dam. The upgrading may be followed by a network of sewer system to ensure that raw sewer does not flow into the dam. There should be well planned commercial

activities within the park to promote well provided recreational services while gaining revenue to protect the dam.

The research also recommends the government should prioritize the implementation of policy and laws while integrating the dam community in the implementation process. The government may also designate the dam as a Ramsar site in order to concentrate efforts to conserve the dam.

Strategic litigation would also go along way towards sensitization of the masses, enforcing the fundamental right enshrined in the Constitution on the right to a clean and healthy environment.

6.5 Suggestion for further research

The researcher suggests that there is need to have further research on the impact of the housing and settlements constructed adjacent to the Nairobi dam and their effects in conservational efforts.

From the research it was realised that there is a lapse in the policy process right from formulation to implementation. It is at this point the further research should be carried out on the influence of corruption on conservation.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

UNIVERSITY OF NAIROBI

DEPARTMENT OF GEOGAPHY AND ENVIRONMENTAL STUDIES

NAME: MARION MURIITHI

Year 2013.

Dear respondent,

I am a student at the University of Nairobi and I am conducting a research on "An assessment of human impacts on conservation of wetlands. A case study of Nairobi dam". This research is a requirement for the award of Master of Arts (MA) in Environmental planning and Management. Your answers and views will be treated with confidentiality and used only for academic purposes only.

Section 1: General Information

Date…….Questionnaire number……

Name of your Village…….Estate…….....

Sub-location…….

Please indicate the option correctly and diligently by putting a tick (√) against options provided in the boxes for each question. For the questions which require your suggestions/comments, use the space provided for each question. Kindly respond to all questionnaire items.

1. Indicate your gender. Male [ ] Female [ ]
2. What is your education level?
   1=None [ ] 2=Primary [ ] 3=Secondary [ ] 4=Tertiary [ ] University [ ]
3. Occupation (main source of income)
   1. Civil servant [ ] 4. Business/investor [ ]
   2. Farmer [ ] Other_____
   3. Wage earner [ ]

Section 2: Wetlands use information (benefits)

1. Do you consider Nairobi dam to be of any value to our society? Yes [ ] No [ ]

2. Which of the following function/values of wetland natural resources are appreciated in your area of residence? Rank attributes below according to considered importance, where 1 represent the most valued, 2 averagely valued and 3 the least valued.
   3. [ ] Control of flooding arid soil erosion
   4. [ ] Discharge and charge of water
   5. [ ] Habitat of biodiversity
   6. [ ] Effective ecosystems for carbon storage J
   7. [ ] Water Purification and Nutrient retention
   8. [ ] Source of agricultural produce, fish, building materials, fuel wood, wildlife products)
   9. [ ] Reliable source of water for domestic usage and irrigation
   10. [ ] Source of income and employment
   11. [ ] Source of fish
   12. [ ] Source of charcoals/timber/papyrus/Firewood
   13. [ ] Good for Tourism and Recreation attraction
   14. [ ] Holds Religious and Cultural Significance
   15. [ ] Provide forage for livestock
   16. [ ] Ideal and extra land for farming
   17. [ ] Dumping site for domestic and industrial waste
   18. [ ] Extra land for human settlement

   19. Are there visible signs indicating Nairobi dam resources are encroached and extracted for household or commercial purposes? [ ] yes [ ] No

   b).If yes, who is involved in extraction/usage of Nairobi Dam resources? (tick in the box)

   [ ] Local residents
   [ ] County government
   [ ] Local small-scale and large plantation farmers
   [ ] Foreigners and tourists
   [ ] NGOs
   [ ] Others, specify

Section 3: Environmental policy

(Please tick in the box)

1. Do people seek permission to extract natural resources from Nairobi Dam?
   Yes [ ] No [ ] Not sure [ ]
2. Are you aware of any rules and regulations to guard against exploitation of wetland natural resources? Yes [ ] No [ ] Not sure [ ]
3. Do you agree that Nairobi Dam is lying idle and could be converted to better economic activities beneficial the neighbouring community? Yes [ ] No [ ]
4. Has Nairobi Dam remained stable and secure over the years? Yes [ ] No [ ]
5. If No, are changes as a result of effect caused by various forms of human activities?
   Yes [ ] No[ ]

Section 4: Human activities on wetland degradation

1. Do you think unchecked over-exploitations and human activities have led to degradation and damaging effects on Nairobi Dam? Yes [ ] No [ ]

   b).If yes, rank the following human activities according to level of serious damage they have caused to Nairobi dam, where

   1 represent the most serious damage 2 average damage 3 the least serious damage

   [ ] Over fishing and poor fishing practices
   [ ] Disposal of agro-chemical substances
   [ ] Deforestation and trees harvesting for firewood, charcoal and timber
   [ ] Agricultural encroachment e.g. flower growing and subsistence farming
   [ ] Over-extraction of water for household and industrial use
   [ ] Sinking of bore-holes
   [ ] Vegetation over-harvesting e.g. pajyrus, fodders etc
   [ ] Reclaim the land for settlement due to population pressure
   [ ] Overgrazing.
   [ ] Destruction to get rid of mosquitoes
   [ ] Water Hyacinth
   [ ] Pollution by industries, sewage and solid wastes

2. Is there a monitoring unit expected to authorize any form of extraction or usage of Nairobi Dam natural resources? Yes [ ] No [ ] Not sure [ ]
3. Is yes, its effective in controlling misuse of the wetland resources? Yes [ ] No [ ]
4. Are you aware of any negative impact on Nairobi Dam resulting from unsustainable human activities around on its resources? [ ] Yes [ ] No
5. If yes, state negative impacts you have noted or you are aware of_____

Section 5: Wetland Conservation and Sustainable Utilization

1. In your opinion, is Nairobi Dam being used in a sustainable way? Yes [ ] No [ ]
2. Do you agree that current un-controlled human activities are a threat to Nairobi Dam ? Yes [ ] No[ ]
3. What is the level of conservation awareness among the local community? High [ ] Average [ ] Low[ ] Not sure [ ]
4. Would you support protection and conservation measures which allow maintenance of Wetlands and their functions? Yes [ ] No [ ]
5. Do you think the current conservation measures have been successful? Yes [ ] No [ ]

   b).If no, which of the following are possible reasons for the failure? Rank them; where 1 represent prime reason, 2 average reasons, 3 least reasons

   [ ] Inadequate funding

   [ ] Lack of good- will and support from local residents

   [ ] Lack of harmonized approach to forge common conservation strategies

   [ ] Ineffective conservation monitoring and enforcement programs

   [ ] Inadequate sensitization and conservation education
6. Who do you think should be responsible for wetland conservation programs?

   [ ] Government and its legal agencies [ ] NGOs [ ] Local community [ ] Not sure
7. In which ways would you wish to assist Nairobi Dam conservation efforts?

   [ ] Educating and creating awareness in the community

   [ ] Offer financial support

   [ ] Offer technical and professional expertise

   [ ] Practicing sustainable utilization of wetland at individual and communal levels.

8. Indicate any other views you may have regarding wetlands use and conservation strategies

_____

_____

_____

_____

_____