



**FLOOD MANAGEMENT AND CLIMATE CHANGE ADAPTATION IN KIBERA
INFORMAL SETTLEMENTS: THE CASE OF SILANGA VILLAGE**

By

**ELIZABETH KANINI WAMUCHIRU
B.A (Planning) Hons, University of Nairobi**

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
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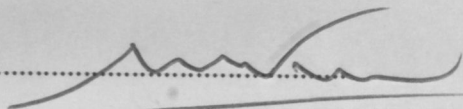
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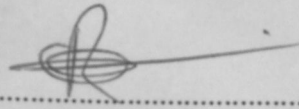
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PROF. ELIJAH NJUGUNA NDEGWA.

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MR. ROMANUS OTIENO OPIYO.

DEDICATION

To my late brother Anthony Njuguna, for the great inspiration u gave me.

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I extend my gratitude to the almighty God for the wisdom, knowledge, providence and good health that He bestowed upon me to complete my studies at the University.

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ABSTRACT

A warmer climate coupled with increased climate variability such as El Niño will significantly increase the risk of floods in poor countries in the developing world (IPCC, 2007). As rains become heavier, streams, rivers, and lakes overflow, increasing the flood risk of settlements located along the riparian land. Heavy downpours as experienced across the country recently led to loss of lives and properties and damage of critical infrastructure like roads, bridges, sewer and solid waste systems, triggering sewage overflows that spread into local waters. These are but some of the effects of flooding. This study looked into the flooding issues and climate change adaptation with specific focus on the urban informal settlements that are considered as the most vulnerable communities to the effects of climate change and flooding.

The area of study was Kibera informal settlement located in Nairobi; Kenya. A detailed study was conducted in Silanga, which is one of the fourteen villages forming the Kibera slums. Floods become a danger to this village when its populations move into areas that are prone to periodic flooding. These areas - called flood plains - are often along rivers. Development in flood plains has increased both the loss of life and property damage in the informal settlements of Silanga, with the main sources being the Ng'ong River, Gatwekera stream and the Nairobi dam which are adjacent to the settlement.

The study addresses the link between flooding and climate change adaptation while emphasizing the role of urban planning in promoting the adaptive capacity of the urban informal settlements. The study has brought out the importance of strengthening the different actors in urban flood management and formulation of policies in reference to flood management for the urban informal settlements.

The study was undertaken through a research methodology that employed both primary and secondary data collection. Primary data collection was conducted through filling in of household questionnaires, interviewing of key informants, expert observation and ethnography. The target population for primary data featured the households in Silanga Village, key informants from sampled civil societies and relevant government institutions dealing with flood management. Secondary data collection was based on previous research on climate change adaptation and flood management for the urban informal settlements through literature review.

The study established the vulnerability status of the people living in the urban informal settlements in regard to flooding and climate change. The local residents in the Silanga informal settlements often attempt to mitigate some of the dangers of living in the flood plain which has exposed them to physical, economic, social, and environmental vulnerability. This was manifested through use of temporal local coping mechanisms such as: compacted sand bags, unblocking of drainage channels and periodic migration during flooding. These strategies as discussed in the study report are considered as weak adaptive mechanisms which need to be upgraded and more sustainable solutions to be offered in line with climate change.

The framework recommended in the study proposes subsequent strengthening of the viable existing mechanisms such as conducting regular cleaning exercises, proper waste disposal and management, rehabilitation of the Ng'ong River and Nairobi dam, besides proposing new ways of managing floods and adapting to climate change such as introduction of climate proof housing units. The role of planning has been applied in coming up with a land use plan which restricts development into the riparian zones where flooding occurs regularly along Ng'ong river and the Nairobi dam for Kibera residents. An implementation matrix was developed to bring all the stakeholders required to manage floods together in order to build resilience of the urban informal settlements to flooding and climate change.

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- KMD- Kenya Metropolitan Development Authority
- KEWA- Ministry of water and irrigation
- KEWA/MD- Ministry of water and irrigation Management and Development
- NCCS- National Climate Change Research Strategy
- NADEMA- National Disaster Management Authority
- NGOs- Non-Governmental Organization
- UNEP- United Nations Environment Programme
- UNFCCC- United Nations Framework Convention on Climate Change
- UNEP- United Nations Environment Programme
- UNDP- United Nations Development Programme
- UNOCHA- United Nations Office for the Coordination of Humanitarian Affairs
- WMO- World Meteorological Organization

ACRONYMS

CBO-	Community Based Organization
DOC-	Disaster Operations Center
DMC-	Disaster Management Committees
EMCA-	Environmental Management and Coordination Act
GIS-	Geographical Information System
IPCC-	Intergovernmental Panel on Climate Change
IWRM-	Integrated Water Resource Management
ISDR-	International Strategy for Disaster Reduction
ICPAC-	IGAD Climate Predictions and Application Centre
KMD-	Kenya Meteorological Department
MWI-	Ministry of Water and Irrigation
MWRMD-	Ministry of Water Resources Management and Development
NCCRS-	National Climate Change Response Strategy
NADIMA-	National Disaster Management Authority
NGO-	Non- Governmental Organization
NRBP-	Nairobi River Basin Programme
UNFCCC-	United Nations Framework Convention on Climate Change
UNEP-	United Nations Environmental Programme
UNDP-	United Nations Development Programme
UNOCHA-	United Nations Office for the Coordination of Humanitarian Affairs
WMO-	World Meteorological Organization

CHAPTER ONE: INTRODUCTION

1.1 Background to the Problem

The issues of flood risk and flood recovery have moved up the political and scientific agendas in recent years following increased frequency and severity in flood incidents and the increased likelihood that this trend will continue as a consequence of climate change (Stern 2007; Pitt 2008; IPCC 2007). In the US, floods have already been identified as one of the most common and widespread natural disasters (FEMA, 2006). In the UK flood frequency has greatly increased in the last decade and is believed to continue to rise in the future (EA, 2004). According to IPCC (2007), "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level". These effects will, in turn, have potentially significant implications for human geography, quality of life, economic and financial systems and how people live (Stern 2007, GHF 2009).

The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) notes that a warmer climate coupled with increased climate variability such as El Niño will significantly increase the risk of floods in poor countries in the developing world (IPCC, 2007).

Climatic related disasters constitute over 70% of all disasters in Kenya. Floods are the leading hydro-meteorological disaster in East Africa. In Kenya, floods are emerging as the most prevalent climatic disaster (RoK, 2007; ISDR). The prevalence rates of floods in Kenya stands at 27% and affects 5% of the population affected by disasters. Floods related fatalities constitute a whopping 60% of disaster victims in Kenya (UNEP, 2009). This study is an assessment of the current efforts to address flood disaster risks and climate change, focusing particularly on aspects that can help build inter-linkage between flood disaster risk management and climate change adaptation in urban informal settlements.

The study will focus on informal settlement of Silanga Village in Kibera, Nairobi. Most people living in informal settlements suffer severe economic stress and poverty caused by low levels of education, lack of skills, lack of job opportunities and lack of basic infrastructure and services such as water, sanitation and drainage systems. This makes them to be at high risk of climate hazards. Informal settlements act as contributors of vulnerability to climate change and as those who have been largely impacted by climate

change. The latter is brought about by the effects of human land use activities that affect climate. This study aims to examine the climate change impacts of flooding as experienced in informal settlements and seeks to develop a framework for sustainable adaptation and mitigation practices in the settlements.

1.2 Problem Statement

Climate change will increase vulnerability of the urban poor throughout Africa. Already many are forced to live in hazardous places, building their homes and growing their food on floodplains in towns and cities. Others construct their shelters on steep, unstable hillsides, or along the foreshore on former mangrove swamps or tidal flats. Already vulnerable to destructive floods, damaging landslides or storm surges, climate change is making the situation of the urban poor worse (Action Aid, 2006).

Kenya has experienced serious incidents of flood and drought disasters, in different parts of the country and caused major disturbances, destroying property and resulting in loss of life. Floods occur due to natural factors like flash floods, river floods and coastal floods. They may also occur due to human manipulation of watersheds, drainage basins and flood plains. For example, in some cases floods have occurred in the river basins even with normal rains because of excess surface water runoff occasioned by deforestation, and land degradation upstream. Kenya is affected by floods following torrential rainfall. These force thousands of people living in the lowlands to move to higher grounds. The people affected are mostly in Western and Nyanza provinces and in Tana River District. However slum dwellers in towns like Nairobi who have erected informal structures near rivers are not spared (MWI, 2009).

Some of the flood risks and climate related challenges in Nairobi's Kibera slum include; flash floods, weak houses built with low quality building materials on riparian zones, diseases and epidemics, poor sanitation, lack of basic infrastructure such as drainage systems, poor solid and liquid waste disposal and management systems, inadequate access roads, and lastly low participation of slum dwellers in issues of climate change and water governance. This exposes them to vulnerability of flood risks with climate variability because there are no clear management/institutional structures, policies and strategies to facilitate adaptation and mitigation against the impacts of climate change on flooding in the informal settlement. The research problem is focusing on the assessment of the factors that put informal

settlement at vulnerability of flood disasters and the measures that are put in place to manage floods while adapting to climate change.

1.3 Purpose of the Study

The purpose of this study therefore is to assess the extent of vulnerability of the residents in the slum and the existing flood risk management including individual coping mechanisms. The research will then inform the formulation of a sustainable framework of flood management and climate change adaptation and mitigation measures in informal settlements.

1.4 Scope of the Study

The project covers one of the 14 villages that make up Kibera informal settlements. The village is Silanga and covers an area of approximately 0.2 km². This is the area bounded by Ng'ong river on the Northern side, Nairobi dam to the East, and borders Lindi village to the West. The study is limited to flooding issues as one of the climate change impacts in informal settlements.

1.5 Research Objectives

1. To assess the vulnerability status of Silanga informal settlements to flooding and its ability to manage floods.
2. To determine the existing adaptation strategies to flooding at household and neighbourhood levels in Silanga informal settlements.
3. To examine the roles of different actors responsible for urban flood management in Silanga informal settlements and establish the level of local participation in its governance and decision making.
4. To design a framework for a sustainable climate change adaptation and flood management in urban informal settlements.

1.6 Research Questions

1. What is the level of vulnerability of Kibera informal settlements to flooding and its ability to manage flood?
2. Who are the actors involved in flood risk management in Kibera informal settlements?
3. What role do the identified actors play in climate change adaption in relation to flood risk management in Kibera?
4. To what extent are the slum dwellers involved in decision making regarding the adaptive and mitigation measures to climate change related risks?
5. What mechanism do the actors and the Kibera community put in place to deal with climate change challenges particularly flood disasters in Silanga?
6. How can resilience and adaptive capacity among the vulnerable slum dwellers of Silanga village in Kibera be enhanced?

1.7 Research Assumptions

1. There are no institutional frameworks for flood management in urban informal settlements in Kenya.
2. There is low level of awareness on climate change impacts among the local residents of Kibera informal settlements.
3. Slum upgrading will be undertaken in Kibera informal settlement and it will not remain to be slum.

1.8 Justification and Significance of the Study

The study is justified in that there are inadequate previous studies which have been conducted linking climate change to flooding and how these issues are articulated in the legal and institutional framework for the urban informal settlements in Kenya. The knowledge gap in flood management for the urban informal settlement is critical in availing important information on methods of raising the resilience of the urban informal settlements to climate related disasters.

The study is significant in the field of planning as it will elevate the mainstreaming of climate related issues in development of sound and sustainable policies and plans for the urban informal settlements across the country. The research will be useful in the countrywide slum upgrading projects which the research assumes will also take place in Kibera. On the institutional and legal front, the study will

inform the relevant authorities on the requirements for a comprehensive flood management policy formulation process and framework for the urban informal settlements. The study findings will indicate the benefits of putting flood management measures in place and the possible effects of not doing so.

The focus is on informal settlements since slum dwellers are at higher risk of climate change impacts. This is because generally slums are situated on hazardous sites such as low areas or steep slopes, unstable grounds which are vulnerable to destructive flooding. This calls for robust measure to manage the effects of urban flooding collectively thus, helping improving the living standards in the informal settlements across the country.

The IPCC report, *The Regional Impacts of Climate Change: An Assessment of Vulnerability* (Watson et al 1996), argues that the vulnerability of a region depends to a great extent on its wealth, and that poverty limits adaptive capabilities. According to the *Second Assessment Report*, vulnerability depends on the level of economic development and institutions. The report argues that socio-economic systems "typically are more vulnerable in developing countries where economic and institutional circumstances are less favourable" (Watson et al, 1996: 24). The report continues that vulnerability is highest where there is "the greatest sensitivity to climate change and the least adaptability."

A working definition of vulnerability therefore is the degree to which a group of people in a city (e.g. urban poor) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, as well as the sensitivity and adaptive capacity of that system. Vulnerability is a concept that links the relationship that people have with their

CHAPTER TWO: LITERATURE REVIEW

2.1 Definition of Terms and Variables

This section provides definitions of major terms as used in this research project report. The definitions are drawn from literature reviewed and sources are acknowledged.

2.1.1 The Concept of Vulnerability: Definitions and Issues

The Intergovernmental Panel on Climate Change (IPCC), in its Second Assessment Report, defines vulnerability as “the extent to which climate change may damage or harm a system.” It adds that vulnerability “depends not only on a system’s sensitivity, but also on its ability to adapt to new climatic conditions” (Watson et al. 1996: 23). In a presentation made at the Sixth Conference of the Parties to the UNFCCC (COP-6), Robert T. Watson, Chair of the IPCC, defined vulnerability as: the extent to which a natural or social system is susceptible to sustaining damage from climate change, and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate and the ability to adapt the system to changes in climate. Hence, a highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained (IPCC, 2000a).

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environment to social forces and institutions and the cultural values that sustain and contest them. Vulnerability is a set of conditions and processes resulting from physical, social, economic and environmental factors that increase the susceptibility of a community to the impact of hazards. Vulnerability also encompasses the idea of response and coping, since it is determined by the potential of a community to react and withstand a disaster.

Damage potential + coping capacity = regional vulnerability.

The Ecological Dimension of vulnerability acknowledges ecosystem or environmental vulnerability or fragility. In the case of ecological vulnerability, it is important to find out how different kinds of natural environments cope with and recover from different hazards. Kibera is on a flood plain land prone to flooding thus, experiences ecological vulnerability.

The Social Dimension of vulnerability acknowledges the vulnerability of people, and the emphasis is on coping capacity. Especially weak and poor population groups are considered vulnerable. Social vulnerability has to do with the different features of human beings. Blaikie et al. (1994) argue that the most vulnerable groups are those who find it hardest to reconstruct their livelihood after a disaster. They find that, as a rule, the poor suffer more from hazards than the rich (Yohe & Tol 2001). The time dimension is relevant since reconstruction in poor areas can take a long time, which affects the economy and livelihood of the area drastically. Further, the poorer population groups do not always have a choice of where to locate, thus they might have to live in risky areas, for example on a muddy hillside or a flood plain just like the case in Kibera informal settlements.

Cannon et al. (2003) see social vulnerability as a complex set of characteristics that includes a person's initial wellbeing, livelihood and resilience, self-protection, social protection and social and political networks and institutions. Cutter et al. (2003) define social vulnerability as "a multidimensional concept that helps identify those characteristics and experiences of communities (and individuals) that enable them to respond and recover from natural hazards".

Social vulnerability includes both social inequalities (social factors that influence the susceptibility of population groups to harm and that affect their ability to respond) and place equalities (characteristics of communities and the built environment, such as level of urbanization and economic vitality). This definition includes both the social and economic vulnerability dimensions.

Physical exposure refers to the number of people located in areas where hazardous events occur combined with the frequency of hazard events. In this dimension, population density is not seen as an indicator of vulnerability, but a condition for a disaster risk to exist. Vulnerability explains why, with a

given level of exposure, people are more or less at risk. Vulnerability refers to the different variables that make people less able to absorb the impact and recover from a hazard event. These may be economic (lack of reserves), social (weak social organization), technical (poorly constructed housing) or environmental (fragility of ecosystems).

The hazards-of-place model of vulnerability has an explicit focus on locality, since it depicts the overall situation and elements contributing to the vulnerability of a specific geographical area.

The hazard potential is filtered through the geographic context (site and situation, proximity) and the social fabric of society (socioeconomic Biophysical vulnerability and social vulnerability together form the overall place vulnerability).

2.1.2 Concept of Adaptation

Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC TAR, 2001 a).

Adaptation - Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change. For example, flood walls should be built and in numerous cases it is probably advisable to move human settlements out of flood plains and other low-lying areas...”(Website of the UNFCCC Secretariat).

Adaptation - Is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2005).

Adaptation - The process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits associated with climate variability and climate change. (UK Climate Impact Programme (UKCIP, 2003).

Adaptive Capacity – The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. (IPCC TAR, 2001 a).

Adaptive Capacity – Is the property of a system to adjust its characteristics or behaviour, in order to expand its coping range under existing climate variability, or future climate conditions. The expression of adaptive capacity as actions that lead to adaptation can serve to enhance a system’s coping capacity and increase its coping range thereby reducing its vulnerability to climate hazards. The adaptive capacity

inherent in a system represents the set of resources available for adaptation, as well as the ability or capacity of that system to use these resources effectively in the pursuit of adaptation. It is possible to differentiate between adaptive potential, a theoretical upper boundary of responses based on global expertise and anticipated developments within the planning horizon of the assessment, and adaptive capacity that is constrained by existing information, technology and resources of the system under consideration (UNDP, 2005)

Adaptive Capacity – The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in climatic conditions. (UKCIP, 2003)

Capacity – A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. (Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability (UN/ISDR, 2004).

Coping Capacity – The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards (UN/ISDR, 2004).

Coping Capacity – Capacity refers to the manner in which people and organizations use existing resources to achieve various beneficial ends during unusual, abnormal, and adverse conditions of a disaster event or process. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and other hazards (European Spatial Planning Observation Network).

2.1.3 Concept of Climate Change

Climate Change – Refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC TAR, 2001 a).

Climate Change – Refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land-use (IPCC TAR, 2001 b).

Climate Change – The climate of a place or region is changed if over an extended period (typically decades or longer) there is a statistically significant change in measurements of either the mean state or variability of the climate for that place or region. (Changes in climate may be due to natural processes or to persistent anthropogenic changes in atmosphere or in land use. (UN/ISDR, 2004).

2.1.4 Concept of Resilience

Resilience – Amount of change a system can undergo without changing state (IPCC, TAR, 2001).

Resilience – Resilience is a tendency to maintain integrity when subject to disturbance (UNDP, 2005).

Resilience – The ability of a system to recover from the effect of an extreme load that may have caused harm (UKCIP, 2003).

Resilience – The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures (UN/ISDR, 2004).

Resilience – Refers to three conditions that enable social or ecological systems to bounce back after a shock. The conditions are: ability to self-organize, ability to buffer disturbance and capacity for learning and adapting (Tompkins E. et al. 2005).

Resilience is thus the inherent ability of a city or town and its citizens to withstand impacts and rebuild or re-organize itself when necessary.

2.1.5 Mainstreaming

Mainstreaming refers to the integration of adaptation objectives, strategies, policies, measures or operations such that they become part of the national and regional development policies, processes and budgets at all levels and stages (UNDP, 2005). The term is also used to describe the process of integrating adaptation to climate change into development assistance (e.g., Agrawala (2005), Klein (2002)). The process by which climate risks to city plans, programs, activities and policies are considered and adjusted to address these risks. Mainstreaming assumes that other projects can be enhanced for example, poverty reduction, urban sustainability, etc. and their benefits increased by integrating climate planning with them. Mainstreaming helps ensure that a city's plans and policies are not at odds with climate risks now and in the future.

2.1.6 Operational Definition of Terms

Mitigation activities which help to reduce the rate and/or magnitude of climate change by helping reduce human-generated greenhouse gas emissions and/ or land use practices that exacerbate global warming (e.g. deforestation). Cities consume most of the global energy supply and subsequently are responsible for a significant proportion of GHG emissions. Therefore cities must be leaders in mitigating climate change, containing urban areas to minimize land clearing, and ‘de-carbonizing’ energy systems (e.g., the energy used for transportation, electricity, heating, industrial processes, and waste disposal).

Exposure: Is a measure describing the external stress brought about by climate change threats (sea level rise, change in temperature, change in precipitation and extreme weather events) in relation to population, resources and property.

Impact: An effect of climate change on the structure or function of a city or town.

Integration: An approach to climate change planning that considers larger and related sustainability issues (i.e., economic, social, governance, environmental, etc.). Integrated planning and action can deliver efficiency and effectiveness by adding value through policies, programs, plans and actions that support, rather than undercut, each other.

Sensitivity: Describes the degree to which a system is affected by the biophysical impact of climate change. It considers the socio-economic context of the system being assessed.

Risk is the possibility of incurring a misfortune or a loss.

Strategic planning: A systematic, transparent and objective decision-making process that provides a process to determine priorities, make wise choices and allocate scarce resources (i.e., time, money, skills) to achieve agreed-upon objectives.

Participatory Planning: A community-based planning approach that works to involve all sectors of a community with a stake in climate planning, including local governments, the private sector, voluntary agencies and civil society.

2.2 Climate Change and Flooding Relationship

This study assumes that there is a relationship between climate change and flooding. The following section provides a background on how climate change impacts on flooding.

Climate change has the potential to increase flooding in three ways:

Sea Level Rise: Climate change is causing higher sea levels due to increased and growing glacial and polar ice melt. It is also causing sea levels to rise by warming the oceans themselves, which causes their overall volume to increase. There are estimates from the United Nations that sea levels could rise between 18cm and 59cm by the end of the 21st century. In combination with the increased frequency and magnitude of marine storms, including cyclones, typhoons, and hurricanes, storm surges associated with these events are becoming larger and more damaging. Currently, about 13 percent of the world's urban population (around 360 million people) live in the low-elevation coastal zones (i.e., less than 10-metres above sea level) and an estimated 10-million people are currently affected each year by coastal flooding.

The impacts of sea level rise on a given city will vary depending upon its location (i.e., sea level rise will not be uniform and forecast rises are different around the globe) and level of development (i.e., some cities may have built sea walls or preserved protective coastal areas like mangrove forests, while other cities have coastlines that are more prone to erosion). Planners, of course, are key players in determining appropriate actions to reduce vulnerability including: the location and scale of marine defenses like sea walls; the identification and avoidance of development in sea level rise hazard areas (or ensuring that new development in hazard prone areas can withstand storm surges and related hazards); and the identification and protection of shoreline areas (like mangrove forests) that provide a natural defense for storm surges and coastal flooding (while providing mitigation benefits).

Increased/Intensified Rainfall: Most climate scientists agree that intense, heavy rainfall events are likely to increase in frequency and magnitude in certain parts of the world because of climate change. Due to the large amount of impermeable surface areas (roads, buildings, paved areas) in cities and towns, places with inadequately designed or limited storm sewer and drainage systems will be faced with flooding during these storm events. Damages and health impacts will be compounded in areas with open sewage ditches and/or a combined sewer-storm water system that tend to be overwhelmed during storms and introduce raw sewage into the flood waters. There is a growing body of research that indicates increased rates of injury and death from flooding in urban areas (especially in Africa, Asia, Latin America and the Caribbean) with inadequate drainage and flood protection systems. The impacts of increased/intensified rainfall will vary depending upon the region (i.e., different regions are forecast to be more subject to increased/intensified rainfall than other areas) and the urban area's level of development and infrastructure. For example, some lesser-developed cities may have more pervious or

unpaved areas where rainfall can be more easily absorbed (absorption rates will depend on how parched the unpaved or pervious land is). Other cities may have more developed storm water management systems and infrastructure with which to manage the increased/intensified rainfall events, although the intensity of the events may well overwhelm even the most comprehensive systems. Planners play an important role in the development and upkeep of storm water systems and can help make sure that new roads, buildings and infrastructure include storm water features (e.g infiltration areas, pervious surfaces, impoundment areas, rainwater gardens) in those regions facing increased/intensified rainfall episodes.

Increased/Intensified River Flooding: Increased and intensified rainfall from storms and, in certain places, bigger river flows due to increased glacial melt due to climate change, ultimately leads to higher incidences of rivers overflowing their banks. This type of flooding has been increasing in urban areas, particularly those in low-lying areas or delta. UN-sponsored research indicates increased runoff and earlier spring melts in many glacier and snow fed rivers may be compounding this situation.

As with the other areas explored in the flooding theme, the impacts of river flooding vary depending upon the region (i.e., some cities are located on river deltas, river confluences, or around larger rivers) and the level of development (i.e., some cities may have built protective dikes or controlled development in the flood plain). Planners are key players in determining the location and scale of river dikes and other flood management systems. Local land use plans and enforcement can also regulate the location, type and scale of development in flood plains.

2.3 Climate Change and Flooding in Kenya

Variability in climate change alongside socio economic and environmental developments is having a major impact in the developing world and particularly affects the poor in those regions. The third Assessment Report (IPCC; 2001) concludes that settlements are among the human systems that are the most sensitive to climate variability and change.

Flood producing rains in Kenya are often driven by complex climatic variability phenomenon such as the El Niño Southern Oscillation (ENSO) and tropical storms (Ogallo, 1988; 1989;1993) cited in ICPAC (2007) notes that specific floods in Kenya have been associated with El Niño. Kenya was amongst the 16 worst affected tropical and Pacific Rim countries during the 1997/98 El Niño (Gadain, 2006; Glantz, 2001).

Urban floods result from over spilling or surface pending or when urban storm water drains become surcharged and over flow (Smith and Ward, 1998). Urban floods are common in major cities and towns in Kenya including Nairobi, Mombasa, Kisumu, Nakuru, and Garissa. Many of these urban areas experienced floods during the El Niño rains of 1997-98. The cause of urban floods in Kenya is mainly poorly maintained drainage systems. Urban floods mainly affect residents of informal settlements (slums) mushrooming in the country's major cities (ICPAC, 2007; UN/OCHA, 2006).

2.4 The Case of Flooding in Kenya

This section gives a glimpse of cases of flooding as per the ministry of water and irrigation reports. Kenya is affected by floods following torrential rainfall. These force thousands of people living in the lowlands to move to higher grounds. The people who are mostly affected by floods live in Western and Nyanza Provinces and in Tana River district. However slum dwellers in towns like Nairobi who have erected informal structures near rivers are not spared (MWI, 2009).

Kenya's record of flood disasters indicates the worst floods recorded in 1961-62 and 1997-98, the latter ones being the most intense, most widespread and the most severe. During this season the flooding was associated with the El Nino phenomenon, a weather pattern that affects most parts of the world. El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe. It may cause increased rainfall in some areas and drought in others thus changing the normal weather pattern.

2.5 Areas Most Affected by Floods in Kenya

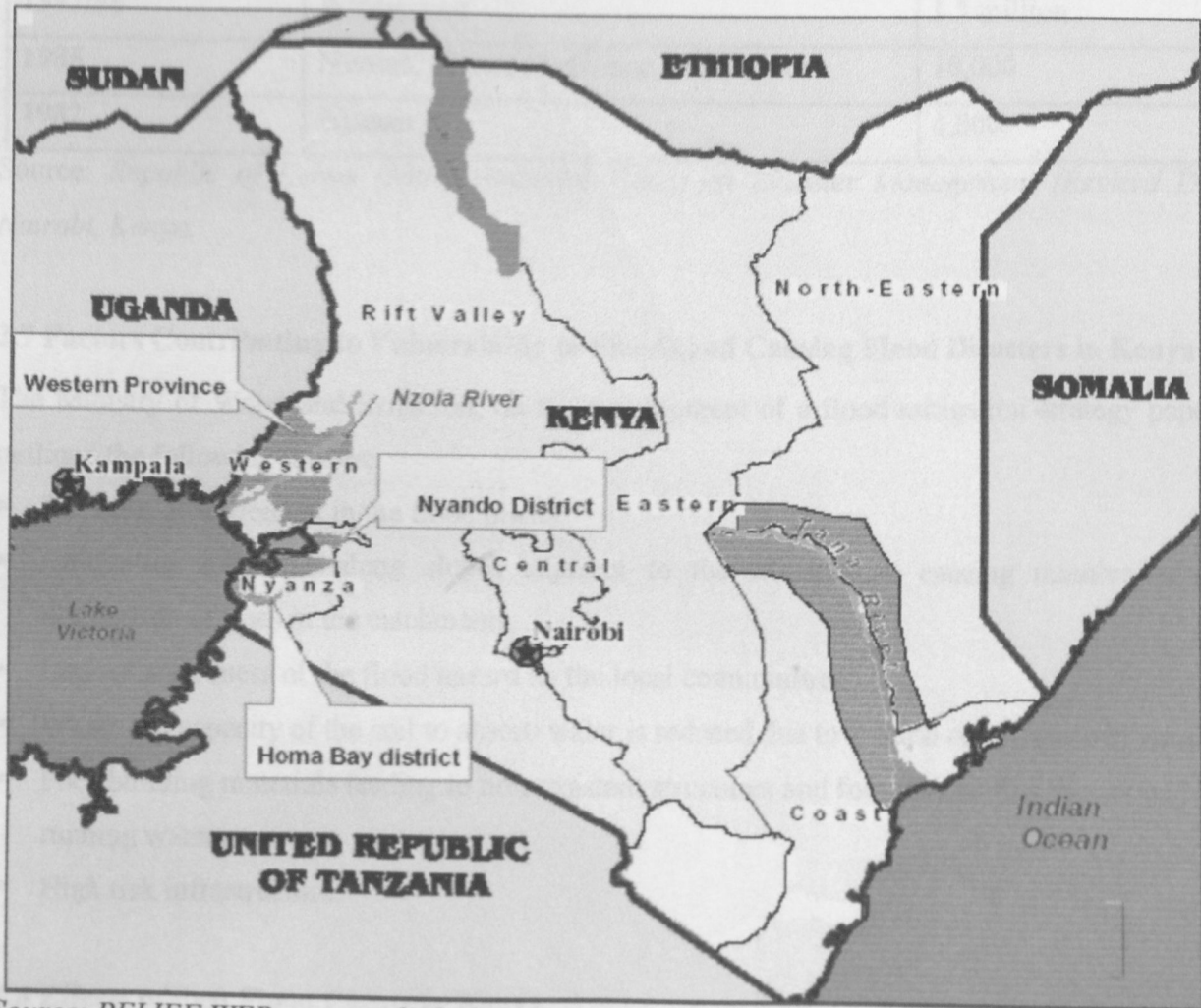
Most parts of the nation experience river floods which are slow onset and mostly predictable. However some parts experience more severe floods than others including most parts of Kano plains (Nyando District) and Nyatike (Migori District) in Nyanza province, Bundalangi in Western province resulting from River Nzoia and the lower parts of Tana River.

The specific areas that experience floods almost annually include:

1. Nyanza Province – Kano plains, Nyakach area, Rachuonyo and Migori.
2. Western Province – Budalangi.
3. Coast Province – Kilifi, Kwale and the Tana River Basin.
4. North Eastern province – Garissa, Wajir, and Ijara.

- 5. Urban Centres – Nairobi, Nakuru, Mombasa, Kisumu.
- 6. Tana River district (the Lower parts).

Map 2.1 Kenya's Flood Prone Areas



Source: RELIEF WEB : www.reliefweb.int; maps- Kenya

N/B the flood prone areas are highlighted in red.

Table 2.1: Recent History of Floods in Kenya

Year	Area Affected	No of People Affected
2003	Nyanza, Busia, Tana River	170,000
2002	Nyanza, Busia, Tana River	150,000
1997/98	Widespread	1.5 million
1985	Nyanza, Western Province, Tana River	10,000
1982	Nyanza	4,000

Source: Republic of Kenya (2004), *National Policy on Disaster Management (Revised Draft)* p4, Nairobi, Kenya.

2.7 Factors Contributing to Vulnerability to Floods and Causing Flood Disasters in Kenya

The Ministry of Water and Irrigation, on the development of a flood mitigation strategy paper , 2009 outlined the following factors:

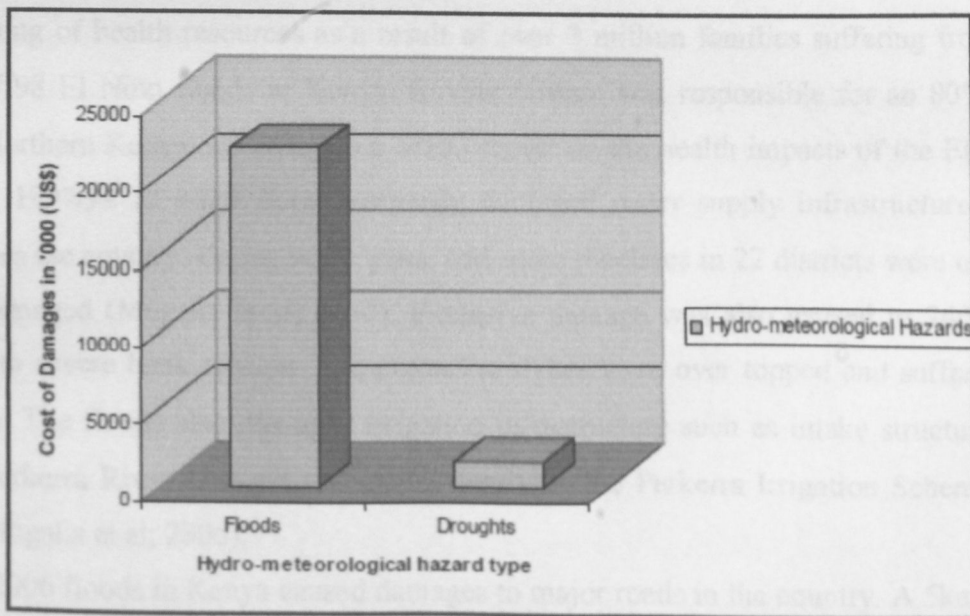
- Location of settlement in the flood plains,
- Cultivation of crops along slopes adjacent to the floodplains, causing massive erosion and destruction of trees in the catchments,
- Lack of awareness of the flood hazard by the local communities,
- Where the capacity of the soil to absorb water is reduced due to erosion or existence of concrete,
- Poor building materials leading to non-resistant structures and foundations that cannot withstand the running waters,
- High risk infrastructure.

2.8 Effects of Past Flood Events in Kenya

It is clear that climate change will, in many parts of the world, adversely affect socio-economic sectors, including water resources, agriculture, forestry, fisheries and human settlements, ecological systems, and human health, with developing countries being the most vulnerable. (IPCC 2000a). Developing countries have lesser capacity to adapt and are more vulnerable to climate change damages, just as they are to other stresses. This condition is most extreme among the poorest people. (IPCC 2001: 8). Kenya is a developing country that shares the common developmental challenges with other African countries. Silanga Village is a low income settlement area and is most vulnerable to the effects of flooding.

An initial scoping study on the economic impacts of climate change in Kenya estimated that extreme floods and drought events have the potential to reduce the country's GDP by about 2.4% per annum. In the last three decades, flood losses in Kenya have been increasing tremendously as compared to drought losses. Figure 2.1 indicates the high cost of floods in the country between 1964 and 2004 as compared to droughts. The 1997/98 El Niño flood was associated with one of the largest flood losses in the country in 50 years (Mogaka, et al; 2006). The economic and financial losses associated with the El Niño flood was in the range of up to US\$800 million (Karanja et al., 2001). The World Bank estimated the cost of the flood at Ksh 70 billion equivalent to US\$ 1 billion. Flood assessment studies recently undertaken along the last 20 km reach of the Nzoia River in Western Kenya indicate that annual flood damages amount to about US\$4.8 million in the Budalang'i floodplains. The average annual flood damage in the Kano Plains is about US\$ 850,000 (Eitel and Ochola, 2006). During the flood of 2003, the ASAL district of Garissa incurred flood losses of over Ksh.500 million following a flash flood according to the Arid Lands Resource Management Project (ALRMP).

Figure 2.1 Cost of Damages from Climatic Disasters in Kenya

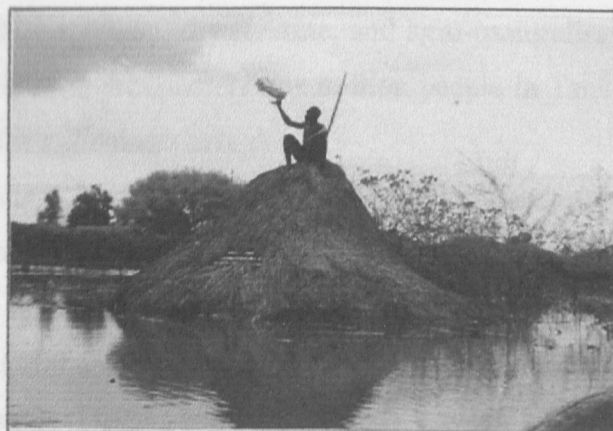


Source: ISDR (EM-DAT Statistics)

Thousands of people in the country's flood-prone areas are displaced and rendered homeless following destruction of their homes leading to internally displaced persons. Buildings and business premises are also affected during floods. The worst affected settlements and businesses are those developed in low-lying lands in rural and urban areas of the country including the lakeside city of Kisumu and coastal city

of Mombasa. The most vulnerable people are the poor who are forced to settle in risk floodplains to make out a living from agriculture, livestock farming and fisheries.

Plate 2.1: Impacts of Floods on Human Settlements



(a) Photos of displaced residents in a slum area in Kenya (b) Submerged hut in Western Kenya

Source: GoK, 2006

The 2006 floods were associated with one of the highest human deaths from malaria and Rift Valley fever epidemic following the 1997/98 El Niño flood (ICPAC,2007; Osbahr and Viner, 2006). There was an overstretching of health resources as a result of over 3 million families suffering from poor health after the 1997/98 El Niño floods in Kenya. Bovine disease was responsible for an 80% reduction of livestock in Northern Kenya according to a WHO report on the health impacts of the El Niño flood of 1997/98. The 1997/98 El Niño floods seriously damaged water supply infrastructure and transport networks across the country. Dams, water pans, and some pipelines in 22 districts were either destroyed or severely damaged (Mogaka et al; 2006). Extensive damage was also caused to 240 river gauging facilities due to severe bank erosion. The protective dykes were over topped and suffered breaches at several places. The floods also damaged irrigation infrastructure such as intake structures, canals and drains. The Perkerra River changed its course, depriving the Perkerra Irrigation Scheme of water for some years (Mogaka et al; 2006).

The October 2006 floods in Kenya caused damages to major roads in the country. A 5km section of the main Bura and Garissa-Dadaab roads was completely cut off resulting in the isolation of communities for extend periods and disruption of transport, communication and business activities. Relief operations coordinated by the government and other relief and humanitarian agencies during the flood disaster were also affected due to destruction of transport infrastructure.

In Kenya, agriculture and livestock production are the main sources of livelihoods and are severely affected by floods. According to a livelihood zoning exercise undertaken by World Bank in 30 districts in the country following the 1997/98 El Niño, most sources of livelihoods in Tana River and Garissa districts- fishing, subsistence cropping, urban and pastoralism, dry riverine, and agro-pastoralism were negatively affected. This resulted in the livelihoods of approximately one million people in Tana River district depending on the River's flooding regime for agriculture at high risk.

Farming communities in Budalang'i, Kano Plains and the lower Tana River Basin are displaced every year. In Budalang'i, there is over 50 percent reduction in agricultural production once every three years. The Kano Plains was almost fully inundated and agricultural crops were completely destroyed during the El Niño Floods in 1997/98. It is estimated that 200 acres of crops along the banks of Tana River in the Coastal province were destroyed during the floods (Osbahr and Viner, 2006). About 1,200 hectares of bananas, tomatoes, and vegetables were reportedly washed away in Garissa district. In Tana River district, 100% of bananas, mangoes, rice, maize and pulses were destroyed (Gadain et al; 2006).

2.9 Flood Vulnerability of the Slum Dwellers

Flooding has been identified as one of the major factors that prevents Africa's growing population of city dwellers from escaping poverty and stands in the way of United Nations 2020 goal of achieving significant improvement in the lives of urban slum dwellers (Action Aid, 2006). This is because many African cities lack the infrastructure to withstand extreme weather conditions. Poor urban planning together with other urban governance challenges contributes to making African urban slum dwellers most at risk.

Global warming is bringing chronic flooding to the cities which can be disastrous to the poor urbanites. Urban floods spread diseases, interrupt schooling, destroy houses, infrastructure, assets and income (Action Aid, 2006). Despite threatening urban poor communities there are few if any collective mechanisms geared towards reducing flood risks or for managing floods (Action Aid, 2006). The poor slum dwellers are solely exposed to all these challenges all by themselves hence forced to develop individual coping strategies. This is worsened by the fact that they are not included in the decision making process on matters affecting them directly, yet there is an opportunity to include them in water policy and governance, which has great potential of addressing and managing climate change related threats.

McGranahan et al. (2007) noted that while economic activity and urban development often increase the environmental pressures that lead to flooding, it is the low income settlements and poor groups within all settlements that tend to be the most vulnerable.

Although the risks faced by urban populations to climate change impacts especially in developing societies has been acknowledged in various regional assessments, their vulnerability cannot be reliably estimated without a detailed knowledge of local contexts since vulnerabilities are so specific to each location and societal context. Also, too little attention has been given to the vulnerability of urban populations to climate change and especially to the vulnerability of their low-income populations (Satterthwaite et al, 2007).

It is the vulnerability of the communities at risk that determines the extent of the flood disasters. This vulnerability is caused by a combination of physical factors such as exposure to floods, degree of protection from flood hazards, quality of infrastructure available, degree of access to resources, and ability to avoid, withstand or recover from the flood hazards. Socio-economic factors like acute poverty, high population density, lack of education, poor planning and management of land, absence of access to modern technological options to cope with the situation increases the vulnerability of the population to floods.

2.10 The Role of Urban Planning in Climate Change Adaptation

Urban planning plays a direct role in shaping and controlling land use and urban form – a significant determinant of both a city's adaptive capacity and climate change resilience, and the level of climate change impact risk for vulnerable urban populations. From a mitigation perspective, urban form is also a major driver of a city's greenhouse gas emissions.

Key areas where planners can support and lead adaptation and mitigation activities in more traditional physical planning capacities are as summarized in Table 2.2 below which is adapted from Eaking, H; Lemos, MC (2006). *Adaptation and the state: Latin America and the challenge of capacity-building under globalization*. *Global Environmental Change* (16).

Table 2.2: Role of Urban Planning in Climate Change Intervention

Type of Plan	General Purpose	Potential Climate Change Features
Town Plan City Plan Physical Land Use Plan	<p>Identifies areas/zones for different types of development (i.e. housing, commercial, industrial, etc.)</p> <p>Identifies development hazard areas(steep slopes, flood plains)</p> <p>To provide long term policy direction on land use and development, transportation and overall community development</p>	<ul style="list-style-type: none"> ▪ Highlight development “hot spots” or “no development areas” where climate change impacts are likely to be most severe ▪ Set policy direction on “climate friendly” and/or “climate resilient” infrastructure and servicing (i.e., storm water management) ▪ Formally recognize climate change and highlight related impacts (i.e., build public awareness, political support) ▪ Land capability, suitability, and the feasibility of different development alternatives are analyzed to determine appropriate spatial relationships that form the basis of the generalized future land use maps
Storm Water Management Plan	<p>Improves storm water management, including drainage and infrastructure</p>	<ul style="list-style-type: none"> ▪ Identifies climate change related storm water/flooding hazard areas. ▪ Considers options for flood management, including promoting appropriate and sustainable defenses and locating new development away from areas of highest risk ▪ Directs new infrastructure to “safer” areas not as exposed to climate change impacts (i.e., can attract or pull development to serviced areas) ▪ Accelerates investment in existing river flood defense programme to protect existing development in flood prone areas. ▪ Identifies options to increase permeability of paved areas in flood affected areas.
Transportation Plan	<p>Improves road, pedestrian, transit and bicycle connections and infrastructure</p>	<ul style="list-style-type: none"> ▪ Identify and improve “weak links” in transportation networks that are threatened by climate change impacts (e.g bridges threatened by storm surges, roads subject to flooding) ▪ Identify and designate emergency transportation networks (i.e., roads and

		<p>transportation links that could be used during a climate change impact event to transport people, supplies and any required relief supplies)</p> <ul style="list-style-type: none"> ▪ Prioritize transportation network improvements that improve transportation connections for climate vulnerable groups ▪ Support climate change mitigation through reduced traffic congestion, prioritizing non-motorized transportation
Local Economic Development Plan or Strategy	<p>Identifies and prioritizes economic sectors and opportunities</p> <p>Identifies economic development priorities (i.e., jobs, capacity, infrastructure, etc.)</p>	<ul style="list-style-type: none"> ▪ Reduces urban poverty levels for key climate change vulnerable groups (e.g. women, children, urban poor) ▪ Promotes “climate friendly” and/or “green development” opportunities
Informal Settlement Upgrade Plans	<p>Develops policies and plans to improve services, infrastructure and sanitation</p> <p>Formalizes property ownership</p>	<ul style="list-style-type: none"> ▪ Identifies potential climate change impacts risks (e.g storm water and flooding, health) and responses to them (i.e., relocation, infrastructure improvements, etc.) ▪ Identifies and relocates housing from high hazard areas and/or develops “planned retreat” and/or relocation strategy
Public Health Plan	<p>Typically focuses on disease prevention and public safety improvements</p>	<ul style="list-style-type: none"> ▪ Identify disease, accident, etc.) associated with climate change ▪ Supports, facilitates and expedites infrastructure and planning improvements to reduce climate change related public health impacts (e.g., supports improved storm water and waste treatment facilities, supports urban greening to reduce heat island effects, etc.)
Emergency Management Plan	<p>Improves disaster response preparedness</p> <p>Identifies hotspots (i.e., areas and groups vulnerable to disasters)</p>	<ul style="list-style-type: none"> ▪ Identifies climate change disaster risks, likelihoods, and adaptive capacity ▪ Supports, facilitates and expedites infrastructure and planning improvements to reduce climate change-related disaster impacts
Sewer / Liquid Waste Management Plan	<p>Improves waste water/ sewer management, and infrastructure</p>	<ul style="list-style-type: none"> ▪ Identifies development and /or construction guidelines for “climate proof” facilities (i.e., facilities that are located and built to

Plan	Focus	Key Functions
Energy Management Plan	Improves energy generation options, distribution, and conservation	<ul style="list-style-type: none"> withstand and function during climate change impact events) Identifies and prioritises high risk areas where new facilities are most needed to reduce climate change impacts amongst vulnerable groups Identifies options to reduce or reuses wastewater (grey water) for urban agriculture and horticulture Identify climate change related risks to energy generation and distribution facilities Supports climate change mitigation (i.e., green energy, conservation)
Water Management Plan	Improves water supply, management and distribution	<ul style="list-style-type: none"> Identifies climate change related risks to municipal water supply, treatment and distribution and adaptive measures to counter them
	Improves water conservation	<ul style="list-style-type: none"> Identifies water conservation and water demand strategies and tools to better manage and adapt to future potential water shortages
Solid Waste Management Plan	Improves solid waste management, including collection, and handling	<ul style="list-style-type: none"> Supports climate change mitigation through improved materials recycling and/or reuse and where practical and feasible landfill emissions capture

Adapted from: Eaking, H; Lemos, MC (2006). Adaptation and the state: Latin America and the challenge of capacity-building under globalization. Global Environmental Change (16)

From the above table 2.2, it is clear that planning plays a critical role in building sustainable city plans which are climate sensitive and enables flood management. The lives in the urban informal settlement can be improved through the various types of plans prepared by planners since all settlements should be guided by a plan.

2.11 Determinants of Adaptive Capacity

The adaptive capacity of a city to climate change impacts can be summarized as indicated in Table 2.3 below:

Table 2.3: Determinants of Adaptive Capacity

Determinant	Description	Relation to Climate Planning
Human Capital	<ul style="list-style-type: none"> Knowledge (technical, political), education levels, and labour 	<ul style="list-style-type: none"> Climate change vulnerability and risk assessments are facilitated and improved by a scientific understanding and knowledge of climate change, combined with good local knowledge, and the human resources to undertake climate change planning work
Information and Technology	<ul style="list-style-type: none"> Communication networks, computing tools, freedom of expression, technology transfer and data exchange 	<ul style="list-style-type: none"> Climate change vulnerability and risk assessments are facilitated and improved by good technical data, data modelling capability, and the ability to share and distribute this information widely, freely and clearly
Material Resources and Infrastructure	<ul style="list-style-type: none"> Transport, water infrastructure, buildings, sanitation, energy supply and management 	<ul style="list-style-type: none"> Well designed, constructed, sited, and managed infrastructure and services tend to be more adaptable or easier to adapt to climate change impacts and risks than poor resources and infrastructure.
Organizational and social capital	<ul style="list-style-type: none"> State-civil society relations, non governmental and community-based organizations, and relationships between institutions 	<ul style="list-style-type: none"> Climate change policy development, implementation and enforcement are further improved in a collaborative, cooperative environment where climate change stakeholders (government, non-government, vulnerable groups, etc.) are able to work well together.
Political Capital (Governance)	<ul style="list-style-type: none"> Modes of governance, leadership, participation, decision and management capacity 	<ul style="list-style-type: none"> Effective, efficient and community supported climate change actions require a functioning local government that is capable and willing to enforce municipal laws, plans and regulations.
Wealth and Financial Capital	<ul style="list-style-type: none"> Municipal financial resources, resident incomes and wealth distribution, economic marginalization, fiscal incentives for climate risk management 	<ul style="list-style-type: none"> Climate change adaptation actions require internal funding (and sometimes external support). Climate change vulnerability, and hence, the level of adaption required, can be reduced in communities with less urban poverty and economic marginalization.

Adapted from: Eaking, H; Lemos, MC (2006). Adaptation and the state: Latin America and the challenge of capacity-building under globalization. Global Environmental Change (16)

In many cases, the development, implementation and ongoing monitoring of local government plans and strategies involve other stakeholders, including other levels of government (e.g state, county, regional, national, federal and provincial governments), community organizations, non-government organizations (NGOs), civil society organizations, academic institutions and local business associations and/or private sector partners. All of these groups and organizations play a role in planning for climate change.

2.12 Flood Management in Kenya

The lack of a flood management policy in Kenya is a major challenge to adapting to the adverse impacts of floods (Karanja: 2001) and (Gadain: 2006) alludes to the policy gap with regard to flood management.

The effective reduction of vulnerabilities to current natural hazards such as floods and to climate change requires coordination across different levels and sectors of governance and the involvement of a broad range of stakeholders. Thus, the need to strengthen the link between flood risk management and adaptation to climate change.

Kenya drafted a National Disaster Management policy in 2009 which makes a way for creation of an overarching National Authority for Disaster Risk Management (NADIMA). The body is to offer coordination and long-term oversight for mainstreaming disaster risk reduction. To this end prioritization of climate change is likely to be closely interconnected with prioritization of disasters

The government of Kenya has put in place some policies and strategic interventions to help in adapting to climate change while countering these climatic conditions. Among these are the signing and ratification of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto protocol, enactment of the Environmental Management and Coordination Act (EMCA) and is actively involved in the clean development mechanisms project around the country. A National Climate Change Response Strategy (NCCRS) was developed in 2010 to act as the key government climate change agenda guide for the country and to inform nationwide climate change programmes and development activities including formulation of documents such as the National Climate Change Policy and efforts towards the attainment of Vision 2030. The need to have proactive policies will help in adapting to the distress climate change may cause.

The purpose of the NCCRS is to put in place robust measures needed to address challenges posed by climate variability and changes. The strategy also recognizes that climate change impacts have not been

factored into most of the sectors of the country's economy including government development policies and plans. The integration of climate information into government policies is important because climate is a major driving factor for most of economic activities in Kenya. The provision of the strategy paper comes in handy to enable development of plans that will sustain the informal settlers in the context of flooding vulnerabilities within the climate variability.

In Kenya, early warning of climatic extremes and prediction bulletins are available to decision makers through the IGAD Climate Predictions and Applications Centre (ICPAC), while climate forecasts are made available to local communities by the Kenya Meteorological Department and local radio stations. However, "Surface water (pluvial) flooding is closely associated with intense, often localised, storms that overwhelm the capacity of local drains, causing flash floods. Pluvial flooding is a characteristic of urban areas where there are large areas of impervious ground and inadequate drainage systems. These events are less easy to predict from weather forecasts and the potential for such an event may need to be anticipated and planned for with appropriate design of landscape and development." (RICS 2009, p.16).

The draft disaster management policy of 2009 created a Disaster Operations Center (DOC) under the office of the President which is responsible for management of all disasters through the Disaster Management Committees (DMC) at the provincial and district levels, under the Chairmanship of the Provincial Commissioner (PC). The role of the DOC is coordination of post disaster related activities of various Ministries up to the district level. The role of MWRMD is mainly in relief operations by providing drinking water for the evacuated people in relief camps.

The Disaster Operations Centre (DOC) is provided with weather forecasts and early flood warning by the Kenya Meteorological Department (KMD). DOC, after making an assessment of the magnitude of the impending flood and its disaster potential, informs the provincial Disaster Management Committees. These committees are responsible for rescue and relief operations through multidisciplinary teams at the district and community levels.

Lack of advance warning of incoming floods takes the public unaware, leaving no time to take preventive measures. Houses are prone to flooding and there are no high grounds nearby for immediate shelter and often the people do not leave their homes unguarded, for security of their meagre assets. The flood forecasting and warning system at the river level needs to be put in place with clear definition of roles. Below is a section that outlines the specific roles of the existing institutions in Kenya which need to help in flood management and climate change adaptation.

2.12.1 Role of IGAD Climate Prediction and Application Centre (ICPAC)

In 1989, twenty four countries in Eastern and Southern Africa established a Drought Monitoring Centre with its headquarters in Nairobi (the DMCN) and a sub centre in Harare (Drought Monitoring Centre Harare – DMCH) in response to the devastating weather related disasters. In October 2003, the Heads of State and Governments of the Intergovernmental Authority on Development (IGAD) held their 10th Summit in Kampala, Uganda, where DMCN was adopted as a specialized IGAD institution. The name of the institution was at the same time changed to IGAD Climate Prediction and Applications Centre (ICPAC) in order to better reflect all its mandates, mission and objectives within the IGAD system. A Protocol integrating the institution fully into IGAD was however signed on 13 April 2007. The centre is responsible for seven member countries namely: Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda as well as Burundi, Rwanda and Tanzania.

The institution vision is to become a viable regional centre of excellence in climate prediction and applications for climate risk management, environmental management, and sustainable development. Its mission is provision of timely climate early warning information and supporting specific sector applications to enable the region cope with various risks associated with extreme climate variability and change for poverty alleviation, environment management and sustainable development of the member countries.

The institution thus is better placed to take the lead in providing important information on climate change adaptation. The centre should play this role by ensuring timely production and dissemination of climate early warning system; improvement of knowledge of process and new empirical models for seasonal forecasts; establishment of a continuously updated data bank for development of baseline statistics and hazards maps; promoting successful networking with users of climate information as well as media groups in dissemination of weather information and products.

The downstream of the climate information should be given priority so that the local users such as those in the informal settlements and flood prone zones can utilize the information to reduce their vulnerability to flooding and climate related disasters. Decentralization of the centre to have community based prediction centre should be considered as a possible area of investment.

2.12.2 Role of the Kenya Meteorological Department (KMD) in Flood Management

The functions of KMD in relation to flood management and climate information and adaptation include the following:

Provision of meteorological and climatological services to agriculture, forestry, water resources management, civil aviation and the private sector including industry, commerce and public utilities for the better exploitation and utilization of natural resources for national development;

Maintenance of an efficient telecommunications system for rapid collection and dissemination of meteorological information required for national and international use in accordance with the World Meteorological Organization (WMO) and the International Civil Aviation Organization (ICAO) procedures;

Co-ordination of research in meteorology and climatology including co-operation with other authorities in all aspects of applied meteorological research, and the maintenance of the National Meteorological Library;

Evolvement of suitable training programmes in all fields of meteorology and other related scientific subjects which are relevant to the development of Kenya and other countries that participate in the Department's training activities.

KMD should use the legal mandate to establish community based meteorological stations that will enable the local residents to interpret and release timely warning. Training of the locals on how to use the equipment will also lead to capacity building of the residents towards effective flood management and climate change adaptation

2.12.3 Role of the Ministry of Water and Irrigation in Flood Management

This is the responsible ministry which deals with water issues in the country. Flood control is implemented by the department of Water Resource Management under the Water Resource and Management Authority (WRMA). They are required to conduct mapping and publishing of key water catchment areas, ground water resources and flood prone areas. The department also conducts mitigation against natural disasters such as floods and droughts. WRMA should focus on capacity development and plans. There is need to strengthen linkage between MWI, Disaster Operations Centre (DOC) and Kenya

implement capacity assessment. It should utilize affordable technology to disseminate flood information to residents and utilize to evacuation activities.

The ministry work has given more emphasis on the L.Victoria region, River Nyando, River Ewaso Nyiro, Western-Budalangi from flooding of River Nzoia and Nyanza Provinces sidelining these other vulnerable areas such as the urban informal settlements. It is high time they include the Nairobi river basin where the Ng'ong River catchment falls to have a flood risk management in the catchment. This will encompass Kibera informal settlement where the Ng'ong river cuts across and is a major source of flooding.

2.12.4 Ministry of State for Special Programmes

This is the ministry mandated to handle all kinds of disasters including flood disasters. Disaster Operations Center (DOC) under the Ministry of Special Programmes in the office of the President is responsible for management of all disasters through the Disaster Management Committees (DMC) at the provincial and district levels, under the Chairmanship of the Provincial Commissioner (PC). The role of the DOC is coordination of post disaster related activities of various Ministries up to the district level. The role of MWI is mainly in relief operations by providing drinking water for the evacuated people in relief camps. The Disaster Operations Centre (DOC) is provided with weather forecasts and early flood warning by the Kenya Meteorological Department (KMD). DOC, after making an assessment of the magnitude of the impending flood and its disaster potential, informs the provincial Disaster Management Committees. These committees are responsible for rescue and relief operations through multidisciplinary teams at the district and community levels. Lack of advance warning of incoming floods takes the public unaware, leaving no time to take preventive measures. Houses are prone to flooding and there are no high grounds nearby for immediate shelter and often the people do not leave their homes unguarded, for security of their meager assets. The flood forecasting and warning system at the river level needs to be put in place with clear definition of roles.

There are no institutional arrangements to review and update the early warning system thereby improving the efficiency and preparedness or determine the adequacy and efficient utilization of resources; assess the impact of disaster management programs on the population, economy and environment and assess the role and effectiveness of various stakeholders in the implementation of these plans. There is need to strengthen linkage between MWI, Disaster Operations Centre (DOC) and Kenya

Meteorological Department (KMD) to develop an integrated flood forecasting and disaster management system. Existing disaster management mechanism is geared primarily to deal with rescue and relief measures and not towards preventive action to minimize the disaster itself.

2.13 Legal and Institutional Framework on Climate Change and Flooding in Kenya

The legal and institutional framework is important since it gives legal mandate to specific institutions to manage, coordinate and carry out operations flood management activities as well as enhancing climate change adaptation in the country. The legal and institutional frameworks provides legitimacy for actions, programmes and activities to address the problems whose resolution may otherwise be unacceptable, sets goals that a society desires to accomplish in light of a recognized problem, it is the only acceptable tool in regulating human behavior and conduct, and has official sanctions and can ensure compliance. Highest in the ranking is the constitution where all laws emanate. The constitution of Kenya has outlined the need to ensure clean environment and sustainable use of natural resources which in essence includes land and water. The constitution also gives legal mandate for regulation of land use activities. the following are specific national strategies and acts of parliament that were developed in line with the provisions in the constitution of Kenya.

2.13.1 International Outlook of Climate Change Policies:

Climate change was first widely recognized as a global problem in the 1980s where it was mentioned in the Brundtland Report published in 1987 and proceeds through to the formation of the Intergovernmental Panel on Climate Change (IPCC) in 1989. This was then followed by the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, which concluded with agreements establishing the United Nations Framework Convention on Climate Change (UNFCCC). Since then, there have been a series of Conference of the Parties COPs to the UNFCCC. Two main outcomes of these COP meetings have been the Kyoto Protocol (COP 3 of 1997) and the Marrakesh Accords (COP 7 of 2001), which contains the detailed rules for the implementation of the Kyoto Protocol. Series of international meetings and conferences on climate change are still held with the aim to combat problems of climate change with the latest being the COP 17 which was held in November, 2011 at Durban; South Africa. Kenya is part of these international agreements and policies.

2.13.2 National Climate Change Response Strategy of April 2010

This Strategy document is the key Government climate change agenda guide in the country and informs nationwide climate change programmes and development activities including the formulation of documents such as the National Climate Change Policy and efforts towards the attainment of Vision 2030. The NCCRS was formulated in response to the challenges and opportunities posed by climate change. The vision of the Strategy is for a prosperous and climate change resilient Kenya. The mission is to strengthen and focus nationwide actions towards climate change adaptation and GHG emission mitigation. The purpose of the National Climate Change Response Strategy (NCCRS) is to put in place robust measures needed to address most, if not all, of the challenges posed by climate variability and change.

This is the first time Kenya developed a document of this kind dedicated to addressing threats posed by climate change as well as taking advantage of any opportunity. The strategy document acknowledges the need for adaptation and mitigation in order to cushion key sectors of the economy against impacts of climate change. The NCCRS also confirms that there is less information on climate change and there lacks policies to deal directly with climate change.

The NCCRS tackles issues at the national level and at a macro scale which has not yet trickled down to local situations. Urban informal settlements have not been adequately considered and thus, the need to highlight the importance of site specific interventions and legal provision for the same.

2.13.3 Draft National Policy for Disaster Management in Kenya, 2009

Kenya lacks a flood management policy and only reacts to flooding whenever it occurs. Flooding is classified as a disaster and it is only partly covered in disaster policies which are also wanting. This policy partly covers flooding as a disaster and thus not comprehensive to provide an effective flood management especially where the informal settlements are concerned.

The policy recognizes the central role of Climate Change in any sustainable, planned and integrated National Strategy for Disaster Management. The policy emphasizes preparedness on the part of the Government, communities and other stakeholders in Disaster Risk Reduction activities. In this regard, the policy aims at the establishment and strengthening of Disaster Management institutions, partnerships, networking and main streaming Disaster Risk Reduction in the development process so as to strengthen the resilience of vulnerable groups to cope with potential disasters. The Ministry of State

for Special Programmes in the Office of President is responsible to coordinate Disaster Risk Reduction initiatives within a unified policy framework in a proactive manner at all levels. The Policy aims to increase and sustain resilience of vulnerable communities to hazards through diversification of their livelihoods and coping mechanisms. This entails a shift from the short term relief responses to development. The Policy will go a long way in preserving life and minimizing suffering by providing sufficient and timely early warning information on potential hazards that may result to disasters. It will also aim at alleviating suffering by providing timely and appropriate response mechanisms for disaster victims. Kibera informal settlement is one of the vulnerable groups to climate change and natural disasters such as floods. The policy thus, addresses this group and has provision for increasing their resilience to flood hazards.

2.13.4 National Disaster Response Plan, 2009

The plan acknowledges flood as one of the disasters comprising Kenya's disasters profile. In the pursuit of effective and timely response to disasters, the Government through the Ministry of State for Special Programmes and National Disaster Operations Centre -Ministry of State for Provincial Administration and Internal Security formulated this National Disaster Response Plan. The response plan seeks to build the resilience of nations and communities to disasters by strengthening disaster preparedness for effective response at all levels. This plan serves to confirm the arrangements in Kenya to effectively address disaster response issues in order to lessen the impact of the disasters once they occur. The responsibility for the implementation of the plan is that of the Ministry for State for Special Programmes in conjunction with National Disaster Operation Centre. The NDRP has established lead and support organizations for emergency response in case of floods. The lead agency is the Ministry of state for Special Programmes (MSSP) while the support organizations includes: NDOC, Kenya Metrological Department, National Youth, Fire Brigade, Agriculture Department, Police, Western Kenya Community Driven and Flood Mitigation Project, military, Metrological Department, Water & Sanitation Department, NGOs, Community, Kenya Red Cross, Min of Health, Livestock and Fisheries Development, Provincial Admin, UNICEF, Min of Energy, Roads and Public Works, KPA, KCAA, UN Agencies, Private sector, CBOs/CSOs/FBOs.

2.13.5 Other Relevant Legislations

Environmental Management and Coordination Act (EMCA) of 1999

The Environmental Management and Coordination Act has elaborated provisions for protection and conservation of environment with specific references to rivers, lakes and wetlands. Paragraph 42 (4) empowers the National Environmental Management Authority (NEMA) to issue guidelines for management of the environment of lakes and rivers in consultation with relevant agencies.

This is relevant in the management of the rivers and streams flowing through Kibera to ensure it does not cause human life disruption through floods. The riparian reserves which are protected areas are also supported by this legal document. EMCA also has important provision on carrying out of an environmental impact assessment prior to development of any building structure. This provision seems not to have any feasibility in Kibera informal settlement structures which do not consider the legal statutes.

The Water Act of 2002

The Water Act provides for development of a “Catchment management strategy” for protection and control of water resources. It specifically provides for protection of catchment areas. This is a significant enabling provision, which, in practical application, may substantially reduce flood hazard. The subject of flood management is dealt with by the Water Department under the Ministry of Water Resources Management and Development (MWRMD). The district units of MWRMD also report on the flood situation. In the water department, there is no section to deal exclusively with flood management issues. The procedure for monitoring is *ad hoc* as there are no field staffs dedicated to keep track of flood situations or to take preventive or remedial measures during or after the floods. Planning of flood mitigation measures should also be factored in to the Integrated Water Resources management and entrusted to River Basin Organizations. These Basin Organizations can therefore provide a forum for the effective participation of the communities in planning of flood mitigation measures considering the basin as a planning unit.

The Physical Planning Act (CAP 286)

This is an important act of parliament that provides for regulation of the use of land and buildings. Control of development has been given legal support and specified that the local governments are responsible to carry out development control in their areas of jurisdiction. The city council of Nairobi is

thus mandated by this act to consider, approve and control development in Kibera informal settlements. The act also has provision on development of a local physical development plan and various action plans which are prepared for efficient use of land and buildings. This thus, informs the formulation of a local land use plan for Silanga informal settlement which will guide development in the flood prone village. The role of planning has been given legal mandate by this act in ensuring that humans settlements are located and built in safe places otherwise it recommends for an environmental impact assessment to be conducted in line with provisions of EMCA.

The Local Government Act (CAP 265)

This is an act of parliament that gives power to the local authorities to control development and provide basic services and facilities to their areas of jurisdiction. The legal mandate thus empowers the City Council of Nairobi in performing these duties in Kibera slums since it is within its area of jurisdiction.

2.14 Emerging Issues

While the impacts of climate change are felt around the world, they are distributed unevenly with some areas and people being affected more than others. Vulnerability to climate change is also distributed unevenly in cities and towns, with some groups being impacted more severely than others. The literature on vulnerability section has explained one of the most climate change vulnerable groups who will require additional consideration in any climate planning initiative – the urban poor who live in the informal settlements. This is the case of the Kibera informal settlement where the study was undertaken. It has been widely acknowledged in the literature that climate change has a disproportionate impact on the lives of people living in poverty. Due to this group's poverty, their capacity to reduce or avoid their exposure to direct and indirect climate change impacts is also reduced. In addition to hazard threats, this group's risk is compounded by their more limited ability to cope with the consequences of any climate change impact (that is; illness, injury or loss of income, livelihood or assets). Simply put, poverty increases people's exposure to climate change impacts and climate change increases risks, therefore people living in poverty and poor communities are most vulnerable to climate change impacts. The urban informal settlers form part of this vulnerable group.

From the literature review on policies, Kenya lacks comprehensive policies on flood management especially for the informal settlements since the available literature sites examples of management

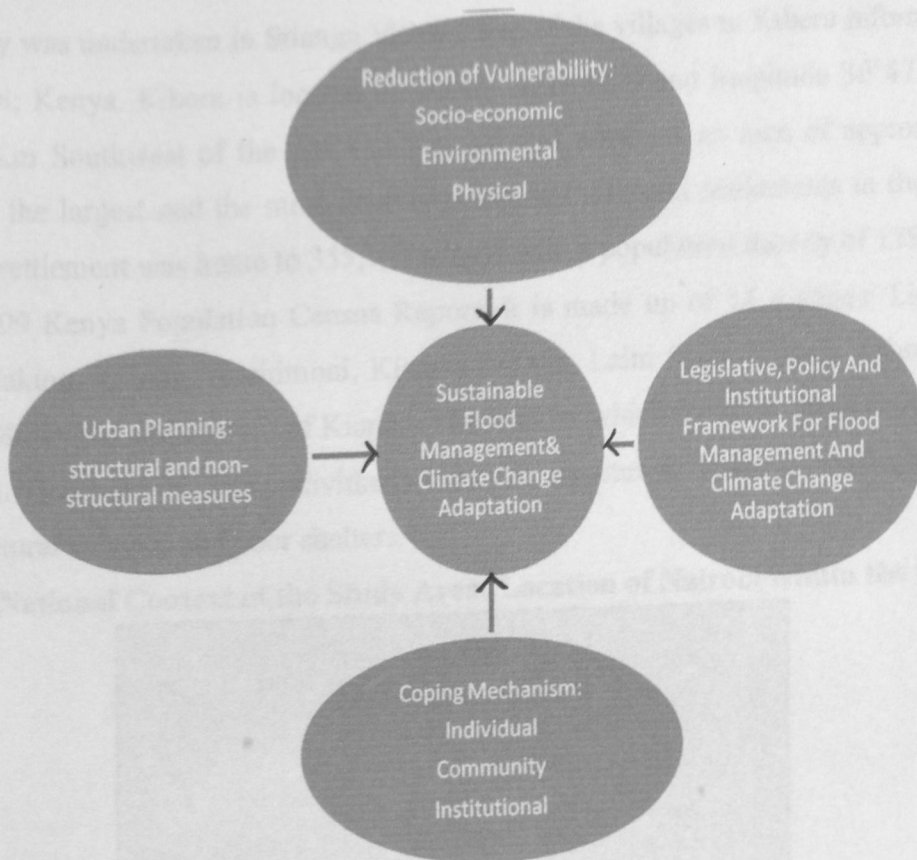
strategies of the Western Kenya and the Lake Victoria basin as specific flood prone areas. The strategy proposed for these regions cannot be adopted in Kibera because this included dykes which is not feasible in the study area. The policy gap is thus a critical emerging area brought by this research. A National Policy on Flood Management has not been formulated despite being proposed in the flood management strategy. This should be formulated and adopted based on the Integrated Flood Management concept integrating land and water management through the process of Integrated Water Resource Management (IWRM).

An effective and evolving inter-sector coordination mechanism should be established at various levels to plan and implement pre-disaster and post-disaster flood prevention and mitigation measures. There is need to strengthen linkage between MWRMD, Disaster Operations Centre (DOC) and Kenya Meteorological Department (KMD) to develop an integrated flood forecasting and disaster management system. Existing disaster management mechanism is geared primarily to deal with rescue and relief measures and not towards preventive action to minimize the disaster itself. There is need to develop a clear fiscal policy on flood management in consultation with the Finance Ministry. The need for capacity building at various levels and in different organizations/ institutions is needed. A comprehensive capacity building programme on flood management issues should be prepared and implemented.

2.14.1 Conceptual Framework

The conceptual framework takes into account the major variables which the literature review has brought out. This includes the vulnerability factors; the policy and legislative framework for flood management and climate change; the role of planning practice and; the coping capacity. This is as presented in the diagram below:

Figure 2.2 The Conceptual Framework



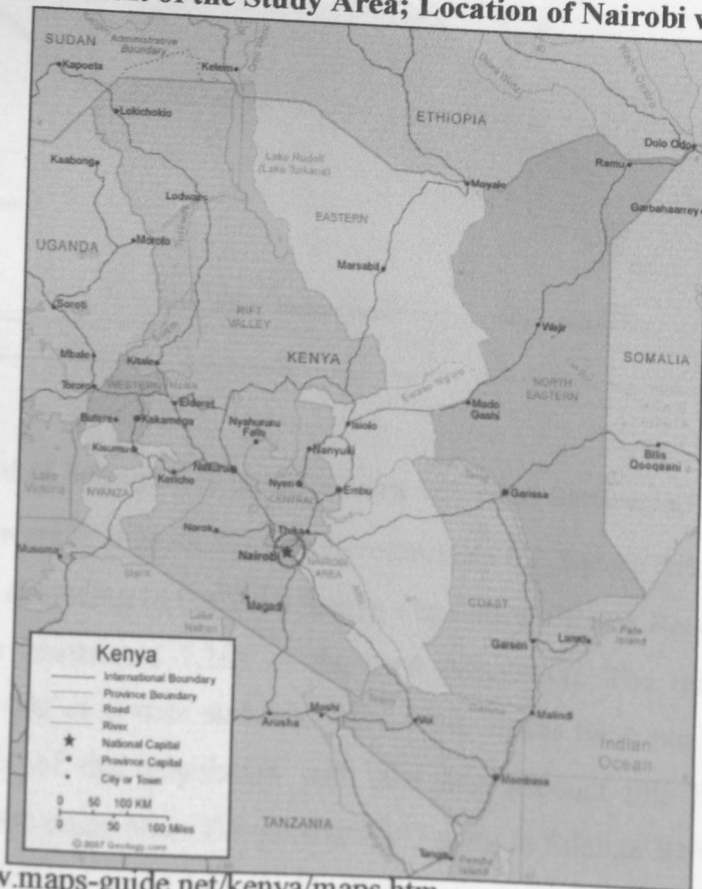
Source: Author, 2012

CHAPTER THREE: BACKGROUND TO THE STUDY AREA

3.1 Location of Study Area

This study was undertaken in Silanga Village, one of the villages in Kibera informal settlements located in Nairobi; Kenya. Kibera is located at latitude $1^{\circ}18'45''S$ and longitude $36^{\circ}47'11''E$. It is situated at about 7 Km Southwest of the CBD of Nairobi and occupies an area of approximately 223.2 sq.km. Kibera is the largest and the most densely populated informal settlements in the City of Nairobi. The informal settlement was home to 355,188 people with a population density of 1592 per sq.km according to the 2009 Kenya Population Census Report. It is made up of 14 villages: Lindi, Soweto (East and West), Makina, Kianda, Mashimoni, Kisumu Ndogo, Laini Saba, Silanga, Kambi Muru, Gatwekera, Kianda, Mkongeni and Soweto of Kianda. The land on which the slum rests belongs to the Government of Kenya. However, private individuals own the structures. There is inadequate provision of basic infrastructural services and poor shelters.

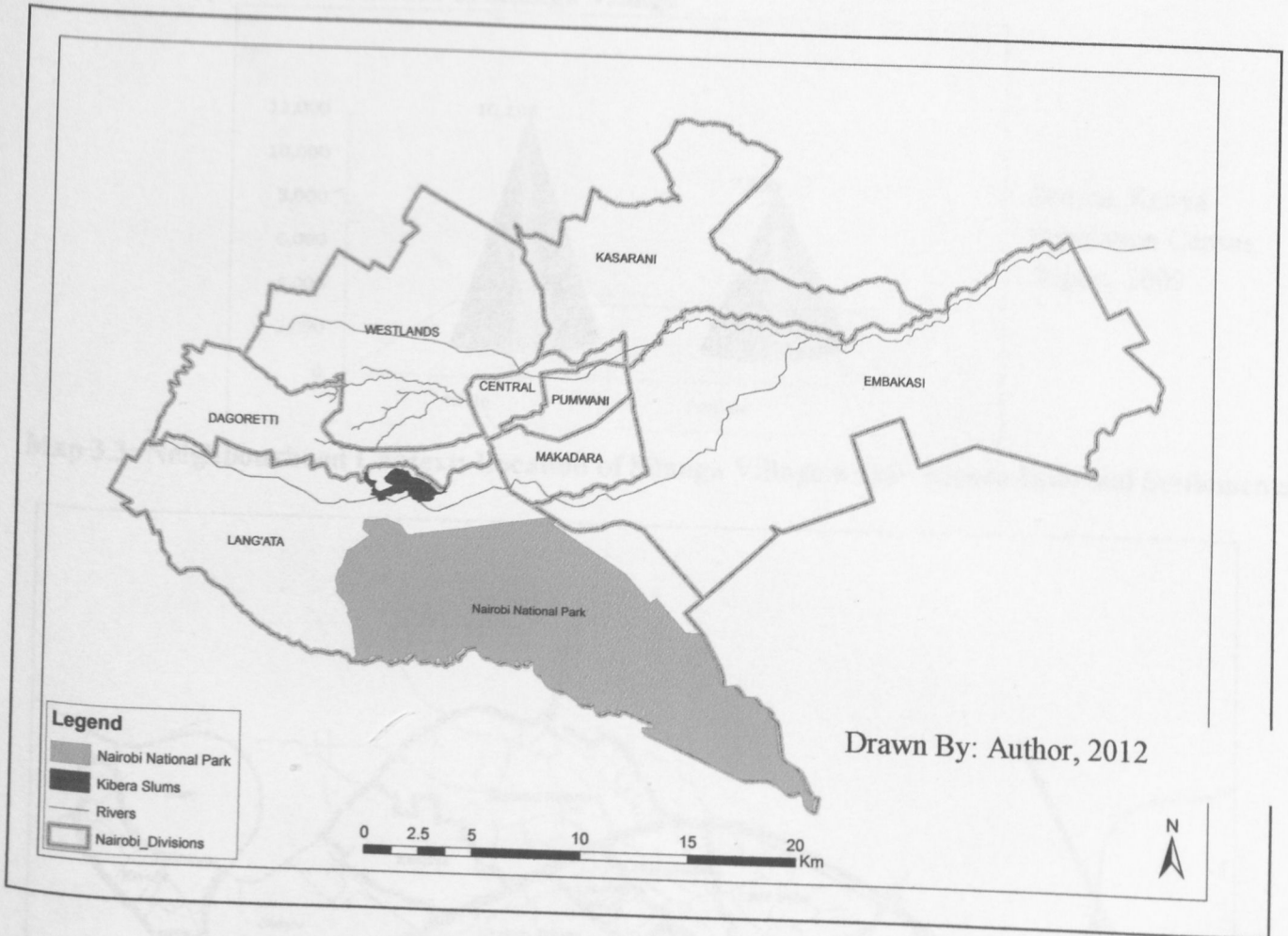
Map 3.1 National Context of the Study Area; Location of Nairobi within the Kenyan context



Source <http://www.maps-guide.net/kenya/maps.htm>

Map 3.2: Regional Context of the Study Area; Location of Kibera Informal Settlements within the Nairobi Context

Figure 3.1 Population Structure of Silanga Village

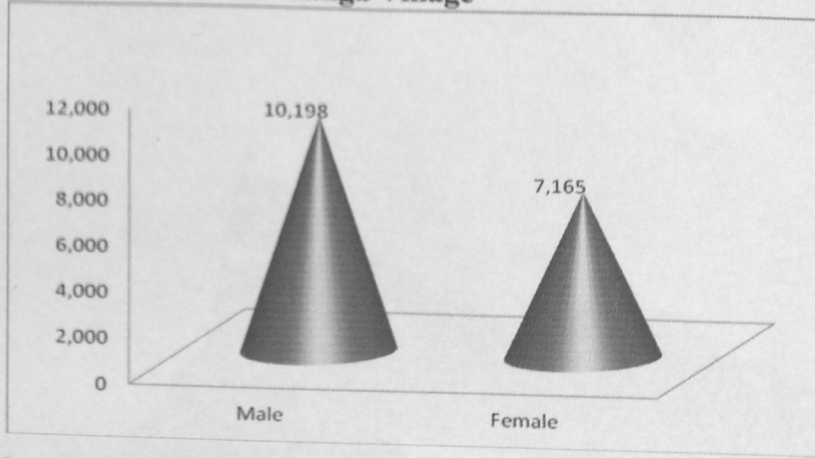


3.1.1 Background of Silanga Village in Kibera Informal Settlements

Silanga village covers an area measuring approximately 0.2 Square Kilometers. It has a total population of 17,363 people according to the 2009 Kenya Population Census Report. The male constituted 10,198 while the female constituted 7,165 of the total population. The male constitute 59% of the total population while that of female stands at 41%. This means there are more males as compared to the females. Sampling of this population will take into account this fact to ensure a proportionate representation of the study area. The population density in Silanga stands at 71,072 persons per square kilometer with a total of 6,164 households. It has an average household size of between 5-7 persons. Kibera informal settlement has an annual growth rate of 5% as compared to that of Nairobi city which is

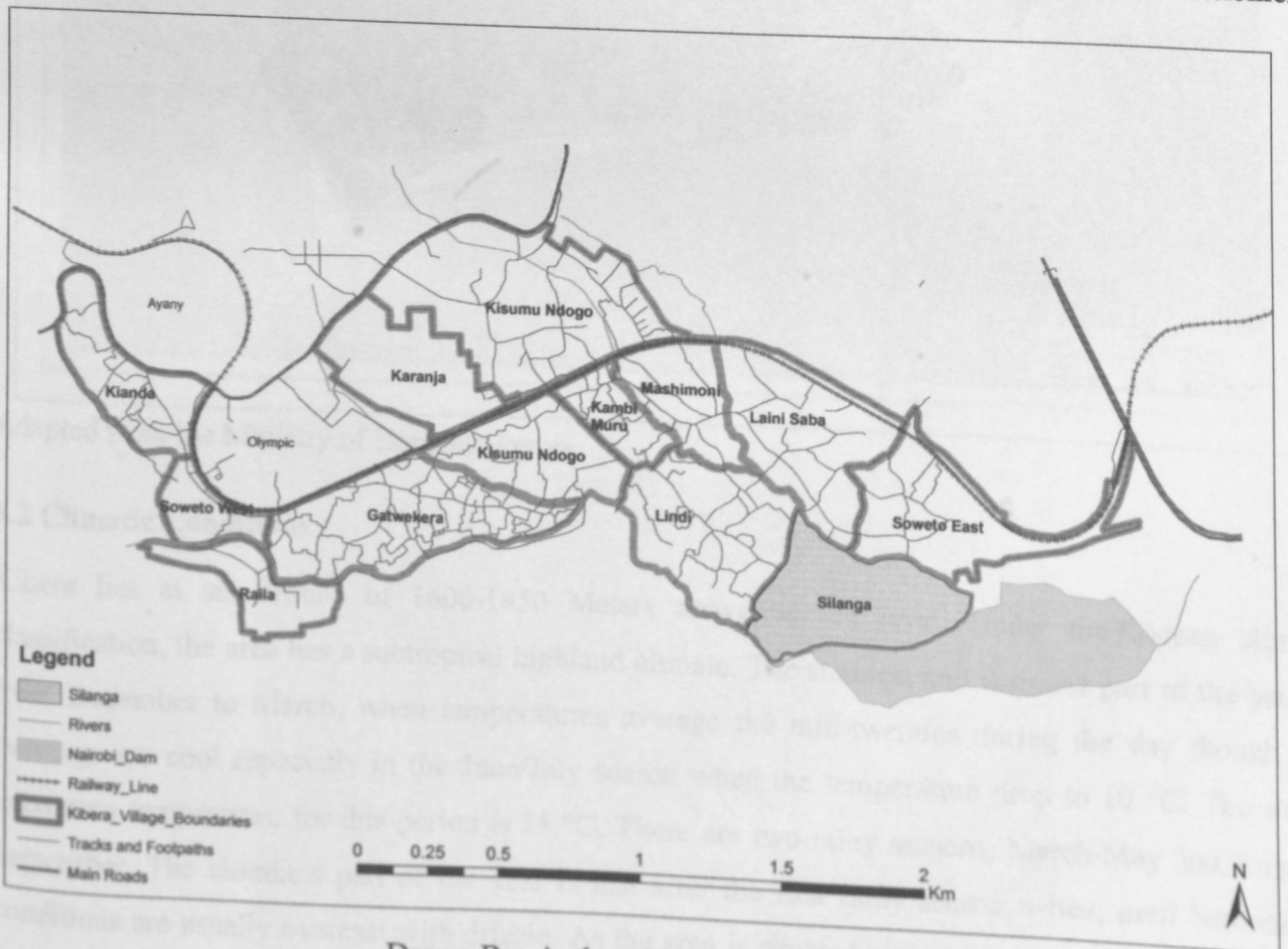
3.8%. This is the highest growth rate in the world and it is likely to double in the next 30 years if positive intervention measures are not put in place (UNDP, 2007).

Figure 3.1 Population Structure of Silanga Village



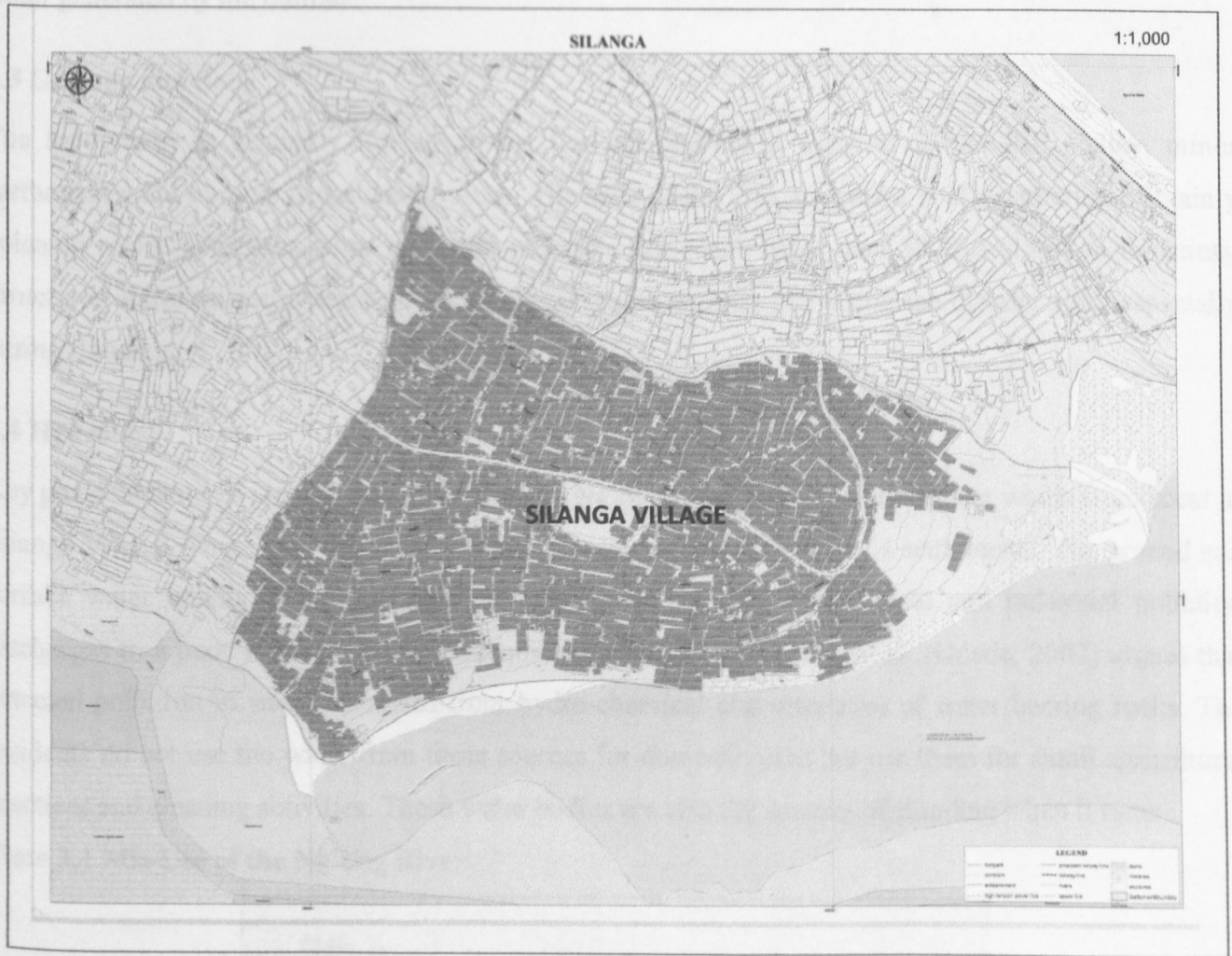
Source: Kenya Population Census Report, 2009

Map 3.3: Neighbourhood Context; Location of Silanga Village within Kibera Informal Settlements



Drawn By: Author, 2012

Map 3.4: Local Context; Silanga Village



Adapted from the Ministry of Housing; kenya

3.2 Climatic Conditions

Kibera lies at an altitude of 1600-1850 Meters above the sea level. Under the Köppen climate classification, the area has a subtropical highland climate. The sunniest and warmest part of the year is from December to March, when temperatures average the mid-twenties during the day though the evenings are cool especially in the June/July season when the temperature drop to 10 °C. The mean maximum temperature for this period is 24 °C. There are two rainy seasons, March-May and August-September. The cloudiest part of the year is just after the first rainy season, when, until September, conditions are usually overcast with drizzle. As the area is situated close to the equator, the differences between the seasons are minimal. The seasons are referred to as the wet season and dry season. During

the rains April/May and December, the areas can hardly be traversed on foot because of the excess storm water generated by the rainfall.

3.3 Geology and Soils

The topography is generally low to almost flat. As Nairobi is adjacent to the Rift Valley, minor earthquakes and tremors occasionally occur. The soils of the area are products of weathering of mainly volcanic rocks. Weathering has produced red soils that reach more than 50 feet (15m) in thickness. Structures are often constructed on top of this unstable ground, increasing the disaster risks especially during flooding.

3.4 Hydrology

Key physical features include the Gatwekira and Ng'ong rivers and the Nairobi dam which is adjacent to Silanga Village. There are other small streams passing through the informal settlements. The ground and surface water quality is polluted in Kibera slum, owing to both domestic and industrial pollution discharges to a poorly designed and inadequately supplied drainage system. (Ndede, 2002) argues that detected pollution in water emanates from hydro-chemical characteristics of water bearing rocks. The residents do not use the water from these sources for domestic uses but use them for small agricultural practices and cleaning activities. These water bodies are also the sources of flooding when it rains.

Plate 3.1 Mis-Use of the Ng'ong River



Source: Field Survey, 2012

3.5 Vegetation

Kibera was once a green area occupied by forest in the 1940s and 1950s. Currently, the area is densely populated with scanty vegetation which can only be found along the drainage features such as the along Ng'ong River, Gatwekira River and Nairobi dam.

3.6 Incomes

Almost three quarters of Kibera's households earn less than Kenya shillings 10,000 per month; with an average of five people per household, this translates to approximately one dollar per person per day—the U.N. standard of poverty. Maintaining housing affordability remains a major challenge to any upgrading or redevelopment project. Any fees for water, sanitation, electricity or rubbish collection may further burden households. Taxation on regularized or legally recognized land or shelter increases financial obligations even more. The dependency ratio is 1:5 which is considerate high pointing out to the level of poverty within the informal settlements.

3.7 Environmental Concerns

The structures in Kibera informal settlements are located on riparian land along the rivers which are flood prone. The haphazard dumping of residential and commercial wastes into the river streams and the Nairobi dam have polluted these water sources. Direct disposal of fecal matters into the streams as an easy way of waste discharge have resulted to black waters, environmental hazards and health problems. These problems are compounded when the area floods as most of the shacks are washed away by flash and riverine floods.

3.8 Cases of Flooding In Nairobi's Kibera Informal Settlement

60% of the population in Nairobi live in the Slums. The slum dwellers face abject poverty and circumstances which force them to live in deplorable environments oblivious of the risks involved. Although most of the land that the slums sit on have been red marked and inhibitors issued with eviction notice, the high cost of living around the city has seen slums continue to mushroom in all corners of Nairobi. The slums are built in prohibited area such swampy region, near airports, over pipelines, under high voltage power cables or near chemical companies, where disasters are far from over.

A year ago (2011) an estimated 100,000 Sinai residents occupying the land where the pipeline passes through was worst hit by fire. Eviction notices were issued demanding them to vacate 15-metre of land

on each side of the pipeline. However the residents shrugged the notice unaware of the threats posed by their environment coupled with the ignorance of the authority who in many occasions fails to enforce law and instead collude with scrupulous landlords to break the law by erecting illegal structures. Although such a huge scale has not hit any other slum yet, conditions are similar and if safety measures are not urgently taken, Kenyans might soon be mourning more deaths in the near future. Fires are not the only risks prevalent in Nairobi's slums. OCHA highlights terrorism attacks, floods, social conflicts, disease outbreaks, insufficient access to water and sanitation, high risk of gender-based violence and food insecurity as some of the major issues facing urban communities.

Kibera, the largest slum in Africa is a time bomb waiting to explode any time soon if the living conditions are not improved. Some of Kibera Line Saba residents construct carton houses during the night on the railway line and comfortably spend the night only evacuating when they hear of a train hoot in the distance. Others have constructed living quarters close to the railway line and even do business on it as usual under the watch of the same authorities that issue warnings. If we draw examples from countries like India where train accidents have been fatal, Kibera could witness the worst disaster in the country's history.

This year; 2012, flash floods were experienced in various parts of Nairobi's slum areas such as Mathare and Kibera. More than 300 people were displaced while one person died when Nairobi river burst its banks in Mathare slums. The floods were triggered by rainfall upstream in Kiambu leading to the flooding of the river that passes through Mathare slums. The tragedy happened at night when residents were sleeping. The raging waters washed away houses and its contents. The affected area in the slum stretches downstream for about three kilometers and almost all makeshifts nearby were submerged by water.

The situation is not different from other slums like Kibera under study. This is because the settlements are located in flood prone areas which are riparian reserves next to streams and rivers.

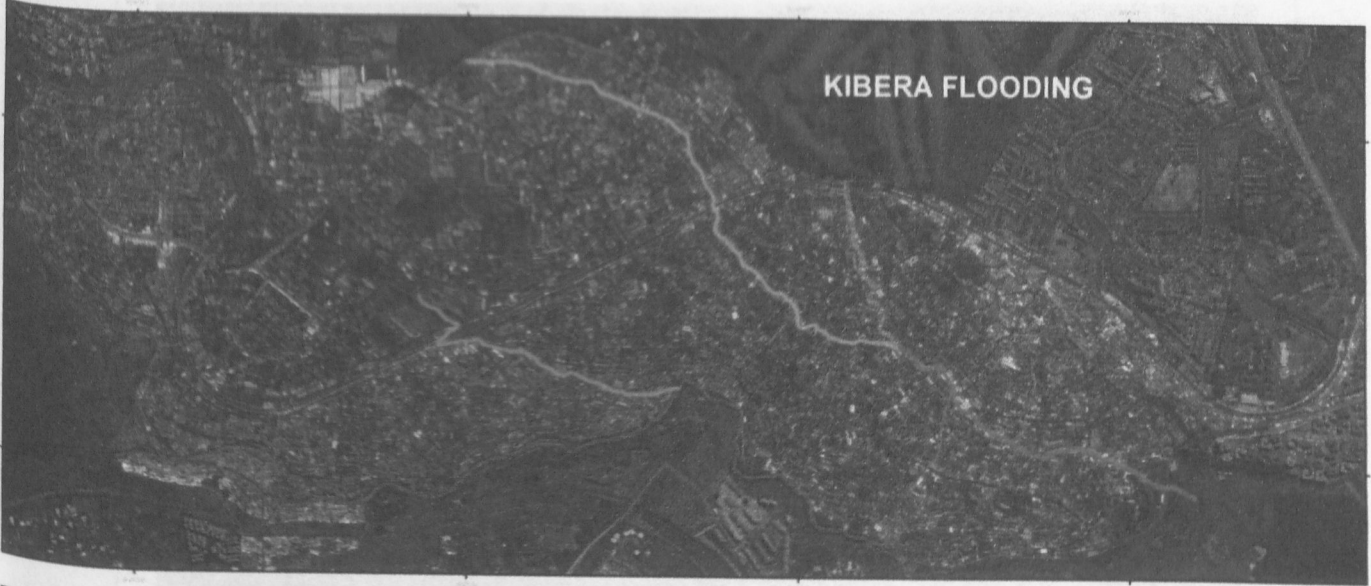
Plate 3.2 Flooding In Mathare Slums (2012)



Kibera is located in a rugged terrain which consists of valleys and hills. There are several drainage features which are intersected by five streams, which all drain their waters into the Nairobi Dam adjacent to Silanga Village. During the heavy rains, excess water from surface runoff travels over the slum land and ends up in the streams. These become overflowing, raging currents, grinding everything in their way, washing away houses, paths, garbage and people. Flooding in the slums found in Nairobi are major incidents which should trigger wide coverage.

In 2010, there were more than 50 houses which were severely damaged, displacing the inhabitants in Kibera slums. One school was completely swept away. This damage was documented by OCHA who rushed to the scene to assess the extent of the damage caused by floods. A team from OCHA collected data points of all the damaged objects which were mostly located on the banks of the streams through the slum. In a testimony to Kibera's obstinate spirit, many of the damaged objects were already being repaired and rebuilt when the team arrived at the site. The paths inside the slum, too, were being fixed by groups of young volunteers. People organized themselves without waiting for any kind of help or intervention from the outside. There was almost an organic reaction of the slum to its wounds. The team focused on the primary damage done along the streams and within two days, they had mapped out the extent of flood damage in Kibera.

Map 3.5: Kibera Flooding *Down the Stream*



<p>DAMAGE</p> <p>1) Along Gatwekera Stream In between the two bridges 6 houses were washed away, 16 family members had to move. Down the stream 20 houses were damaged, 11 were rebuilt, 15 people had to move.</p> <p>2) From Olympic 13 houses along the stream were flooded.</p> <p>3) From Golf Course 12 houses destroyed, 3 repaired. School completely destroyed. Couple of houses flooded.</p> <p>4) Bankar 12 houses destroyed, people moved, 4 repaired. Church destroyed. 9 houses flooded.</p> <p>5) Undungu 15 houses destroyed, 25 family members moved. There is a section where water is still there.</p>	<p>Nairobi KENYA</p>	<p>Kibera NAIROBI</p>	<p>Legend</p> <ul style="list-style-type: none"> Bankar From Golf Course From Olympic Gatwekera Stream Undungu Boundary <p>Credits, Copyrights & Information</p> <p>Data: Vector data: OpenStreetMap, ILRI GIS Services Satellite Imagery: GeoEye-1, 25 July 2009</p> <p>Information & Contacts: www.mapkibera.org, primoz@mapkibera.org Created: 21st May 2010</p> <p>Scale 0 50 100 200 300 400 500</p>
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Source: primoz, 2010 <http://www.mapkibera.org/blog/2010/08/28/mapping-flood-damage-in-kibera/>

Map 3.6 Damaged Objects Down the Streams



Source: primoz, 2010 <http://www.mapkibera.org/blog/2010/08/28/mapping-flood-damage-in-kibera/>

Lessons learnt by OCHA from Flooding Experience in Slums

- The importance of having local people on the ground, trained in data collection, which can be activated at any time. Because of this, the time in which information was available to OCHA was shortened to only a couple of days.
- The information on repaired objects could be used to make a case for compensations.
- Visibility matters: Even major events with many deaths and widespread destruction can go mostly unnoticed by the outside world when they affect marginalized places like Kibera. Recording information on damage, be it on a map or through local newscasts and papers, is the crucial first step to mobilize help in support of the local community.

4.2 Research Population

The target population comprised of all households living in the flood-prone Silanga Village in Kibera informal settlement. In addition, key institutional representatives of the community dealing with floods were also part of the target population. Others included the Non-Governmental Organizations working in Kibera, Community Based Organizations, Youth Groups and Women Groups of Kibera Informal Settlements. However, due to resource and time limitations, the accessible population comprised those households sampled from the population of Silanga village and key informants from the City Council of Nairobi, Ministry of State for Special Programs, Ministry of Water, Ministry of Environment, NGOs and CBOs.

4.3 Sampling Method

Simple random method was used in the sampling of households to be interviewed in Silanga Village. The total number of households in Silanga Village according to the 2009 Kenya Population Census Report was 6,104. A sample size of 147 households was arrived at by use of the simple random formula as discussed below.

The appropriate sample size for a population-based survey is determined largely by three factors: (i) the estimated prevalence of the variable of interest – flood vulnerability in this instance, (ii) the desired level of confidence and (iii) the acceptable margin of error.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Research Design

The study used survey research design which is also referred to as non-experimental. This is a research design in which an experimental variable is not introduced but measures can be taken. Control is given on what is to be observed, and when the observation is taking place. The main purpose of using this type of research is to assess the relationship between or among variables. In this case, flooding and climate change were the research variables whereby flooding is the depended variable whereas climate change is an independent variable. The study sought to examine the correlation between climate change and flooding just as explained from the literature review. Both qualitative and quantitative techniques were used in this study.

4.2 Research Population

The target population comprised of all households living in the flood prone Silanga Village in Kibera informal settlement. In addition, key institutional representatives of the ministries dealing with floods were also part of the target population. Others included the Non-Governmental Organizations working in Kibera, Community Based Organizations, Youth Groups and Women Groups of Kibera Informal Settlements. However, due to resource and time limitation, the accessible population comprised those households sampled from the population of Silanga village and key informants from the City Council of Nairobi, Ministry of State for Special Programs, Ministry of Water, Ministry of Environment, NGOs and CBOs.

4.3 Sampling Method

Simple random method was used in the sampling of households to be interviewed in Silanga Village. The total number of households in Silanga Village according to the 2009 Kenya Population Census Report was 6,164. A sample size of 147 households was arrived at by use of the basic simple random formula as discussed below.

The appropriate sample size for a population-based survey is determined largely by three factors: (i) the estimated prevalence of the variable of interest – flood vulnerability in this instance, (ii) the desired level of confidence and (iii) the acceptable margin of error.

For a survey design based on a simple random sample, the sample size required was calculated according to the following formula.

Formula:

$$n = \frac{t^2 \times p(1-p)}{m^2}$$

Description:

n = required sample size

t = confidence level at 95% (standard value of 1.96)

p = estimated prevalence of flooding in the project area

m = margin of error at 5% (standard value of 0.05)

The sample size was objectively chosen and had high probability of being representative of the population.

Purposive sampling method was used to get key informants from the City Council of Nairobi, Ministry of State for Special Programs, Ministry of Water, Ministry of Environment, NGOs and CBOs, Youth and Women Groups. The use of purposive sampling is justified since the relevant departments within the government ministries were to be contacted through key informants thus, a determinant of the sample size which was mainly one for each ministry. Sampling for NGO, CBO, Youth and women groups contacted for this research was established through snowball method whereby knowledge of existence of an NGO working in Kibera and helping in the area of flooding was passed during the interviews and the number grew bigger from an initial smaller number.

Table 4.1 Sampling Distribution

Population	Sample Size	Justification
Silanga Households	147	Objectively calculated using the official number of households in Silanga and applied the scientific sampling formula in arriving at the required sample size.
NGO	3	These had their activities based in Silanga as opposed to the other identified organizations that were not accessible. The sampling was also informed by the activities of the organization whereby only those dealing with flood management and climate change were contacted. They thus presented greater knowledge and understanding of Silanga vulnerabilities and their activities were conspicuous by the residents who referred to them. Judgmental method was used here.
CBO	3	
Women Groups	2	
Youth Groups	3	

4.4 Data Collection Methods

Primary and secondary data collection methods were used in this study.

4.4.1 Secondary Data Collection

This involved library and desktop studies on the current knowledge of theory and variables used in climate change research as well as impacts of climate change and flooding in informal settlements. Literature review narrowed down to flooding and climate change in Kenya, vulnerability of the informal settlements, the role of urban planning in climate change adaptation and the legal, policy and institutional framework for flood management and climate change adaptation in Kenya.

Sources of this information were found through literature review of published books, government documents and journals, acts of parliament, policy and strategy papers whose topics were of relevance to this research project. Web based information also formed an important source of secondary data. All the sources have been well acknowledged in this report.

4.4.2 Primary Data Collection

This was mainly based on field work whereby investigations on local knowledge and solutions to climate change challenges focusing on flood risks management was conducted to inform the formulation of a sustainable adaptive strategies and mitigation measures, in urban informal settlements.

Focus group discussions and workshops sessions were held with stakeholders to assess their awareness of climate change vulnerabilities and their understanding of climate change adaptations in the informal settlements. Discussions with actors in flood management sought to collect information on whether these actors are aware of the effects of climate change and variability in Silanga settlements and on any measures they take to mitigate the impacts of climate change on flooding in the informal settlements.

House hold questionnaires, and key informant interview schedules were used to collect primary data. Other techniques included the use of a geographical position system (GPS) to map out flood prone zones, observations skills on type of structures, materials used, conditions of the access streets and environmental data; and taking of photographs in addition to questionnaire administration and interviews.

4.5. Data Analysis and Synthesis

This is whereby the data collected from the field surveys was cleaned, sieved, analyzed and synthesized for meaningful interpretation of research findings. This research has involved both quantitative and qualitative methods of data analysis. Qualitative data was analyzed by use of logical analysis which is also called matrix analysis. This is a generalized causation and logical reasoning on the study findings from Focus Group Discussions. The household questionnaires were coded and the data keyed into a computer using SPSS programme for analysis. This is mainly for quantitative type of data collected from the field work and helped in statistical analysis. Mapping using Geographic Information System (GIS) was used in this research to locate important features such as the building structures, rivers, access paths and the Nairobi dam. Use of GIS was also an important tool in mapping out flood prone zones in Silanga which acts as an informative tool in controlling development in the floodplains.

4.6 Data Presentation

The analyzed data was presented in form of a compiled research study report. This report has graphs, flow charts, pie-charts, photographs, diagrams, figures, plates and tables as generated from data analysis representing information gathered from the field survey. Of importance are maps indicating the research project site location at national, regional and local contexts, flood disaster prone areas as well as areas adversely affected by floods in the past. A proposed land use plan for flood management is presented in form of a map which indicates zoning of various land uses in Silanga informal settlement. A designed implementation framework has been presented in form of a matrix and table. Graphical impressions have also been used to illustrate the envisioned scenarios in the quest to manage floods in Silanga. The compilation of all these presentation types makes up this research project report.

CHAPTER FIVE: RESEARCH FINDINGS AND ANALYSIS

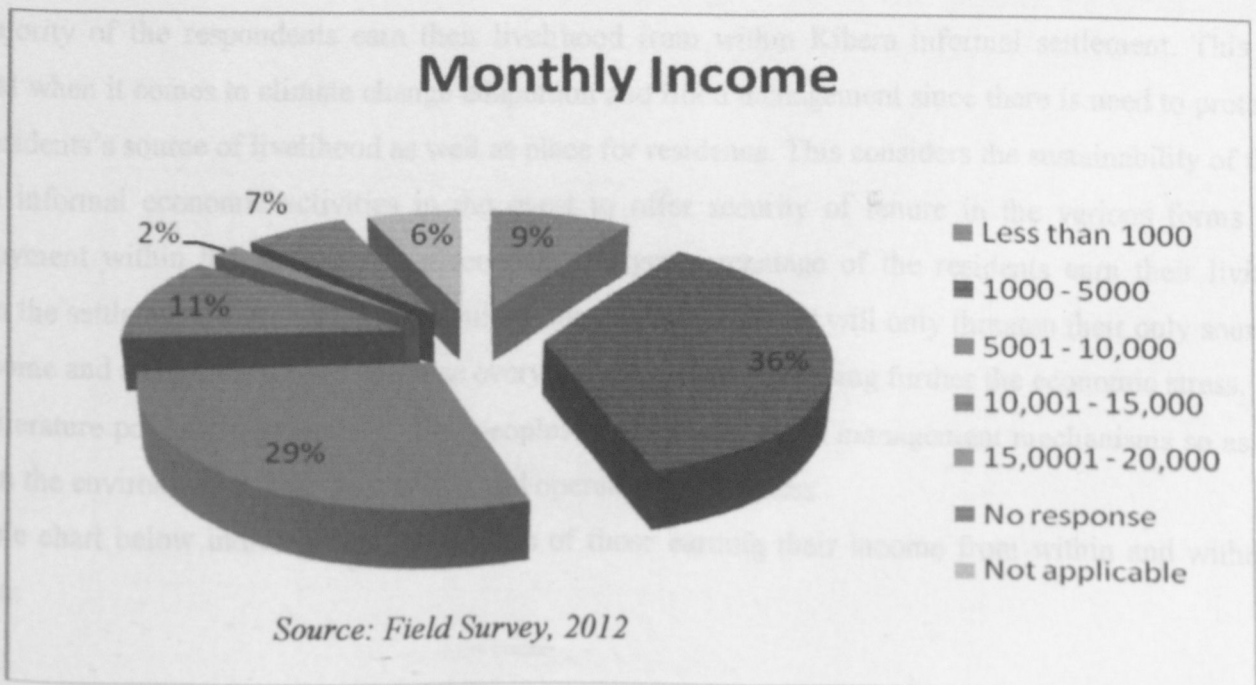
5.1 Introduction

The chapter gives the findings of this research project using the information gathered from the field work conducted as specified in the methodology chapter. The findings are presented following the objectives of this study. The chapter starts with giving the general socio-economic characteristics of the respondents sampled from the whole population. The socio-economic attributes consists of the level of monthly income, level of education, sex composition of the respondent and their places of work. The findings on causes of flooding in Silanga Village, effects of the floods and the factors that contribute to vulnerability of people living in the informal settlement to flooding are discussed in line with climate change adaptation. All these research findings bring out the vulnerability of the Silanga Village to flooding. In addition, the chapter presents the existing local adaptation strategies to curb flooding in Silanga Village. The roles of different actors in flood management are also discussed herein.

5.1.1 Socio-Economic attributes of the Respondents

Figure 5.1 indicates the average monthly income of the respondents who participated in interviews carried out in Silanga Village.

Figure 5.1 Average Monthly Incomes of the Respondents



From the above pie chart, it is seen that 36% of the people in Silanga village earn a monthly income of between Ksh.1,000-kshs 5,000. This is followed by 29% who earn monthly income of between kshs. 5001- Kshs10,000. 11% of the population earn a monthly income of between ksh.10,001-Ksh.15,000 whereas 9% earn less than Ksh. 1,000. The income level is an indicator of socio-economic vulnerability of the respondents who live in the informal settlement of Silanga Village. As earlier discussed in the literature review, poverty increases the vulnerability of communities to flood disasters and also determines their adaptive capacity and period of recovery after suffering loss from flash floods. The incomes as presented in the chart above reflect the meager capacity of the residents to cope and respond to climate change impacts. The level of income also determines the affordability of housing structures thus, contributing to socio-economic vulnerability. This means that the residents can only afford the houses in the informal settlement which are inadequately serviced to withstand extreme climatic change impacts such as floods. A comparison with the larger Kibera neighbourhood indicates that about three quarters of Kibera's households earn less than Kenya shillings 10,000 per month; with an average of five people per household, this translates to approximately one dollar per person per day—the U.N. standard of poverty. Income levels is thus a measure of determining the socio economic vulnerability of the urban informal settlers to climate change impacts and flood disasters.

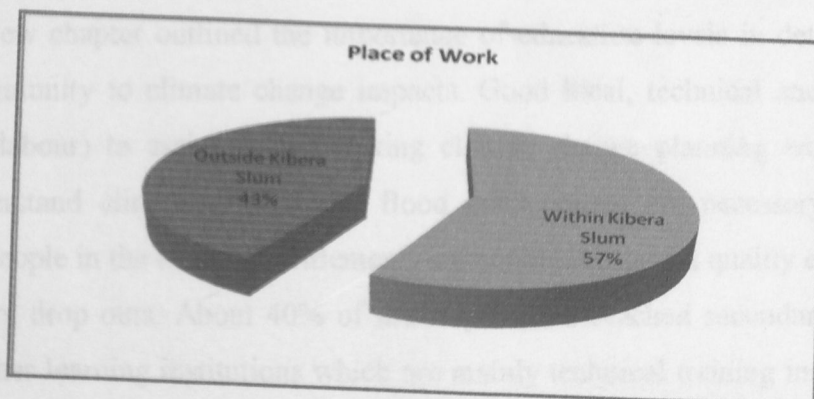
5.1.2 Place of work of the respondents

A majority of the respondents earn their livelihood from within Kibera informal settlement. This is critical when it comes to climate change adaptation and flood management since there is need to protect the residents's source of livelihood as well as place for residence. This considers the sustainability of the urban informal economic activities in the quest to offer security of tenure in the various forms of employment within the settlements. given that a larger percentage of the residents earn their living within the settlement, then lack of flood mitigation and management will only threaten their only source of income and affected residents will lose everything they own increasing further the economic stress.

The literature pointed to the need to link peoples livelihood to flood management mechanisms so as to sustain the environment where people live and operate their business.

The pie chart below indicates the percentages of those earning their income from within and without Kibera:

Figure 5.2: Respondents Place of Work

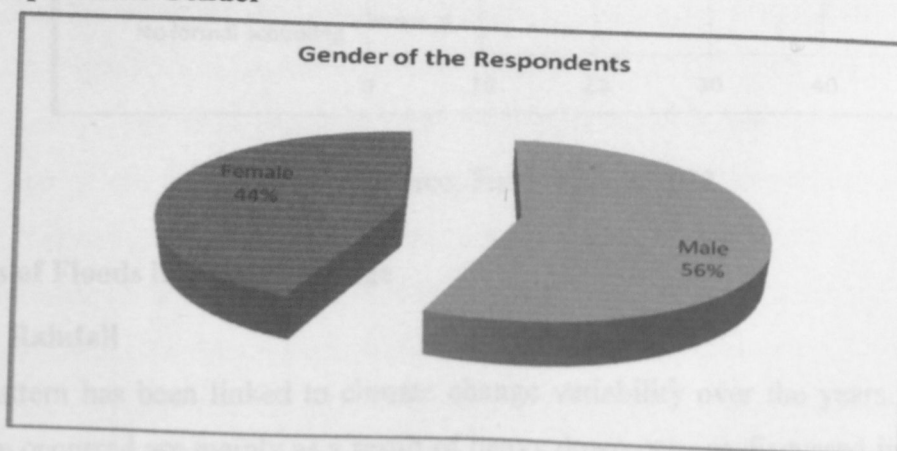


Source: Field Survey; 2012

5.1.3 Gender Composition of the Respondents

The respondents in the research study were fairly balanced. 56% of the accessible population comprised of males while 44% represented the female. The more males is attributed to the fact that there are more males than females in Silanga informal settlement as pointed out in chapter three. Gender consideration is relevant in flood management and adaptation so that the issues affecting both genders are addressed in the research and proper recommendations made to suit the whole population. This is therefore a gender aggregate research findings whereby the respondents were proportionate to the whole population and bias was reduced by observing objectivity in including both genders in the research. The views used herein this report thus, informs strategies that are suitable for both the males and females in the urban informal settlement.

Figure 5.3: Respondents Gender

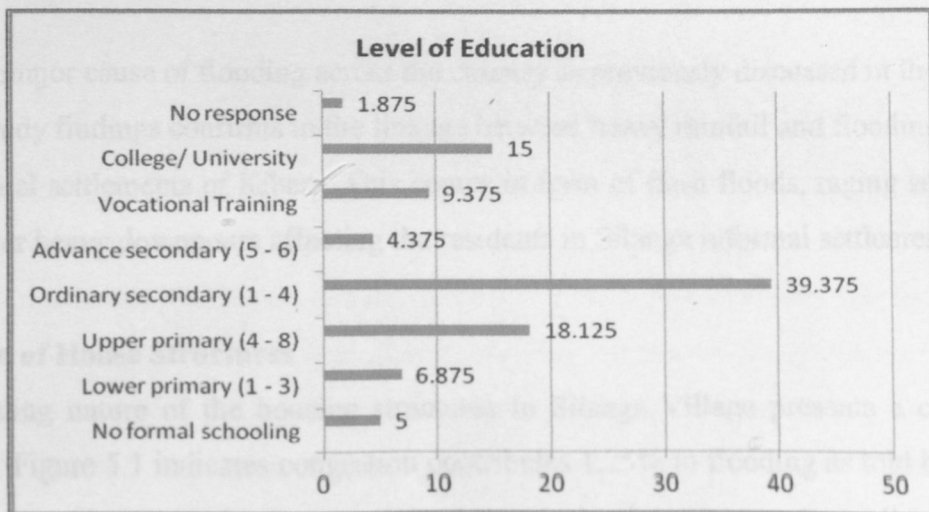


Source: Field Survey; 2012

5.1.4 Level of Education

The literature review chapter outlined the importance of education levels in determining the adaptive capacity of a community to climate change impacts. Good local, technical and political knowledge; human resource (labour) to assist in undertaking climate change planning work and the ability to scientifically understand climate change and flood management are necessary factors to consider. Majorities of the people in the informal settlements are not able to access quality education and faces the challenge of school drop outs. About 40% of the respondents reached secondary level and only 15% have accessed higher learning institutions which are mainly technical training institutions. The level of knowledge base is important in developing flood management policies and plans and conducting community training and awareness programmes for easier interpretation of information channeled to the community in regard to climate information and forecasting such as in early warning systems. The figure below shows the various levels of educations that the respondents reached.

Figure 5.4: Respondents level of education



Source: Field Survey; 2012

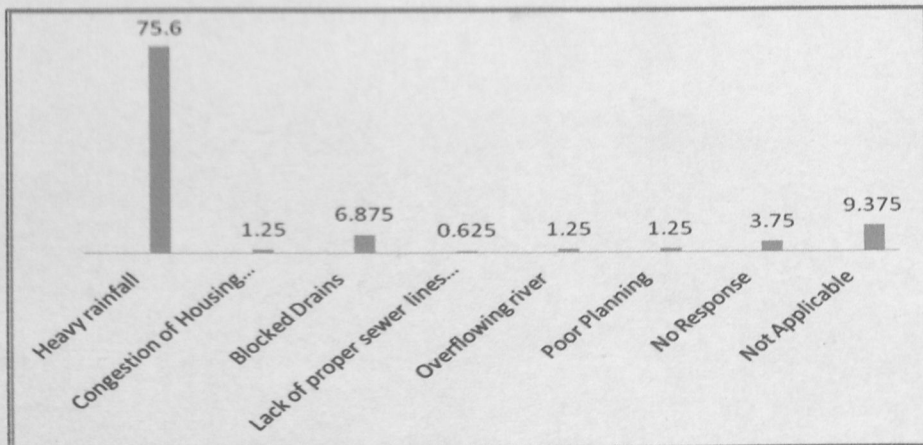
5.2 Causes of Floods in Silanga Village

a) Heavy Rainfall

Rainfall pattern has been linked to climate change variability over the years. Most of the past floods which have occurred are mainly as a result of heavy down pour as discussed in the example of Mathare and Kibera flash floods. Heavy rainfall accounted for 75.6% of the causes of flooding in Silanga Village. 27% of the respondents indicated that the rainfall pattern in the area is predictable and attributed

the start of the long rains in April to be a major time when they are faced with flooding. 23% could not predict the rainy seasons of the area due to weather variations over time. Only 3% acknowledged there is an abrupt change of rainfall pattern in the area in the recent past years.

Figure 5.5: Causes of Floods in Silanga Village



Source: Field Survey, 2012

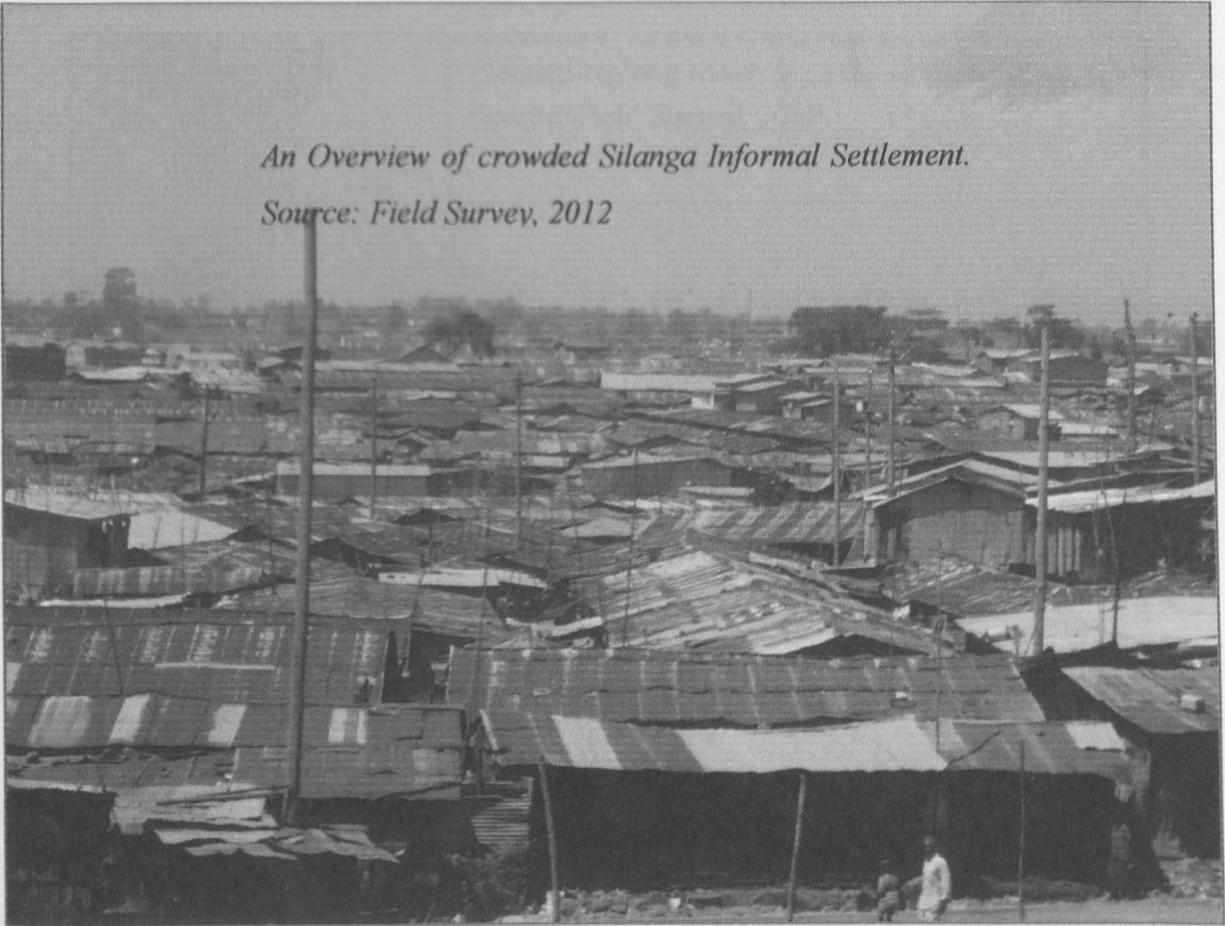
Rainfall was a major cause of flooding across the country as previously discussed in the literature review chapter. The study findings confirms to the linkage between heavy rainfall and flooding occurrence even in urban informal settlements of Kibera. This comes in form of flash floods, raging surface runoffs and river floods after heavy downpours affecting the residents in Silanga informal settlement.

b) Congestion of House Structures

The overcrowding nature of the housing structures in Silanga Village presents a cause for flooding vulnerabilities. Figure 5.1 indicates congestion contributes 1.25% to flooding as told by the respondents during the survey. The slum dwellers explained that lack of space for channeling storm water and putting up new storm water drains due to overcrowding of house structures contributes to flooding because the covered ground by roofs increases surface run off with nowhere to channel the water. The flooding causes mass damage on the overcrowded settlement especially when flash floods occur. This is a unique factor which the literature review did not point out as a cause for flooding. The high density is a character of the urban informal settlement which presents a vulnerable situation to flooding. This has implication on the extent of damage caused since many structures/households are affected on a highly settled area as compared to a lesser dense human settlement. The losses is of higher magnitude in densely settled urban informal settlements.

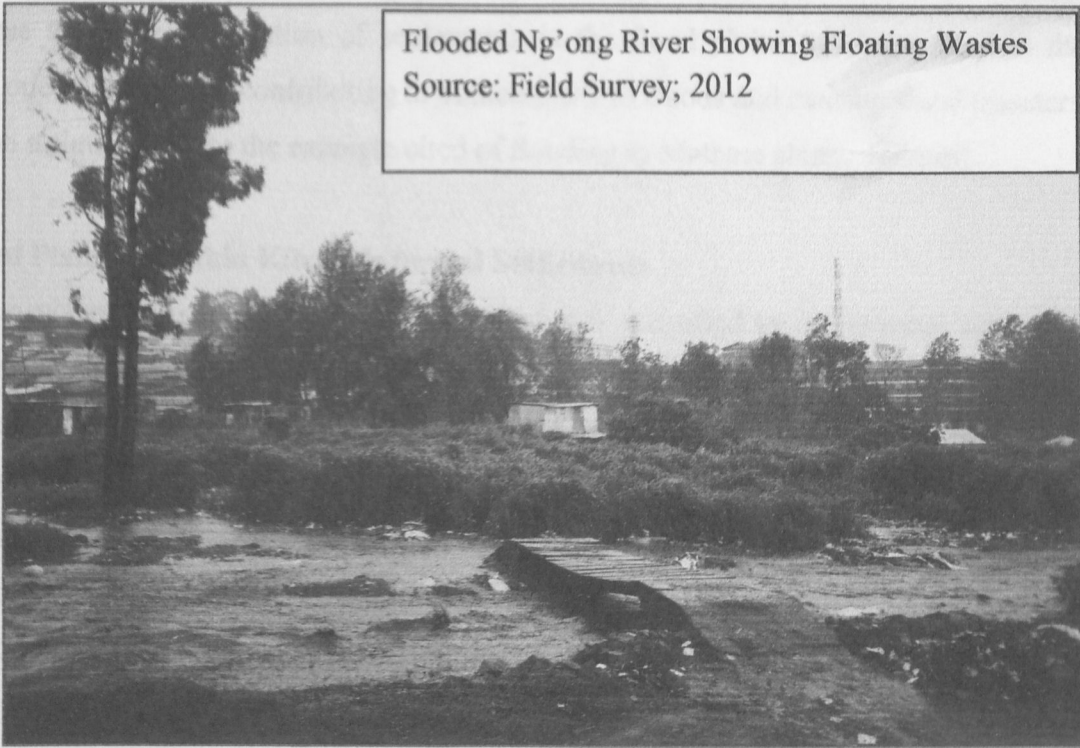
An Overview of crowded Silanga Informal Settlement.

Source: Field Survey, 2012



c) Lack of Proper Solid Waste Disposal

Blocked drains accounted 7% to the causes of floods. Respondents pointed the lack of proper solid waste management within Silanga Village. It was cited that vendors in the groceries business and other commercial activities besides the households contribute to the blockage of drains since they dump their garbage directly in the open drains. This contributes to blockage of drainage channels which would otherwise drain away the storm water causing flooding. Poor dumping of solid wastes was a cause for flooding in the City of Nairobi during the recent floods (April, 2012) which blocked the storm water drains incapacitating them from draining the excess storm water from surface runoff. This factor has not come out clearly in the literature reviewed. Flooding in the urban areas has been largely associated with poor storm water drains as presented in the literature. This study has gone further and established the reason for poor drainage whereby lack of proper solid waste disposal contributes to blockage of the drains causing flooding. The issue at hand therefore is not poor drainage but rather poor disposal of solid wastes which are washed to the existing drainage channel blocking them.



Flooded Ng'ong River Showing Floating Wastes
 Source: Field Survey, 2012

d) Lack of Proper Liquid Waste Disposal

Sections of Silanga Village do not have a sewer line for liquid waste disposal. The residents said that they have no option other than to dispose all their waste water and fecal matters on the narrow trenches in front of the housing structures. This poor disposal of liquid waste aggravates the situation and contributes to temporal flooding even after light rainfall. The storm water mixes with the sewer on the trenches overwhelming their capacity to drain away thus causing flooding. This is a unique factor that has not been tackled in the literature review. The reason to this is that the informal settlement is inadequately covered by a sewer line for liquid waste disposal thus, residents resort to use of flying toilets and direct defecation into the existing open trenches that are used as storm water drains.

e) Riparian Settlements

Silanga Village is bordered by N'gong River to the North, Nairobi dam to the West and Gatwekera stream to the South. These water bodies overflow during the heavy rainy seasons (April-May). The people living next to the rivers and the dam are more affected by the flooding. These have constructed on the riparian reserve being a flood plain, thus, prone to flooding. This is a serious cause of flooding due to implications it has on the nearby settlements. During the interview, the respondents cited the lack

of an alternative space to live and the riparian land is an opportunity they utilize oblivious of the danger they expose themselves. Location of settlements in the flood plains has been cited in the literature review as one of the factors contributing to vulnerability to floods and causing flood disasters in Kenya. This is also a similar case to the example cited of flooding in Mathare slums; Nairobi.

f) Lack of Planning within Kibera Informal Settlements

There is no planning in Silanga Village given that it is classified as an informal settlement. Lack of planning means there lacks basic infrastructure and if any, inadequate to serve the people efficiently. This explains the overcrowding of housing structures, poor access roads, lack of proper waste disposal and management. This compounds the problem of flooding in the locality even in times of response to flood disasters and rescue missions. The lack of planning was an observation made on the site and this is a site specific cause contributing to flooding in the urban informal settlements. The planning regulations have not been enforced especially on restriction of human settlements on riparian zones and building standards.

5.3 Effects of Flooding in Silanga Village

This section mainly discusses the significance and the need to propose ways of reducing the vulnerability of the informal settlements by discussing the effects of flooding. The discussion is based on what the respondents view during the household survey.

5.3.1 Negative Effects of Flooding in Silanga

As discussed earlier in literature review chapter, flood disasters have immense effects on human systems, livestock, agriculture, water resources and the economic sectors of the country. Effects of climate change and flooding is more felt by the vulnerable group who mostly consists of the poor living in the slums. This section will discuss the effects of flooding in the study area and relation is made to the reviewed literature. This is because of site specific features which require a local context approach that the study embraced.

a) Destruction of Roads and Bridges

The normal daily activities are interrupted when flooding occurs. This results to; transport paralysis (15%), disruptions in learning activities (5%), and business (9.4%) which account to 29.4% of all the effects of flooding in Silanga. These effects impact the social-economic life negatively.



Source: Field Survey, 2011; Courtesy of Sadique K.I

A section of busted Ng'ong River: stranded people, vehicles trying to cross from one end to the other.

The river passes through Silanga Village draining its waters to the Nairobi dam. Silanga residents cannot access the other parts of the neighbourhood during flooding that destroys bridges.

b) Outbreak of Diseases

Outbreak of diseases represents 18% of the effects associated with flooding in Silanga Village. The flooded and stagnant dirty and polluted water are the cause of waterborne diseases such as typhoid, malarial, dysentery and cholera. Air pollution, a resultant of odor from the flooded sewer adds to infections. Children play in the dirty flooded water and in the event get contaminants to cause diseases.

c) Destruction of Properties

Properties are lost during severe flooding. This accounted for 20.7% of the total effects of flooding in Silanga Village. The housing structures are swept away by flooded water carrying personal belongings and destroying the housing structures. This is because the house structures are not strong enough to withstand the pressure from flood waters. Destruction of properties encompasses destruction of house structures, loss of personal belongings, destructions of crops grown around the dam and rivers and destruction of facilities such as schools and playing field. 43.8% of the respondents earn their livelihood

within the settlement. This represents a significant percentage of those who suffer workplace loss and business investments in the event of flooding.

d) Loss of Life

Loss of life and properties accounted for 22% of the effects of floods in the informal settlement of Silanga. The most vulnerable to succumb to flooding are children as they are carried and buried by flash floods after a heavy downpours. Death also occur when the poorly built structures collapse and burry people after a heavy downpour. Mud slides also occur and kill people in dangerous sites such as the flood plains.

e) Pain and Agony

Pain and agony inflicted on the survivors of floods cannot be quantified but it's an emotional loss suffered by the community as a result of death of loved ones and property loss. The weak capacity to adapt and recover from the loss aggravates the pain and agony that the victims suffer emotionally and psychologically.

5.3.2 Positive Effects of Flooding

1.2% of the total effects of floods were positive. This consisted of the economic benefit from the casual labourers hired to construct bridges on impassible paths and across rivers. Small scale agricultural activities also take place with availability of water from the rains and floods.

From the literature review section, effects of flooding across the country included economic loss resulting to reduced GDP of about 2.4% per annum; damages to human settlements and infrastructure; loss of properties, lives, livestock, and agricultural plants, and outbreak of diseases both human and animal diseases. These effects are also felt in the informal settlement of Silanga as discussed above. Loss of properties, lives, destruction of infrastructures especially roads and outbreak of diseases tally with the literature reviewed.

5.4 Physical, Socio-Economic and Ecological Vulnerability Factors

Silanga, one of the Villages of Kibera informal settlements presents a zone that is highly vulnerable to floods within the urban areas of Nairobi city. The findings on vulnerability status will be discussed under three dimensions. These are physical, socio-economic and ecological factors that contribute to Silanga's vulnerability to flooding.

5.4.1 Physical Vulnerability

a) Housing Structures Characteristics



Structures erected along the polluted Ng'ong River
Source: Field Survey, 2012

The housing structures in Silanga Village are characterized by weak building materials. The shacks are made out of mud, plastered over sticks and boards, or made from corrugated iron sheets. A few are plastered over with cement and others are made of wood material. The roofs are all made from corrugated iron. The photo below shows weak housing structures which are vulnerable to flooding. The mud walls

are eroded by water from floods. (Source; Field Survey, 2012).The structures are crowded with each room measuring approximately 8 feet by 8 feet to 10 feet by 10 feet. This presents risk in overall mass damage in the event of flash floods. The poor



housing structures are located at vulnerable sites such as next to the river and streams which is used as an easy way of disposing waste. The roofs cannot allow for rain water harvesting adding to the storm water runoff.

b) Streets and Circulation

The paths leading through the homes are narrow and one can touch the structures on both sides of the path. In addition, the pathways are separated at the middle by an open shallow trench that drains storm water, waste water and other liquid wastes. The pathways are also filled with solid wastes such as domestic refuse, plastic bags, pieces of metal, wood, human wastes among other dirt. These flood at every fall of the rains.



Poor internal street networks that act as passage way, drainage channel and dumping spot adds to the vulnerability to flooding in case of rainfall.

Source; Field Survey, 2012

Flood prone internal circulation networks which are clogged as a result of poor waste disposal.

Source: Field Survey, 2012



c) Solid and Liquid Waste Disposal



There is poor solid and liquid waste disposal and management within the informal settlement. Blocked open drains by solid materials compounds flooding. The inhabitants dump their wastes on any open space available and this is mainly the streams and Nairobi Dam which clog causing flooding.

Flooded Ng'ong River displaying floating solid wastes affecting the nearby housing structures.



Waste Disposal at the Ng'ong River

Source: Field Survey, 2012

d) Vegetation Cover

There is thin vegetation cover in Silanga Village. Bare ground is prone to soil erosion by floods and runoff.

5.4.2 Socio-Economic Vulnerability

As discussed in figure 4.1 on average monthly income for Silanga people, majority of the people in Silanga are low income earners (kshs 1,000-5,000). The meager capacity not to be able to cope with floods and recover from loss suffered put Silanga as most vulnerable to flooding in economic terms. This concurs with the literature reviewed on flood vulnerability of the informal settlements. The Silanga residents have lesser capacity to adapt to climate change impacts due to their low living standards as evidenced by the poor and weak structures, low income and skimpy properties.

5.4.3 Environmental Vulnerability



Children playing in polluted environment.
Source Field Survey, 2012

The polluted N'gong River, streams and the Nairobi dam are major environmental problems in Silanga village. The fact that Silanga Village lies next to the clogged and polluted Nairobi dam presents a risk of flooding. The informal settlement is also situated on a flood

plain which is susceptible to flooding. The environmental pollution is exacerbated during floods which carries

the top soil exposing the underground laid water pipes which are susceptible to breakage mixing with overflowing dirty water thus, causing health problems from consumption of polluted water. The mixing of water with sewer is compounded with poor disposal of wastes contributes to the environmental vulnerability of Silanga Village to effects of flooding.

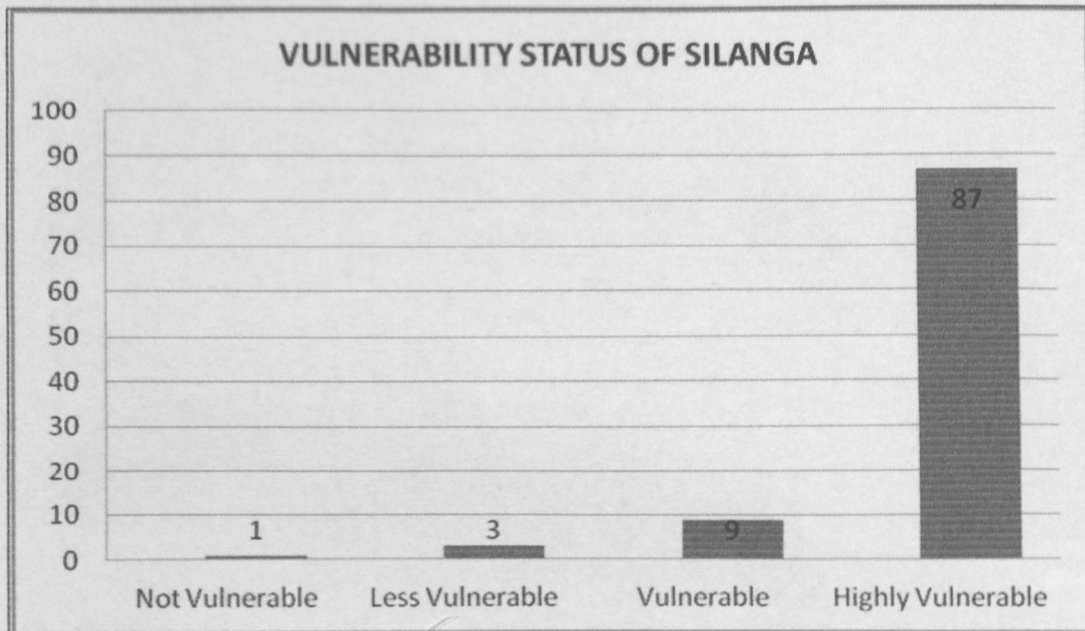
5.4.4 Institutional Vulnerability

There is institutional weakness especially in the lack of coordination of activities that could strengthen the efforts of the community to climate change adaptation and flood management. The inadequate involvement of the community members in the governance structures of some of the institutions working in Silanga misses the real issues at hand and loses the benefit of community collaboration. There exists various institutions especially NGOs, CBOs, Youth Groups and Women Groups which work in the larger Kibera informal settlement but are incapacitated in terms of knowledge/training in flood management and climate change adaption, equipments and funding in community adaptation. The institutions have not also embraced the full involvement of the local residents in its governance structures, thus having low involvement of the locals in their decision and choosing of benefiting community projects.

5.5 Analysis of Vulnerability Status of Silanga to Flooding

From the above discussions on physical, socio-economic, environmental and institutional vulnerability factors, an overall rating was done during the interview with the local residents and this is what their response was:

Figure 5.6 Vulnerability Status of Silanga to Flooding

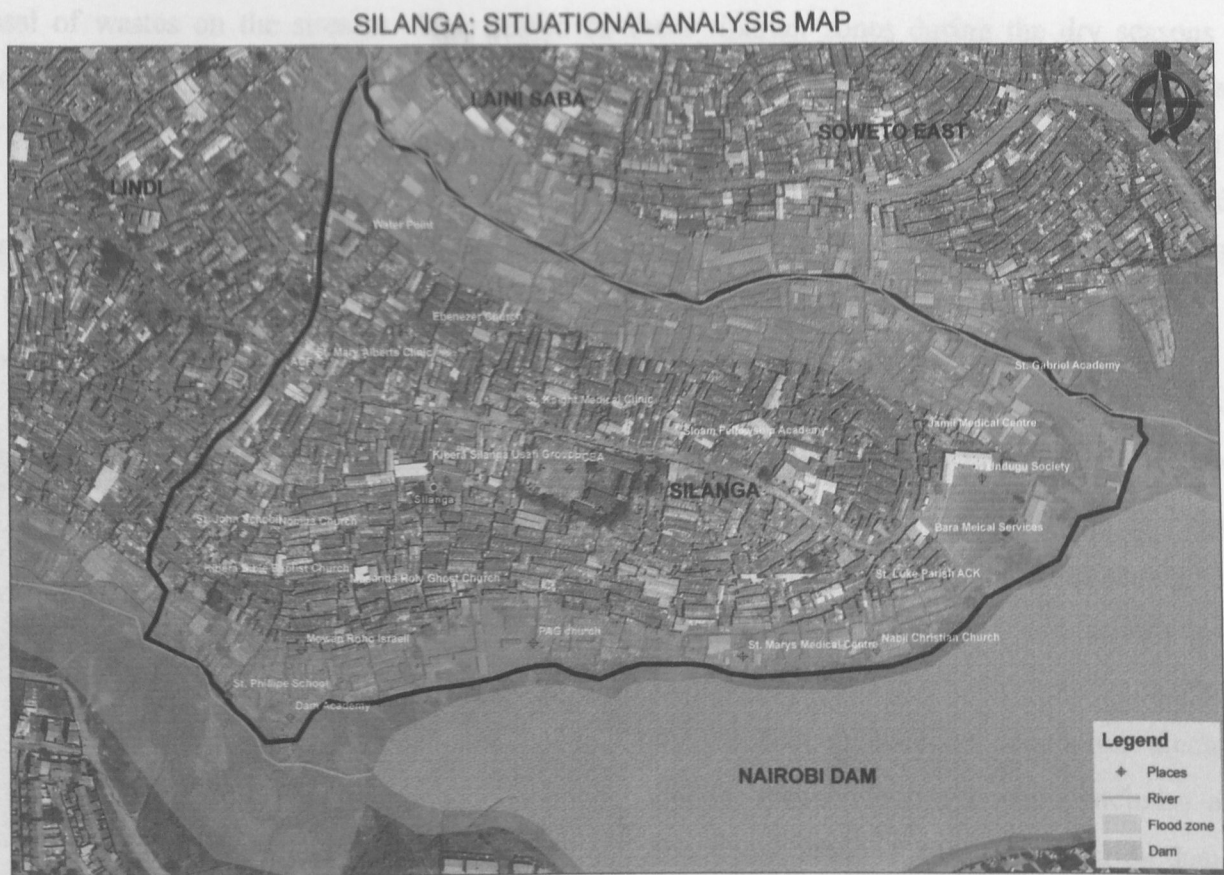


N/B: vulnerability status expressed as percentage (%) Source: Field Survey; 2012

Silanga Village is classified as a highly vulnerable (87%) zone to flooding. This is a high percentage which can be attributed to the risks posed by the nature and characteristics of the human settlements as earlier discussed. This therefore calls for planning action to avert the vulnerability to building resilience among the informal settlement. Planning proposes structural and non-structural measures which reduce the physical, socio-economic, environmental and institutional vulnerability thus, embracing sustainability concepts in enhancing the living conditions of the urban informal settlements.

Below is map 4.1 that shows the most vulnerable zones of Silanga village to flooding. These are the zones where there is riparian location of housing structures close to the rivers and the Nairobi dam. The zones also lack storm water drains due to back to back construction of structures as in a low lying plain as compared to the upper parts of the village which is served by a major access street with open storm water drain to drain away surface run offs.

Map 5.1 Summaries of the Most Vulnerable Sections of Silanga Village to Flooding



Drawn By: Author; 2012

Source: Google Map; 2012

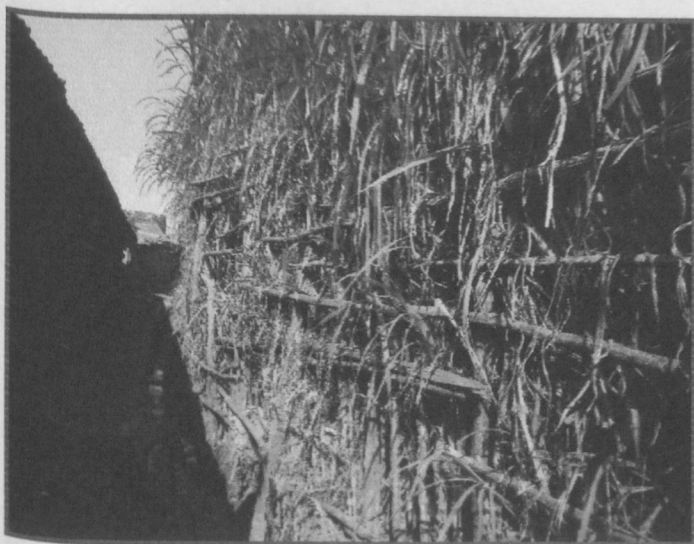
5.6 Existing Local Adaptation Strategies to Flooding

The field survey conducted in Silanga informal settlement established a number of local adaptation and coping mechanisms to flooding. These are both at household level and neighbourhood level. The strategies are also discussed in the categories of temporary/short term and long term measures.

5.6.1 Periodic Moving to Higher Grounds

One of the common adaptation strategies is the periodic moving to safer and higher grounds during the rainy seasons. These are the upper parts of Kibera informal settlements consisting of Soweto East, Laini Saba, Mashimoni and Lindi Villages. Silanga is low lying and receives all the surface runoff from the upper parts of the slum. This disrupts the lives of the households who are affected by floods especially those who have structures next to the river bed and Nairobi dam. This is a seasonal adaptation method

which the residents attributed to the lack of an alternative affordable and permanent safer location of their housing structures. They erect their temporary and informal structures close to the rivers for easier disposal of wastes on the streams. They reside on these riparian zones during the dry seasons and temporarily migrate when it rains heavily since their houses and properties are at risk of being washed away by floods. Those who do not move in ample time lose their meager properties in flood waters and some even lose their lives when the rivers swell and drown people. Some of the residents acknowledged living temporarily with their family friends who have structure on these upper parts of Kibera where there is less flooding as compared to the lower parts until the heavy rains subside.



5.6.2 Planting of Vegetation along the drains

This can be seen as a possible intervention to prevent flooding. The vegetations planted alongside the drainage channel as shown on the photo help to absorb water and to hold the soil firmly. Silanga has little vegetation cover and by planting appropriate vegetation along the highly vulnerable zones which includes along the drains, streams, rivers and Nairobi dam, the residents shelter themselves to the adverse

flooding. The initiative is mostly practiced by a few households who live along the drains and does not extend to the whole village. The vegetation is still a weak adaptation method as it consists of Napier grasses which are also supported by sticks due to their weak stems. The long Napier grass is able to hold water from washing on wet areas but is overwhelmed during the heavy rainy seasons leaving the households at risk of flooding.



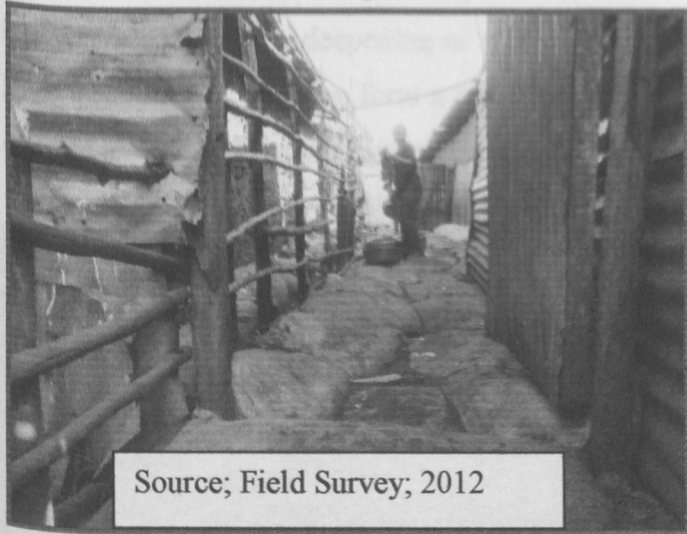
5.6.3 Use of Mobile Footbridge

Individual households erect wooden footbridge across the open trench to the doorstep. This raises the stepping ground in cases where the drains are flooded with polluted storm water. This is a weak adaptation method

Use of Foot Bridge at the Door Entrance
Source; Field Survey, 2012

since the flood waters rise to the door step level during the heavy downpour and water seeps into the houses.

5.6.4 Use of Sand Filled Bags



Source; Field Survey; 2012

Sand filled bags are used to raise the ground and also to cover wet areas as a way of coping with flooding. Sand filled bags are also put across broken bridges as a measure to allow for traffic movement as shown in the photo below.

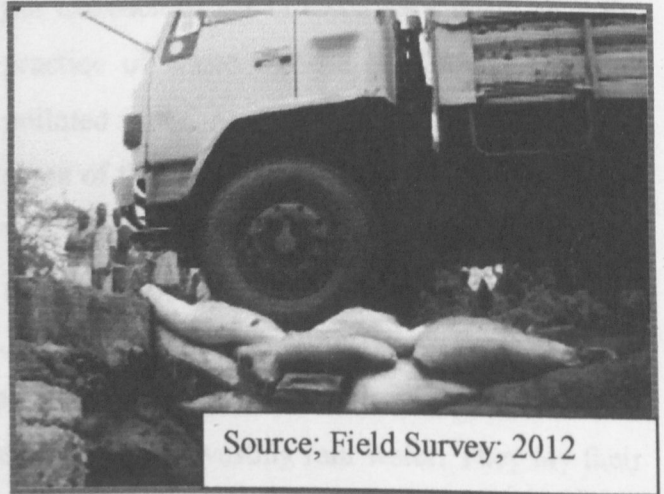
The use of sand bags is widely used as a way of preventing flooding since it is affordable and uses locally available materials which includes

soil and cheap labour to lay the bags. When properly used, sand bags are a stable method of preventing flooding. The compacted soil bags can be laid along river banks and drains and can withstand heavy downpour to secure the residents from the risk of flood waters. The practice is common among the Kibera residents and is used both at household and neighbourhood level.

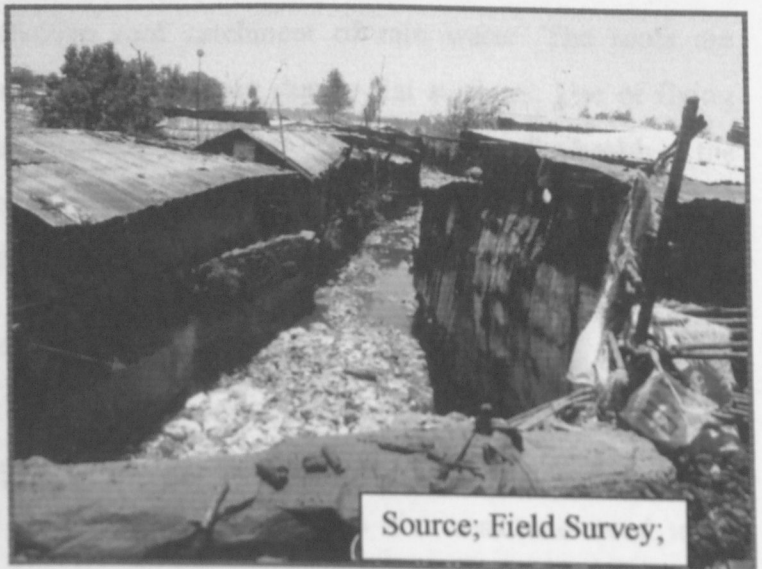
The sand bags are used to temporarily fill the broken bridge to allow vehicles and peoples movement from one village of Kibera slum to another.

5.6.5 Use of Barricades

Walls are built alongside the river using either concrete or corrugated iron sheet to control flooding into the poor vulnerable structures as shown on the picture. The adaptation is partly used by those whose land lords were able to



Source; Field Survey; 2012



Source; Field Survey;

put up the walls in order to protect their structures which are on riparian land/river line. There are structures which hang onto the river but are not protected by a wall. The use of flood walls has been used in many cases of river flooding and is complemented by embankments which involve raising the banks along the rivers, deepening of river channels to hold more water before it floods thus, protecting land around them. This can form a sustainable adaptation method when regulated and constructed using durable materials that withstand water forces from flooding and swelling rivers.



Cleaning of the drains. Source: Field Survey, 2012

5.6.6 Digging Trenches

The residents dig trenches fronting their houses to drain away flood waters. This is complemented by regular cleaning/unblocking of the trenches to get blocked as a result of poor practice of waste disposal leading to stagnant polluted water. As a way of preventing flooding, some of the residents use garbage bags for solid waste disposal which are used to collect all garbage and disposed properly. This prevents

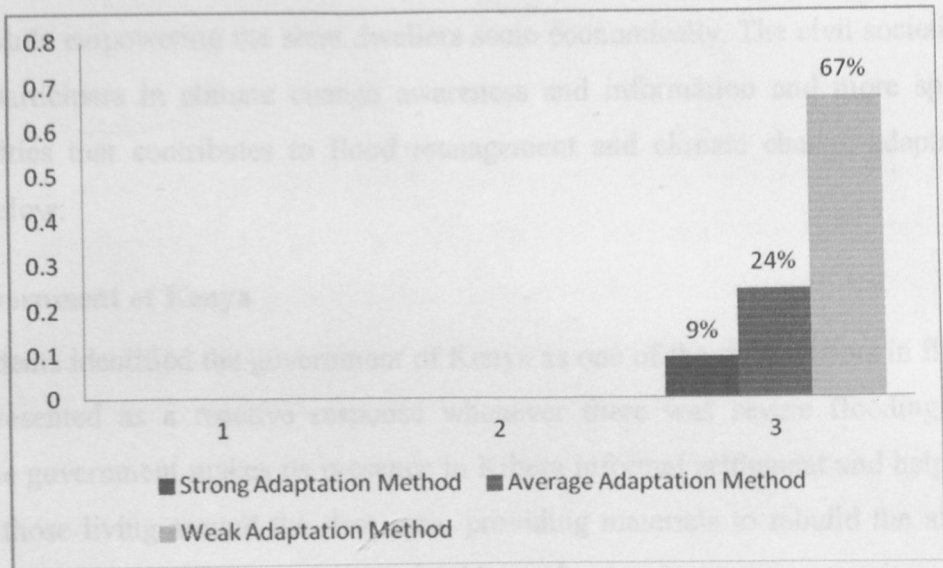
haphazard littering of wastes which add to flooding. Another way of draining flooded water is by digging a hole through the house so that the water can find its way out. On the same note, residents reduce the amount of runoff from their roofs into the drainage by harvesting rain water. They lay their basins and any useful wares to collect water from their roof tops. This is challenging as the structures are not fitted with gutters which would allow effective roof catchment of rain water. The roofs are constructed in a manner that does not allow rain water harvesting due to flat surfaces. Use of flying toilets which land on the rooftops also contaminate the collected water posing danger to the health of the residents. However, the frequent cleaning exercises and unblocking of existing storm water drains presents a good case of reducing flooding and adapting to climate change impacts.

5.7 Analysis of Local Adaptation Strategies at Planning Dimension

A question was asked on whether the strategies discussed above were adequate and residents rate d the overall strength of what they do to adapt to flooding menace. A larger proportion of the respondents consisting of 67% affirmed that the existing flood coping mechanisms are weak and need to be

strengthened to sustainably help the community to build resilient to climate change impacts. 24% of the respondents said the strategies averagely prevents flooding but are not strong to withstand extreme conditions during erratic and heavy downpours. Only 9% acknowledged that the mechanisms were strong adaptation method. Majority of these are residing in houses provided with barricades of concrete walls which at the time stood as the strongest flood control measure within the informal settlement and thus, do not experience flooding.

Figure 5.7 Rating of Strength of the Local Adaptation Strategies in Silanga



Source: Field Survey; 2012

The role of planning is to provide sustainable solutions to problems of the informal settlements. As previously discussed in the literature review chapter, various types of plans come in handy and aid in climate change adaption in human settlements. This can be linked to some of the above discussed local practices/strategies so as to strengthen them. The flood risks from the vulnerability section should be mainstreamed into city plans, programs, activities, policies and respective plans so as to address them in formulating sustainable flood management strategies. These include: informal settlement upgrade plans, local economic development strategy, transportation plan, storm water management plan, solid waste management plan, sewer/liquid management plans, energy management plans, water management plans, emergency management plans, public health plan which will provide stronger adaptation strategies building on the existing ones. The local strategies thus, inform planning of the slum housing and services/infrastructures with regard to flood management.

5.8 Roles of Different Actors in Flood Management and Climate Change Information

This section covers the third objective of this research project which aimed at examining the roles of different actors in urban flood management especially from the study area. A further examination was on the level of local participation in the governance and decision making of these organizations. The residents of Silanga Village were able to identify the various actors who come into play during floods and these agencies range from the Government of Kenya, NGOs, CBOs, Youth Groups, Women groups. These can be classified as the civil societies working with the informal settlers in improving their living environment while empowering the slum dwellers socio economically. The civil societies contacted are those which participate in climate change awareness and information and more specifically which supports activities that contributes to flood management and climate change adaptation. These are discussed as below:

5.8.1 The Government of Kenya

The local residents identified the government of Kenya as one of the major actors in flood management which was presented as a reactive response whenever there was severe flooding in the informal settlement. The government makes its presence in Kibera informal settlement and helps the community by relocating those living around the dam area, providing materials to rebuild the affected houses as compensation to the flood victims, sending health workers to spray on mosquitoes which breed on stagnant waters, funding of projects while partnering with nongovernmental organizations to manage floods, giving relief food and dissemination of information through chiefs.

The local residents in Silanga Village seemed not to be aware of the government institutions mandated to manage floods and assist in climate change information. These institutions were discussed in the literature chapter but the field survey established a missing link between the institutions and the local people. This results to breakdown of communication of climate information and flood disaster preparedness and management at the practical and local level. The informal settlements are not adequately covered by these institutions and thus, an indication of low level of community participation in the governance and decision making in managing floods and adapting to climate change within the established government institutions.

5.8.2 Kazi Kwa Vijana Initiative:

The KKV programme was launched in 2009. Its aim was to employ both urban and rural youth in labour intensive public works projects like road maintenance, water harvesting, afforestation and waste collection. The government also supports a fund providing young people with finance for self employment and entrepreneurial skill development. What's most significant about the project is the level of awareness and involvement of the youth in community projects. In Silanga village, the KKV has helped in digging new trenches to drain storm water, unblocking the existing trenches, collection of garbage and conducting general clean up exercises in Silanga.

5.8.3 The City Council of Nairobi

The City Council of Nairobi is responsible for provision of municipal services such as water supply, sewerage and drainage services, solid waste collection and disposal, street lighting among other environmental services. This it does through complementing bodies such as the Nairobi water and sewerage company. There is inadequate provision of these services in the informal settlement of Kibera and thus need to efficiently provide the social amenities in order to reduce the vulnerability of the residents to flooding. The council should also be on the fore front in helping the community adapt to the climate change and variability through implementation of environmentally friendly development plans.

5.8.4 Non-Governmental Organizations

Relevant NGOs that were recognized by the local residents includes: International bodies such as The Red Cross Society, World Bank, Amref, Care Kenya, Global Peace, Kilimanjaro Initiatives (KI), and Carolina for Kibera. The section below expounds on the activities of KI in Silanga Village. Its activities were well documented and provided a good case study for mapping of best practices in flood management. It is important to note that the research aimed at observing the activities of NGOs who are specifically involved in flood management and climate change related projects and programmes within the informal settlement.

Plate 5.1: Clean Up Projects by Kilimanjaro Initiative (KI)



Before, the open drains were blocked by solid wastes causing flooding. After unblocking the drains, there is flow of water thus reducing flooding.

KI is one of the NGOs that initiate community projects in Silanga informal settlement which help in managing flood occurrence through clean up exercises. Some of the projects includes: constructing new storm drains, unblocking of storm water drains, cleaning of Ng'ong River, cleaning of the Silanga sports field and upgrading of the same, building of gabions and footbridge on Ng'ong River, and planting of trees to curb flooding of Ng'ong River.



Photos courtesy of (Sadique, KI)

This is one of the good practices that the NGOs conduct in Silanga Village. The organization identifies with the local adaptation strategies of periodic cleaning the trenches in order to drain away storm water. The official from this NGO mobilizes the community members especially the youths and organizes the community clean up exercises with the locals. This enhances ownership of the project activities and raises the level of local community participation and decision making.

Plate 5.2: Cleaning of Flooded Silanga Field By KI



One: Flooded Silanga Field from Ng'ong River before rehabilitation by the KI and the local residents



Two: Cleaning exercise organized by KI involving members from Silanga Village



Photos Courtesy of (Sadique, KI)

Three: Current status of the field after the clean up; rehabilitated and planted with trees enhancing the environmental quality of the informal settlement

Source: Field Survey, 2012

Plate 5.3 Cleaning of Flooded Ng'ong River by KI



From a sea of
garbage to a river.
KI project.

Photo courtesy of Sadique; KI



The above shows the cleared Section of Ng'ong River which passes through Silanga Village after removal of garbage from the river channel reducing blockage and allowing flow of water.

The right photo shows KI participating in tree planting on the rehabilitated field by manage flooding as well as increasing vegetation cover of the site. This has added the environmental value of the field as a multipurpose meeting place.



to



The rehabilitated Undugu sports field is currently in good condition and hosts most of the games in Kibera. It is the only open space for the whole of Kibera informal settlements. It was rehabilitated by KI.

Source: Field Survey, 2012

5.8.5 CBOs

The CBOs which help in Community clean up projects related to flood management and climate change adaptation consists of the Health Workers, and Health Life Group. These are CBOs which residents of Silanga Village were able to identify during the field survey. They organize and mobilize the residents on the importance of maintaining a cleaner environment free of garbage and training on alternative ways of disposing human wastes by discouraging use of flying toilets and promoting use of latrines with facilitation of frequent emptying of the sewer, as well as providing education on ways of maintaining a healthy population.

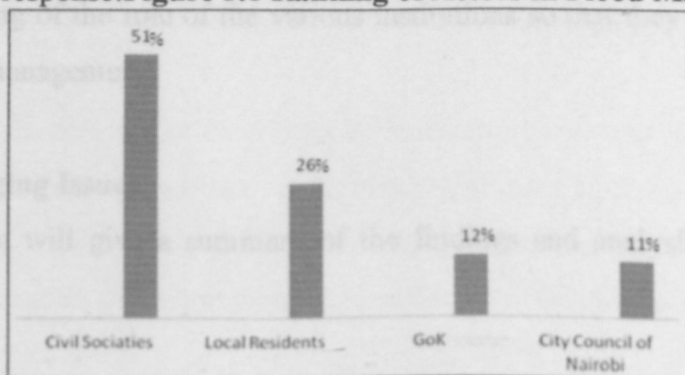
5.8.6 Youth Groups

Silanga Youth Groups, Undugu Society, Ghetto Prodigals, Kounkey Design Initiative, Kysport Group, Kisua-Kibera, Silanga Ushirika Group were the list of some of the youth groups conducting activities and projects in the village aiming at reducing vulnerabilities of the community to flooding menace. The youth groups draw members from the Kibera informal settlements and train their own in taking care of the environment besides economically empowering the youths and nurturing their talents through sports and social media reporting. The youth groups are engaged in collection of garbage around the settlement and sensitizing the other residents on importance of proper waste disposal methods. The youth thus, become agents of positive change within the informal settlement and raising awareness on cross-cutting issues including climate change information. The youth groups partner with other civil societies in carrying out collective community projects such as cleaning of the Ng'ong River.

5.9 Analysis of Roles of Different Actors in Flood Management in Silanga

When residents were asked to rank the agencies that help them best in managing flood, the following formed the response:

Figure 5.8 Ranking of Actors in Flood Management



Source: Field Survey, 2012

The civil societies had the highest ranking in terms of involvement into flood prevention activities within Silanga Village. This shows poor visibility of the government institutions in flood management issues in the informal settlement of Kibera. The civil society's presence and involvement in community projects which improve the environment in terms of draining storm water and unblocking clogged drainage channels are good flood mitigation practices.

Ideally the government presence should be strong in the area especially when it comes to flood disaster management and water catchment management of the Ng'ong River and the conservation of the Nairobi dam. The government institutions mandated by different acts of parliament and national strategy papers such as those under the ministry of water and irrigation and ministry of special programme should be on the forefront in helping communities adapt and deal with flood disasters. The MWI cites the involvement of the marginalized communities in its strategy to manage water resources but this is still to be implemented at the urban informal settlements.

The City Council of Nairobi is mandated by the Physical Planning Act and the Local Government Act to control development and to provide essential services and infrastructures to the people in its area of jurisdiction. The council has inadequately provided its services to the people living in Silanga village as in the larger neighbourhood of Kibera slums.

As a result of lack and inadequate presence of the institutions in flood management and climate change adaptation in Kibera informal settlements, local residents have devised ways of coping with flooding and adapting to climate change. This calls for strengthening of these adaptation methods and improve their capacity and resilience to manage floods in more sustainable ways. This also points out to strengthening of the role of the various institutions so that they can effectively adapt to climate change and flood management.

5.10 Emerging Issues

This section will give a summary of the findings and analysis emerging issues as derived from the discussions.

5.10.1 Emerging Issues in Vulnerability of Silanga to Flooding and Climate Change

This study has classified Silanga Village as a vulnerable zone to flooding and impacts of climate change. This is in tandem with the literature reviewed which pointed that informal settlements are one of the vulnerable areas to experience flooding and bear most of the risks associated with climate change impacts. The vulnerability in Silanga exhibits itself in form of physical, socio-economic, environmental and institutional factors as earlier discussed. Factors which contribute to the physical vulnerability include: the poor and weak housing structures, lack of a proper waste disposal and management methods, riparian location of housing structures, and poor streets and circulations. Low income level and activities were factors contributing to economic vulnerability while pollution of the environment was the main factor contributing to environmental vulnerability. These compounded with weak institutions puts Silanga as the most vulnerable area to the effects of climate change and flooding.

It has also emerged that there is inadequate measures put into place to reduce the vulnerabilities of the informal settlements. The institutions which are mandated with controlling development on flood plains have not enforced the stipulations in the regulations on building development. This is evident by the riparian location of human settlement in Silanga Village and poor buildings. There lacks planning in the informal settlement and basic services and infrastructures do not commensurate the high population in the slums.

There is existence of laws and institutions on water resource management where flood management is concerned as outlined in the literature review chapter. However, this has not been implemented and management of the river catchments passing through the slums is wanting. The waters in Ng'ong River, Gatwekera River and Nairobi dam is polluted and cannot be used as a source of safe-clean drinking water. Conservation and protection of these key water features has not been undertaken.

Disaster response in the urban informal settlements is poor as the mandated institutions to handle flood disaster operations and activities lack presence at the grassroots. Their operations are also hampered by the poor road networks which makes accessibility into the slum difficult. The disaster operation centres are not well known to the local residents and this results to organic reaction whenever flooding strikes in the informal settlements.

5.10.2 Emerging Issues in Existing Local Adaptation Strategies

The existing local adaptation strategies in Silanga Village included periodic migration to safer grounds, unconscious planting of vegetation along wet areas, use of mobile foot bridges, compacted sand filled bags, construction of barricade walls and regular unblocking of existing open storm drains. These coping mechanisms are not adequate to sustainably manage floods and adapt to climate change.

The urban informal settlement residents have inadequate knowledge on the flood risks they expose themselves. The awareness level is still low as this should inform designing strong coping mechanisms. The use of two way communication on weather forecasts and flood warning systems is non-existent in the informal settlement.

5.10.3 Emerging Issues in Roles of Different Actors in Flood Management

The research findings have pointed out the weak flood disaster management capabilities within Silanga informal settlement residents. Both the community and relevant institutions have weak base in terms of planning, preparedness and equipment in facing floods. This may be attributed to inadequate information and data access on extreme weather conditions as predicted and announced by the early warning systems in place. The low level of awareness of climate change impacts contributes to the low capacity to adapt and manage floods.

There is also inadequate integration and coordination between and among the local community and the relevant institutions. There is low involvement of community members into water governance structures. The community seems to find their local coping mechanisms with no complementing strengthening from the institutions mandated to control floods. However, the civil societies seemed to have a stronger base with the community initiatives to prevent flooding. There is still inadequate policy coordination in the institutional framework, inadequate finances, human resources and equipment to manage flood incidences effectively.

There is however opportunity to reduce the vulnerability of the informal settlement to flooding and impacts of climate change through preventive and responsive strategies for the local communities. Integration of the flood risks management in the preparation of a development plan for Silanga Village will thus form a basis for sustainable urban flood management in the context of a changing climate and highlighting the important role of planning in climate change adaptation. This is discussed in the next chapter on recommendations.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Introduction

This chapter provides answer to the fourth objective of this study which was to design a framework for a sustainable climate change adaptation and flood mitigation practice in urban informal settlements. Decreasing the vulnerability of socio-economic sectors and ecological systems to natural climate variability through a more informed choice of policies, practices and technologies will, in many cases, reduce the long-term vulnerability of these systems to climate change (IPCC 2000a). Experience with adaptation to climate variability and extremes can be drawn upon to develop appropriate strategies for adapting to anticipated climate change. Adaptation to current climate variability and extremes often produces benefits as well as forming a basis for coping with future climate change (IPCC 2001: 8). This then calls for the need to address the vulnerabilities facing silanga village as well as strengthening their adaptation strategies to withstand flooding and climate change.

6.2 Conclusion

The residents in Silanga village have developed local strategies which helps them to adapt to climate change and flooding. As previously discussed, some of these strategies are weak and cannot withstand extreme flood conditions. There is need for sustainable measures to be put in place within the urban informal settlement taking opportunity of the already existing local adaptation measures. Mitigation practices such as digging of new trenches, unblocking of storm water drains, planting of vegetation, use of sand bags and cleaning exercises are good examples of what can be enhanced and retained to reduce flood incidences in the urban informal areas. There is need for strengthening these activities such as in funding and improving the capacity of both the local residents and institutions involved in these activities.

Handling of the flood disasters by the institutions which are legalized in the country has not been effected at the local levels in the urban informal settlement. The role of civil societies working on flood management and climate change adaptation in the urban informal settlements need to be strengthened since they operate at the local level and have better rapport with the residents. Training, public education and equipping actors in urban flood management should be followed up to help communities and institutions to better adapt to climate change.

Urban planning should play its role in reducing the flood vulnerabilities of the urban informal settlements. This is through putting into place both structural and un structural measures such as; to site the human settlements in safer grounds; ensuring that the housing structures are made from standard locally available and affordable materials; approve and ensure that the housing units are climate proof and promote use of environmental friendly building designs to adapt to climate change; ensure provision of commensurate social amenities, services and infrastructures such as adequate street circulation, storm water drains, sewer lines, solid waste management; electricity and recreational facilities. Planning should also ensure that the human settlement is self sustaining by creating economic opportunities for the locals to earn their livelihood so as to raise their capacity by improving their living standards.

6.3 Recommendations

The research proposes a number of actions which will be helpful in managing flood in the whole of Kibera informal settlements and other settlements with similar characteristics. These are discussed as follows:

6.3.1 Reduction of Vulnerability of Silanga to Flooding

In order to reduce the physical, environmental, socio-economic and institutional vulnerabilities exhibited in Silanga Village, the following proposals are made:

a) Raising Awareness and Community Participation on Climate Change Information and Flood Mitigation Practices

The local residents need to be empowered with timely information on climate change, weather forecasts and flood management practices. Community participation will involve data collection, operation and maintenance of a local hydro-meteorological network, ensuring security, interpretation of forecasts/warnings at local level and training of the local flood management teams. Support will also be availed to the local community in developing their capacity in flood disaster management and the development of national and local flood management plans.

This component will enhance the collection of hydro-meteorological data, rainfall and river levels in the catchment; build capacity in flood forecasting and generation of early warnings and the use of remote sensing technologies (satellite imagery, radar, lightning and storm detectors, etc.) – with the objective of providing information to decision makers, disaster managers and vulnerable communities at the earliest possible time.

b) Community Collective Clean Up Projects and Activities

This was well elaborated in the findings chapter as a good practice that the residents engage in collaboration with Non-Governmental Organizations and civil societies. The Community Based Organizations also work together with local residents in organizing general clean ups activities within the informal settlements. These activities include unblocking the drainage channels, digging of trenches and collective efforts in managing wastes whereby the residents are facilitated with waste bags and youth groups assist in the collection and dumping of the wastes appropriately. Cleaning of the streams passing through the settlement is also one of the ways to enhance flood mitigation practices. Community mobilization and facilitation in terms of equipments and finances will promote environmental projects that form part of good mitigation practices. These activities should be encouraged regularly with special consideration to periods before the rainy seasons so that all wastes are removed from land and drains to prevent flooding.

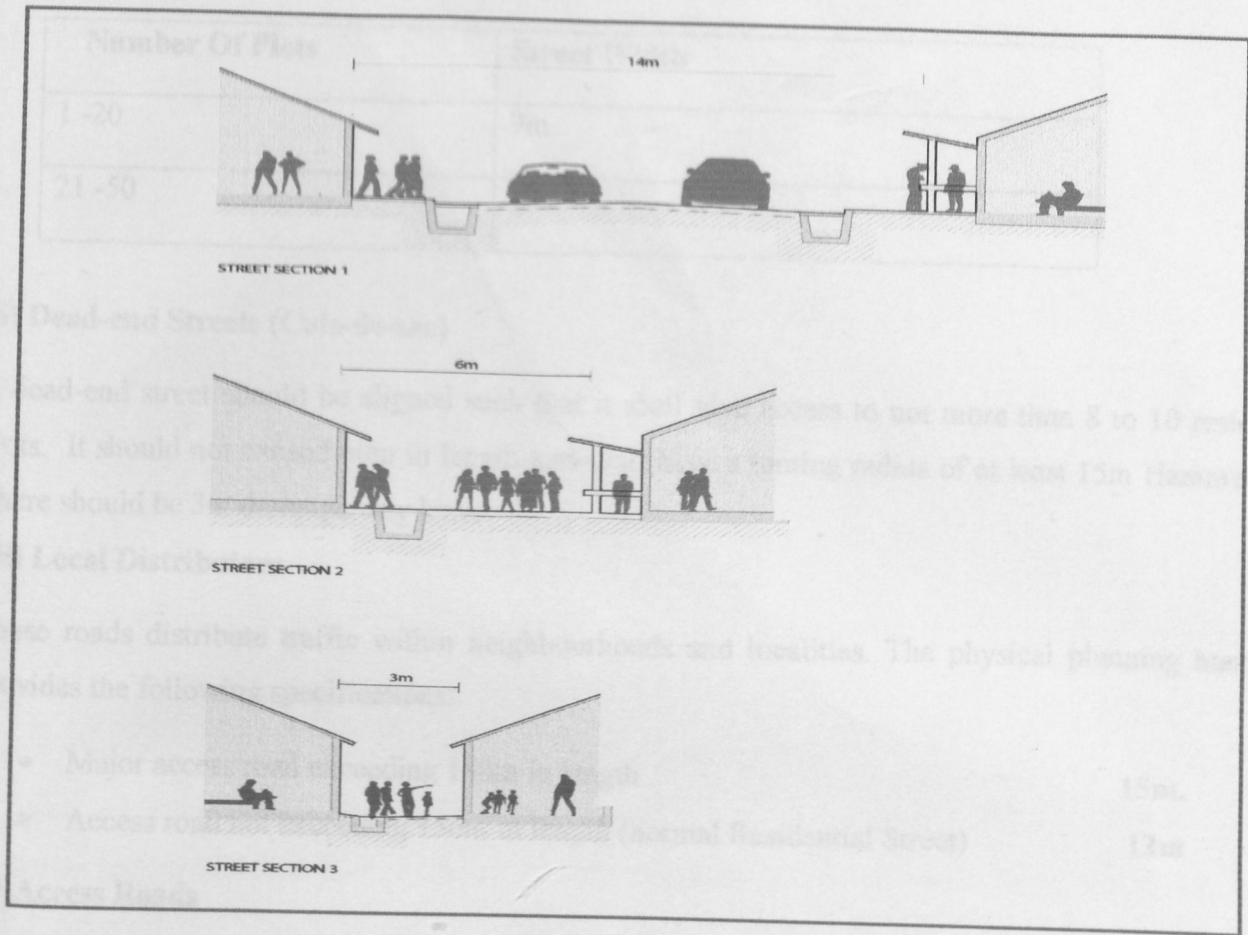
C) Proper Waste Disposal and Management

In addition to the proposed new housing units, there is need for provision of necessary services/facilities and infrastructures for waste management in the informal settlements. This will be to ensure holistic approach to settlement upgrading. Proper methods of solid and liquid waste management should be put into place. It was seen from the field findings that poor disposal of wastes contributes to flooding as the wastes block storm water drains and chocks the rivers and the dam. Provision of waste collection bags to the households made from environmentally friendly materials will go a long way in reducing haphazard dumping of wastes into the drains. Waste collection points should be designated where the service provider's trucks will collect the wastes and transport to a designated dump site. Efficient collection and disposal of wastes will promote a cleaner environment. Extension of sewer line to cover the whole settlement will enhance liquid waste disposal and reduce the vulnerabilities posed by the current poor waste management in the informal settlements.

d) Improvement of the Streets and Circulation within the Informal Settlements

The poor circulation paths should be cleaned from all wastes and street widening to be undertaken so as to allow adequate and free movement of people and vehicles especially in times of disaster response. The streets should be fitted with closed storm water drains to prevent blockage from liters and facilitate draining of storm water. Effective storm water drains and adequate street provision will enhance accessibility, reduce flooding from storm water and aid in response activities during in the event of disasters thus, reducing flood vulnerability of the urban informal settlements.

Plate 6.1 Proposed Street Sections



Drawn by: Author, 2012

Planning Standards for Residential Streets

The Physical Planning Handbook (2007 Edition)

i) Street Width

It is recommended that the width of streets or access lane in a residential area be determined by the number of dwelling units or plots to be served. The minimum street width for given number of plots may be indicated as shown in the table below. It is further recommended that the street network be hierarchical so that in the future urban areas will have a high rise urban morphology even in residential areas

Table 6.1 Minimum Street Width Per Given Number of Plots

Number Of Plots	Street Width
1 -20	9m
21 -50	12m

(ii) Dead-end Streets (Culs-de-sac)

A dead-end street should be aligned such that it shall give access to not more than 8 to 10 residential plots. It should not exceed 60m in length and shall have a turning radius of at least 15m Hammerhead. There should be 3m drainage way leave.

(iii) Local Distributors

These roads distribute traffic within neighbourhoods and localities. The physical planning handbook provides the following specifications:

- Major access road exceeding 150m in length **15m.**
- Access road not exceeding 150m in length (normal Residential Street) **12m**

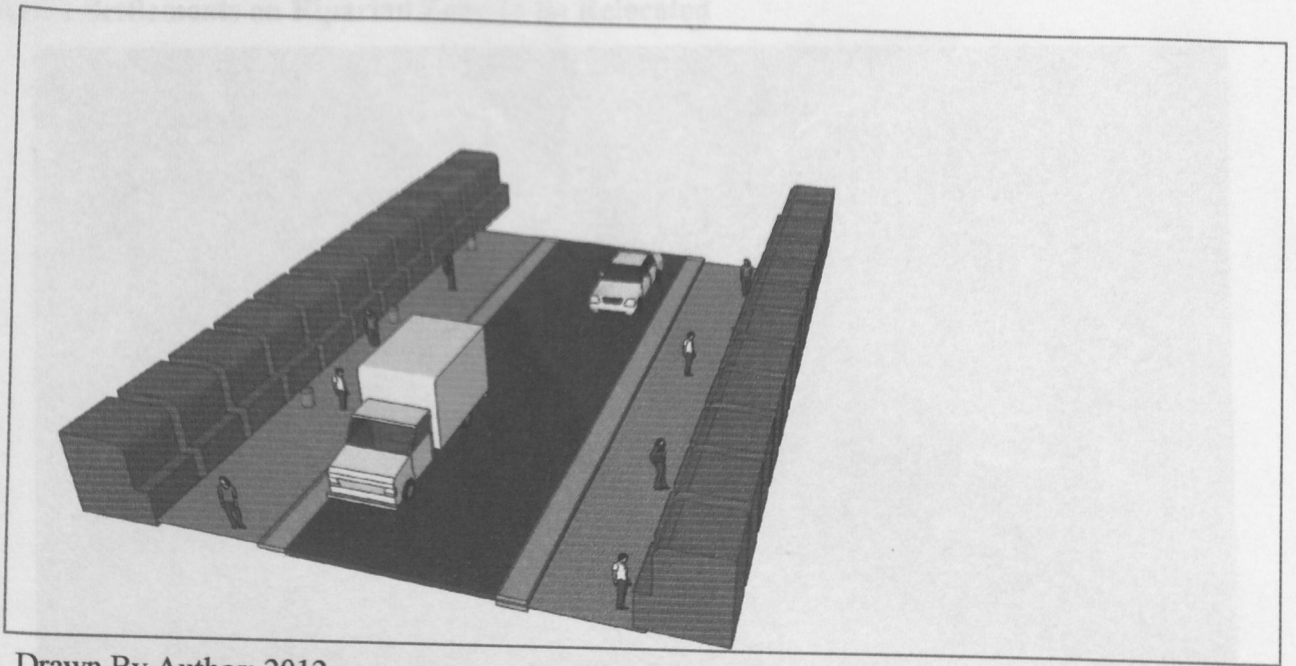
(iv) Access Roads

These roads give direct access to buildings and land within neighbourhoods and localities.

- Cul-de-Sacs or short connecting road not exceeding **6m- 9m**
- Service lanes **6m**
- Cyclist lanes **3m**
- Footpaths **2m.**

Plate 6.2 Impression of Improved Streets

This shows the basic infrastructure to be placed along the road such as storm water drains, pedestrian walkways, dust bins and space for vehicular movement. The street lining is used for retail shops and light commercial activities as there will be regularization of the stalls.

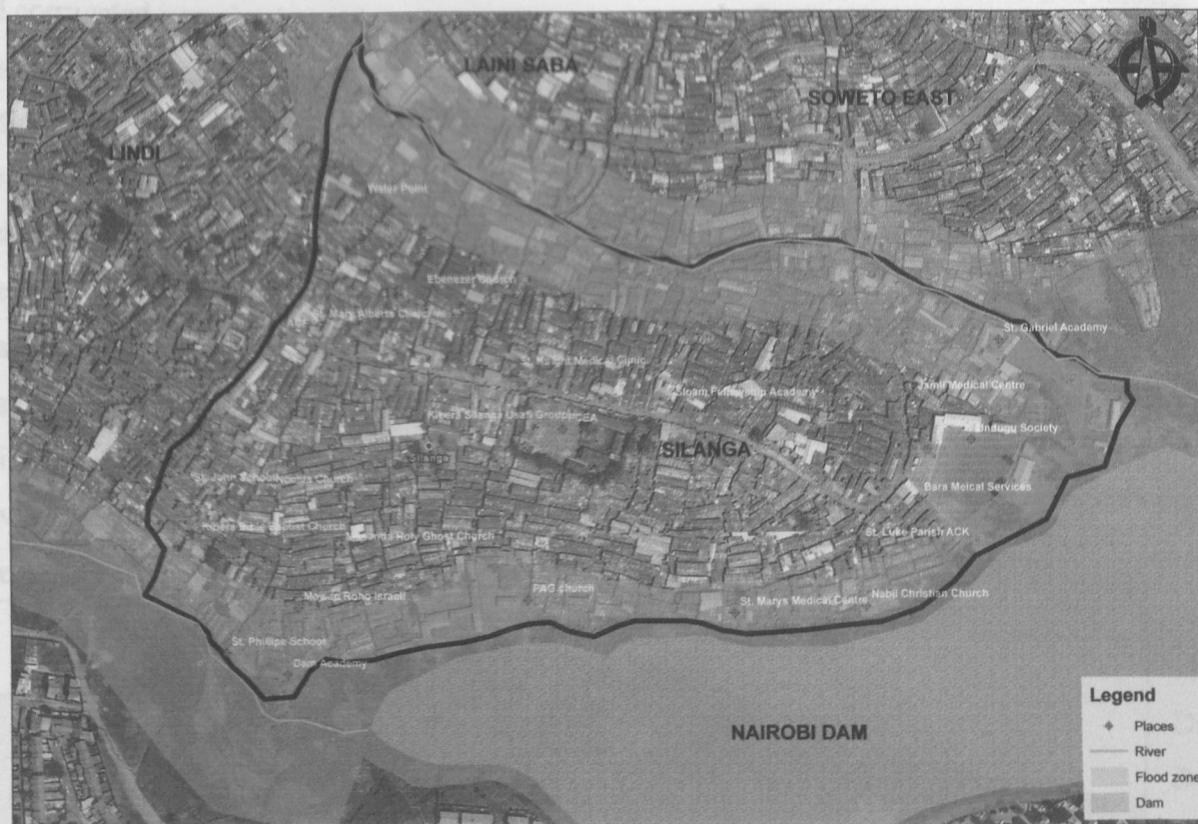


Drawn By Author; 2012

e) Restriction of Settlement on Riparian Land

Riparian land is that land that adjoins or directly influences a body of water. It includes riverbanks and land immediately alongside gullies, streams, creeks, rivers and wetlands that interact with the water flow. Riparian lands in Silanga Village include all the land alongside the Ng'ong River, Gatwekira stream and land adjacent to the Nairobi Dam. As indicated in the map below, these areas have been settled yet they are known to be flood prone. In planning profession, a minimum of 3 Metres to a maximum of 60 Metres depending on the width of the river/stream is recommended to be reserved as riparian zone with no human settlement. This plan therefore recommends that all structures located along the riparian to be demolished and alternative safer site to be identified to settle the displaced households. A cost benefit analysis of this option gives the benefits advantage since the move will be one way of reducing flooding vulnerability and its effects to the affected households as it is said *'prevention is better than cure'*. The move will lead to preservation and conservation of the riparian areas as well as enabling river rehabilitation.

Map 6.1 Settlements on Riparian Zone to Be Relocated



The riparian zone should be recovered and planted with vegetation and appropriate tree species to conserve the River line and protect the river and streams from pollution. The trees will also serve as a way of preventing flooding and increasing the vegetation cover in the settlement. Minimal agricultural practices may be encouraged along this land in order that the local livelihood of the residents is maintained and promoted. This will enhance their commitment to take care of their environment and be monitors of any illegal practice on the riparian reserve.

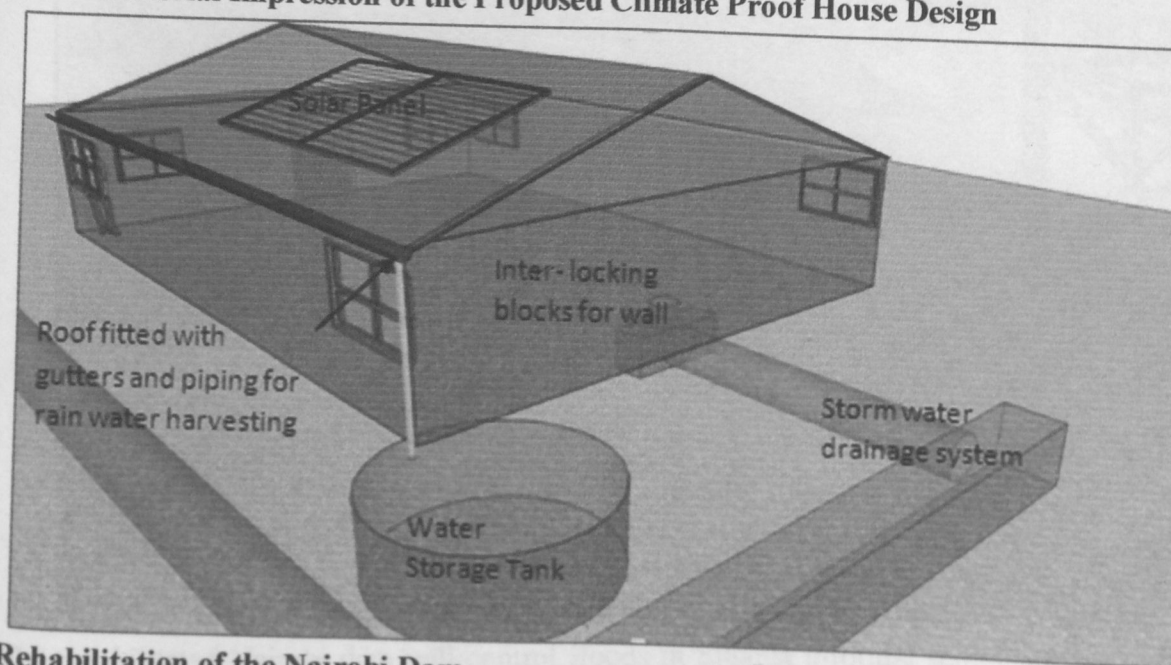
f) Redevelopment of Housing Units (Climate Proof Low Cost House Designs)

This is where planning of slum housing and infrastructure plays a major role in building resilience of the buildings which are currently made of poor and weak materials that are easily washed by floods. This plan proposes redevelopment of housing structures in the informal settlement from shacks to climate proof and environmentally friendly housing units. The new houses will be built using durable, locally and affordable materials which are strong enough to withstand extreme weather conditions such as heavy rainfall that causes flooding in the settlement.

The walls of the proposed housing units will be made of interlocking blocks which will replace the mud and corrugated iron sheets used presently in the slum structures. This will involve laying of a foundation to support the walls thus, able to withstand soil erosion. Corrugated iron sheets will be used as the roofing material.

The roof design will be modified to allow slanting and will be fitted with gutters to enhance roof catchment of rain water. The design also proposes installation of solar panels to tap sun energy as a clean source of energy and to cut down on dependence on hydropower generated electricity that is already threatened by reduced water resources attributed to the impacts of climate change. The new housing units should also include storage tanks to store water from rainwater harvesting. All these details should be checked by the approving authority before new developments are undertaken in the redevelopment programme. The main components of the house are as shown below:

Plate 6.3 Pictorial Impression of the Proposed Climate Proof House Design



Drawn
By:
Author,
2012

g) Rehabilitation of the Nairobi Dam

This can be possible using the already existing measures such as the Nairobi Dam Trust Initiative. This is a trust fund that was set up by the friends of Nairobi Dam Association to provide a forum to address issues specifically related to the Nairobi's rivers ecosystem and to mobilize financial and other resources to support a healthier environment for the present and future residents. The stakeholders for this trust fund include: Land lords and tenants of Kibera slum, NGOS, Neighbourhood associations, water users associations, City Council of Nairobi, sailing club, government ministries, NEMA, provincial administration, UN agencies, multilateral and bilateral agencies. The Nairobi Dam Trust Initiative is a

toolkit that will enable the rehabilitation of the dam and incorporate the commercial aspects of scenic beauty and ideal location such as: Water sports, amphitheater, walkways, cottage industries, picnic sites and several other income generating activities to sustain the project. Rehabilitation of this dam will greatly control floods as the dam will now be use to trap and store water without flooding. The initial use of the Nairobi dam can be restored to promote tourist activities and economic activities to earn the local residents their livelihood.

Plate 6.4 Pictorial Impression of the Nairobi Dam in 1960s



The rehabilitated Nairobi dam will control floods in Silanga informal settlements as well as providing numerous recreational activities and employment opportunities to the local residents.

h) Rehabilitation of the Ng'ong River and other Streams

Interventions on the streams and the N'gong River include:

- ✓ Delineation and securing of the riparian reserve.
- ✓ Removal of accumulated solid waste along the river stretch & tunnels.
- ✓ Landscaping, bank stabilization and greening the area.

- ✓ Construction of storm drains to minimize soil erosion.
- ✓ Installation of floodlights to enhance security.
- ✓ Co-ordination of informal business activities into organized enterprises such as gardening practices.
- ✓ Embankments –these are raised banks along the river which make the river deeper so that it can hold more water protecting the land around from its flooding.
- ✓ Channelizing of the rivers and streams-this prevents flooding though there is risk of flooding downstream where the river is not channelized causing water to build up and flood.
- ✓ Construction of flood walls along the rivers to prevent flooding on the settlement.

Existing established initiatives on The Nairobi Rivers Rehabilitation and Restoration Programme of NEMA will act as a major opportunity in achieving this recommendation. This was initiated to carry out rehabilitation activities on Nairobi river basin at various parts of the basin. The work was supplemented by the engagement of the youth under the Kazi Kwa Vijana (KKV) initiative which still stand a chance of being employed for further activities.

Its main activities include the following:

- ✓ Removal of solid waste from illegal dumpsites within estates, the river basin and riparian reserve,
- ✓ Clearing of the river channel,
- ✓ Tree planting in cleared and cleaned areas.

The above activities can be replicated in the rehabilitation of N'gong River that passes through Kibera and all other small streams that drain into the Nairobi dam.

The Nairobi River Basin Programme of UNEP is another opportunity. It is a multi-stakeholder initiative that brings together the Government of Kenya, UNEP, UN-Habitat, UNDP, the private sector and the civil society. Their vision is a restored riverine eco-system with clean water for the capital city and a healthier environment for the people of Nairobi. The objective of the NRBP is to rehabilitate, restore and manage the Nairobi River ecosystem in order to provide improved livelihoods, especially for the poor, enhanced biodiversity, and a sustainable supply of water for domestic and industrial, recreational and emergency uses. NRBP as an initiative was launched by UNEP in 1999.

Plate 6.5: Pictorial Impression of Rehabilitated Ng'ong River



Before and after of rehabilitation of Ng'ong River: the polluted Ng'ong river passing through the slums and encroached by structures dumping wastes directly into the stream. Rehabilitation brings back the river into life, providing a safer ground acting as a recreational area while observing a riparian zone free from human settlements as shown in this plate.



Source: Author; 2012

The above pictorial impression envisions Ng'ong River as a stream with life, clean water and protected river banks by building gabions. This will go along way in enhancing a sustainable flood management in the urban informal settlements and will also act as a sustainable climate change adaptation method in the flood plains.

i) Re-Afforestation of the Ng'ong Forest

Afforestation will include replanting of trees in the catchment region of Ng'ong River. This will involve massive planting of appropriate tree species in the Ng'ong Forest and Ng'ong Hills where the river's catchment is. The principle of managing the water cycle as whole is enhanced through tree planting programmes along the catchment. This will have environmental benefits such as changing the ecosystem

and the micro climate of the surrounding areas, as well as reviving the flow of the rivers and streams, soil erosion control and high water retention capacity of the soils due to increased vegetation.

6.3.2 Strengthening the Local Adaptation Strategies by Mainstreaming Flood Risks into Planning

a) Integrating Land Use Planning and Flood Management in Silanga

This is necessitated by the lack of planning in the urban informal settlements as pointed out in this study. In this plan, the land will have different building controls depending on how far away they are from the rivers, streams and the Nairobi dam. The immediate land next to the river is not allowed for any housing structures but will be preserved as the riparian zone with greenery and vegetation consisting of trees. Minimal agricultural practices will be allowed. The adjacent land to this riparian zone may be used for only low risk housing. This means that Silanga informal settlement will be formalized in terms of its spatial arrangement and abiding to local building regulations and by-laws to control development on the flood prone zones. The local by-laws will be special consideration specific to the site in Kibera informal settlement as the area stands as a special planning area. This will also mean that the settlement can be provided with essential municipal services such as water supply, sewerage services, storm water drainage and solid waste disposal services. As a result, the overall vulnerability of the informal settlement to flooding will be greatly reduced in a more sustainable way. The settlement is organized into courtyards whereby all housing units will face a common open space at the middle as shown in the proposed land use for Silanga.

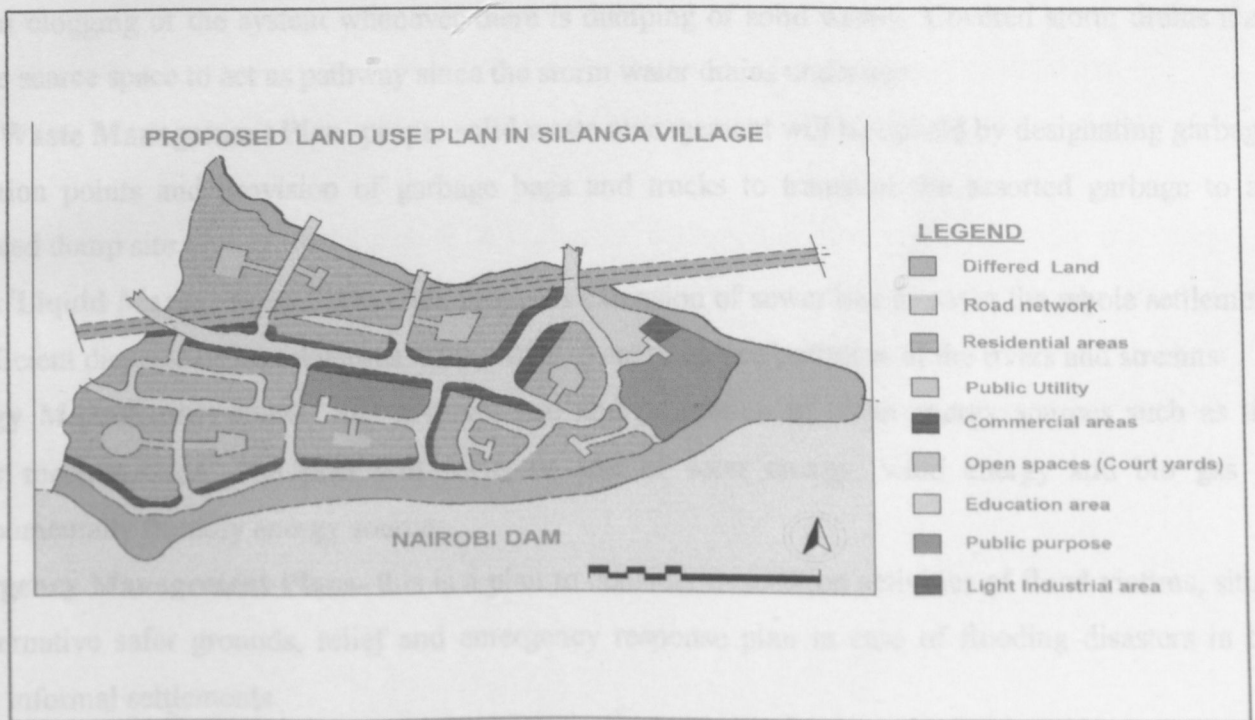
Land use planning can be used to serve a broad range of beneficial purposes. For example, reducing storm and flood damage by mapping flood zones and restricting development can be compatible with environmental and recreational agendas by creating natural spaces and parkland. On the other hand, zoning for commercial or residential development can enhance a community's tax base, and diversify and increase its economic base, but may ultimately increase vulnerability to extreme events. These different agendas or needs can all be valid to a community and require a zoning process that considers multiple stakeholders to trade-off costs and benefits.

Land use planning such as floodplain zoning is a process of determining the most desirable way in which land should be used so that it can help to mitigate disasters and reduce risks by directing development away from hazard-prone areas. Land use planning plays a major role in regulating

development and the use of land. It is normally carried out in two ways (Gunne-Jones 2003). First, it works by controlling developments through a system of issuing permits or approvals. Second, it involves planning for the future needs of a state, region, or locality through the publication and adoption of development or zoning plans.

The first step in land use planning for flood management/damage reduction is to prepare flood risk maps in which flood magnitude, water depth, flow velocity, flood duration, etc., for a specific return period are incorporated. The main purpose is to inform the public about the flood risk derived from occupying a floodplain. Flood risk maps communicate the degree of flood risk to concerned agencies and the public, enabling a dialogue on the most appropriate flood prevention and protection measures (European Environment Agency, 2001). Land use planning for areas vulnerable to flooding from overflowing rivers includes setbacks from the edge for new developments, etc. In the United Kingdom, the findings of the Environment, Transport, and Regional Affairs Committee (2000) recommended that flood risk maps should be included in development plans and information about flood risk should become a standard part of local authority searches that are carried out by prospective property purchasers.

Map 6.2 Proposed Land Use Plan for Silanga Informal Settlement



Drawn By Author, 2012

b) Mainstreaming Flood Risks into Action Plans

The local adaptation strategies in Silanga can be improved and upgraded to inform formulation of action plans to adapt to climate change and promote flood management within the proposed land use plan as discussed above. The land use plan acts as the zoning plan and controls development at the neighbourhood level. In order to realize its provisions, detailed action plans which requires short term measures/immediate actions are proposed. These include action plans for:

Local Economic Development Strategy- this will promote initiatives to create employment opportunities within the Silanga. Areas of opportunities include local business activities at various commercial nodes, agricultural practice on riparian reserve, employment at the rehabilitated Nairobi dam in activities such as boat sailing and other support economic activities that emanates from recreational facility. This will boost the economic capacity of the residents as well as raising their social standards.

Transportation Plan-this is the detailed street designed as discussed in the previous section which will enhance circulation of both the people and vehicular especially increasing accessibility in times of disaster response.

Storm Water Management Plan- the plan proposed closed storm water drainage systems so as to prevent clogging of the system whenever there is dumping of solid wastes. Covered storm drains also use the scarce space to act as pathway since the storm water drains underway.

Solid Waste Management Plan- proper solid waste management will be upheld by designating garbage collection points and provision of garbage bags and trucks to transport the assorted garbage to an approved dump site.

Sewer/Liquid Management Plans- this proposes extension of sewer line to cover the whole settlement for efficient disposal of liquid wastes. This will also act to reduce pollution of the rivers and streams

Energy Management Plans- this involves use and promotion of clean energy sources such as the earlier recommended. The plan will focus on use of solar energy, wind energy and bio gas as environmentally friendly energy sources.

Emergency Management Plans- this is a plan to consider evacuation activities of flood victims, siting of alternative safer grounds, relief and emergency response plan in case of flooding disasters in the urban informal settlements.

6.3.3 Capacity Building and Coordination of Various Institutions and Actors

This will be done through Information, Institution Strengthening, and Education so as to strengthen the roles of various institutions and actors in climate change adaptation and flood management. This will include building the capacity of the local community to prepare, respond and manage floods in a more sustainable way through public education and information. The early warning systems and data availability are information which should be accessed by all relevant stakeholders to enhance flood and disaster management. Facilitation of this information and knowledge will play a pivotal role in reducing the damage caused from unpreparedness.

Integration and strengthening of the existing institutional framework will go hand in hand towards effective flood management. There is need to develop the capacity of the key institutions to plan and implement flood management activities in informal settlements.

6.4 Other Recommendations

- ✓ Investing and equipping the institutions dealing with urban flood disasters.
- ✓ Training local members in urban informal settlements on handling flood disasters.
- ✓ Providing and creation of employment opportunities for the unemployed in the urban informal settlements.
- ✓ Creation of an autonomous body to handle flood issues in the urban informal settlements.
- ✓ Enforcement and successful implementation of laws and regulations on flood management.

The recommended actions discussed in this chapter will require facilitation in order that they are actualized for the benefit of the flood victims in the urban informal settlements. Various stakeholders will need to be involved in the implementation of the same since pooling of resources and building the capacity of each actor will be important. This then takes us to the next chapter which has outlined the implementation framework of these recommendations.

CHAPTER SEVEN: IMPLEMENTATION AND MONITORING MATRIX

7.1 Introduction

This chapter outlines the various stakeholders who will be involved in implementation of the research proposals and recommendations to achieve the objective of this plan which is climate change adaptation and flood management in informal settlement.

Table 7.1 Implementation Matrix

Strategy	Actions	Responsible Actor	Time Frame	Indicators
To reduce physical, socio economic, environmental and institutional vulnerability	<ul style="list-style-type: none"> ▪ Redevelopment of housing units ▪ Relocation of settlement from riparian zones ▪ Waste management plan ▪ Upgrading of Street and circulation ▪ Provision of storm water drains and extension of sewer line ▪ Creation of employment opportunities ▪ Planting of trees ▪ Rehabilitation of Ng'ong River, Gatwekira stream and Nairobi dam 	<ul style="list-style-type: none"> ▪ Approving Authority ▪ Local Residents ▪ Donors ▪ Private Sector 	Short term 1-5years	<ul style="list-style-type: none"> ▪ Durable building ▪ Resilient community ▪ Reduced cases of flooding occurrence ▪ No. of people trained in flood management and climate change adaptation ▪ No. of institutions strengthened and trained personnel
To strengthen climate change adaptation methods and flood management in informal settlements	Mainstreaming of flood risks into planning policies, programmes, projects and plans	Approving authority Physical planning department Local residents	Short term 1-5years	<ul style="list-style-type: none"> ▪ Approved building plans ▪ Building resilience
To strengthen the role of	<ul style="list-style-type: none"> ▪ Budgetary allocation to flood 	Gok Donors	Short term	<ul style="list-style-type: none"> ▪ No. of personnel trained in flood

different actors	<ul style="list-style-type: none"> disasters ▪ Training in climate change information and flood management ▪ Installation of equipment for early warning 	Civil societies Local residents	1-5years	<ul style="list-style-type: none"> disaster management. ▪ No. of strengthened institutions
To develop and institutionalize a proactive mechanism for a community-based flood early warning system	<ul style="list-style-type: none"> ▪ Designing community based Early warning system ▪ Capacity building of disaster management committees in flood prone areas on flood management ▪ Developing national and district contingency plans and funding mechanisms ▪ Establishing new hydromet stations ▪ Installing early warning communication systems ▪ Upgrading existing rainfall/meteorological and river gauging stations ▪ Setting up integrated hydro-meteorological data collection systems and linking with other data sources ▪ Calibrating and 	KMD MWI/WRMA Local residents	Short term 1-5years	<ul style="list-style-type: none"> ▪ Percentage completion in establishment of a community responsive flood monitoring system ▪ Percentage completion of establishment of a disaster management and communication system in the urban informal settlements

	validating hydro-meteorological models for River Basins in urban informal settlements. <ul style="list-style-type: none"> ▪ Preparing flood hazard maps for the River Basis/floodplain ▪ Capacity building in flood forecasting and formulation flood warning systems ▪ Harmonizing data generation and handling amongst collaborating institutions 			
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Source: Author, 2012

7.2 Conclusion

The study has brought up the essential considerations for ensuring that flood protection is provided in an integrated fashion in the urban informal settlements. The study has addressed the questions of how informal settlements are vulnerable to flooding and discussed on the existing local adaptation and coping mechanisms in place. It is thus, important to have a holistic approach to flood management towards integrated flood risk management. Progress towards an effective integrated flood risk management framework should be formulated to monitor and measure its success in the context of climate change. Evaluation and benchmarking are important steps in improving the design and implementation of flood risk management measures, both structural and non-structural.

The key points that have come up from this research can be summarized as:

- Flooding is having a major impact on people living in the urban informal settlements therefore implementation of flood risk management on short term measures need to be undertaken to reduce the vulnerability of this low income dwellers.

- There is need to integrate both the structural and non-structural measure of flood management and climate change adaptation.
- Long terms measures to adequately manage floods and promote climate resilience settlement must be given legal mandate from the right institutional and legislative frameworks.
- Monitoring and evaluation of flood risk management practices is important to continually review and update the already existing measures.

7.3 Recommended Area for Further Research

It is recommended that a further research be conducted on the use of indigenous knowledge of the urban informal settlements in climate change adaptation and flood management. These should consider the cultural beliefs and customs of the urban informal settlements which informs their adaptation methods to flooding in the context of climate change. The research is envisioned to develop and help document local knowledge of the urban informal residents which has not yet been adequately covered in the research arena. The significance of this recommended area of further research will be to avail crucial information which can be integrated and reconciled with use of scientific methods for better flood management practices and climate change adaptation in the urban informal settlements.

SELECTED REFERENCES

- Action Aid (2006). climate change, urban flooding and the rights of the urban poor in Africa. A report by Action Aid International
- Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., Mclean, L., and Campbell, J. (2008). "Climate change, flooding and the urban poor in Africa". *Environment and Urbanization* 20,187-205.
- Ibidun O. Adelekan (2009) Vulnerability of Poor Urban Coastal Communities To Climate Change In Lagos, Nigeria: Ibadan Nigeria.
- IPCC (2007) report by the intergovernmental panel on climate change
- ISDR (International Strategy for Disaster Reduction). 2004. Living with risk: a global review of disaster reduction initiatives. Hyogo: United Nations, International Strategy for Disaster Reduction. 588 p.
- ITDG-Bangladesh (Intermediate Technology Development Group-Bangladesh). 2003. An attempt on application of alternative strategies for community based flood preparedness in South-Asia (Bangladesh) [Web:] http://www.unisdr.org/eng/public_aware/world_camp/2003/english/Others/Bangladesh.pdf
- Kenya, Republic of, (2010). National Climate Change Response Strategy. Nairobi: Government Printer.
- Kenya, Republic of. Environmental Management and Coordination Act (EMCA), of 1999 Nairobi. Government Printer.
- Kenya, Republic of (2010) *National Population Census Reports, 2009*. Nairobi: Kenya National Bureau of Statistics.
- Kenya, Republic of (2002) The Water Act of 2002. Nairobi. Government Printer
- Pitt, M. (2008) "The Pitt Review: Lessons learned from the 2007 floods", Cabinet Office, London.

Stern, N (2008) "The Economics of Climate Change", *American Economic Review*, Vol 98, No 2, pp1-37

UNEP-GEMS/Water (2010). GEMStat. United Nations Global Environment Monitoring System Water Programme. <http://www.gemstat.org/default.aspx>

UNEP (2010). Production and Consumption of Ozone Depleting Substances under the Montreal Protocol. United Nations Environment Programme, Ozone Secretariat, Nairobi. http://ozone.unep.org/Data_Reporting/Data_Access/

UNEP-WCMC (2010). World Database on Protected Areas. UNEP World Conservation Monitoring Centre, Cambridge. <http://www.wdpa.org/Statistics.aspx>

WGMS (2010). Glacier mass balance data 1980-2009, World Glacier Monitoring Service, Zurich. <http://www.wgms.ch>

WHO/UNICEF (2010). Joint Monitoring Programme (JMP) for Water Supply and Sanitation. World Health Organization/The United Nations Children's Fund. <http://www.wssinfo.org/data-estimates/introduction>

World Bank (2006, 2008, 2010). World Development Indicators. The World Bank. <http://data.worldbank.org/indicator>

APPENDIX -1 RESEARCH WORK PLAN

Activity	Jan 2012	Jan-Feb 2012	Feb- Mar 2012	Mar- Apr 2012	Apr- May 2012	May- June 2012	June- July 2012
1. Development of Research Proposal	DONE						
2. Approval of the Proposals and the Research Instruments		DONE					
3. Literature Review (Analysis of secondary data)							DONE
4. Preparation of Data Collection tools (Field reconnaissance, identification of sample size & sampling technique, identification and training of research assistants, identification of key research informants.)			DONE				
5. Collecting of Primary Data			DONE				
6. Data Analysis				DONE			
7. Review of methodology seminar; this is to check on the relevance of the chosen methodology. Presentation of research findings					DONE		
8. Incorporating comments from the seminar and submission of draft research project report.						DONE	
9. Submission of final research project							DONE

APPENDIX -2 RESEARCH BUDGET

Item	Cost per unit	Total Cost
a) Stationery & Equipment		
i. External hard drive for data storage	6,000	6,000
ii. Project Camera	9,000	9,000
ii. Books related to climate change and adaptations	10,000	10,000
v. Printing, Photocopying and binding	15,000	15,000
v. Writing materials (Pens, Pencils, Notebooks)	2,500	2,500
c) Data Collection & Analysis		
i. Student's Transport costs to & from field	@ 300 per day(5days)	1,500
ii. Student's lunch in field	@200 per day (5 days)	1,000
iii. Communication costs (Mobile charges)	@300 per day(5 days)	1,500
iv. Hiring of four Research Assistants	@1,500 per day (5 days)	30,000
d) Facilitation of Academic seminar and Focus Group Discussions		
i. Refreshments for guests and participants		20,000
GRAND TOTAL		Kshs 132,500

APPENDIX -3 HOUSEHOLD QUESTIONNAIRE



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
MASTERS OF ARTS IN PLANNING

Household Questionnaire-Silanga Village

INTRODUCTION

This household questionnaire is meant to help in achieving the goals of a research entitled: *Flood Management and Climate Change Adaptation in Kibera Informal Settlement; The case of Silanga Village*. The aim of the research is to assess the vulnerabilities in Silanga Village, existing flood coping mechanisms in Silanga Village and evaluate the roles of different agencies in helping the community in times of flood.

Note: The information given herein will be solely used for academic purposes.

Questionnaire Number: _____ Date: _____

Section of Silanga Village: _____

Name of Interviewer: _____

Checked by: _____ Date: _____

SECTION 1: RESPONDENT INFORMATION

1. Name (optional) _____
2. Sex: 1. Male 2. Female
3. Age: _____
4. Position in Household _____
 1. Father 2. Mother 3. Child
5. Years of stay in Kibera/Silanga _____
6. Place of work _____
7. Primary Occupation of Respondent
 1. Unemployed 2. Formal business owner 3. Informal business owner
 4. Salaried employee 5. Casual laborer 6. Farmer
 7. Other (specify) _____
8. Average Household Income per Month (*from all income sources*) _____
 1. less than 1, 000 2. 1,000 – 5,000 3. 5, 001 – 10, 000 4. 10,001 – 15,000
 5. 15,001 – 20, 000 6. 20,001 – 25,000 7. 25,001 – 30, 000 8. Over 30,000
9. Highest level of education attained
 1. No formal schooling 2. Lower primary (1-3) 4. Upper primary (4-8)
 5. Ordinary secondary (1-4) 6. Advanced secondary (5-6)
7. Vocational Training 8. College/university

SECTION 2: CLIMATE CHANGE IMPACTS AWARENESS

10. What's your understanding of the term climate change?

.....
.....
.....
.....

11. Could you give a timeline of rainfall pattern/drought in this area ?

.....
.....
.....

12. How do you relate the occurrence of flooding to climate change?

.....
.....
.....

13. Do you think you are at a more risk of suffering from flooding as compared to neighbouring planned neighbourhood?.....

14. If yes, what are the reasons that make you to be at more risk?

.....
.....
.....

SECTION 2: FLOOD COPING MECHANISMS

15. Have you ever experienced flooding in Silanga?.....

16. If yes, which year/period did you experience severe flooding?.....

17. What was the cause of the flooding during the above mentioned year/period?.....

18. How was that flooding different from other cases of flooding that you experience here in Silanga?.....
.....

19. How does flooding affect the residents of Silanga?.....

.....
.....
20. Which are the most affected areas within Silanga village? (indicate on map).....

21. What factors contribute to the severity of the above mentioned areas?.....
.....

22. How does flooding of the Ng'ong river and Nairobi dam affect the Silanga community?.....
.....
.....

23. How do you adapt/cope to flooding as an individual and as a community?

a)
Individual.....
.....

b)
Community.....
.....

24. Is what you do to cope with floods adequate in tackling the challenges associated with flooding?

If not, what are the reasons for inadequacy?
.....
.....

25. Name any Government Agencies, NGOs or any other institution that come to help you during the floods.....

26. Are the above agencies adequate in helping you deal with challenges of flooding?.....

27. If no, what are their weaknesses?.....

28. How would you wish to be helped in the area of flooding?

SECTION 3: ROLES OF DIFFERENT ACTORS IN URBAN FLOOD MANAGEMENT

29. Do you know of any civil society organizations that help the people of Kibera in times of floods?.....

.....

30. Name any other agencies which help you to cope with flooding challenges here in Silanga?

.....

.....

31. How are you involved in the activities of the above mentioned agencies?

.....

.....

32. What kind of support do the above organizations give the people of Silanga?

.....

.....

33. How does the government of Kenya help you in coping with floods?

.....

.....

34. If yes, how are you involved as a community in their decision making and governance?

.....

.....

35. Does the City Council of Nairobi help you with flood management strategies?

.....

.....

36. In order of priority, which agencies help you best in tackling flooding challenges?

(a) Government of Kenya

(b) City Council of Nairobi

(c) NGO s

(c) CBOs

(d) Community Initiatives

37. What is your recommendation on the role of civil societies in helping the community adapt to flooding and climate related disasters?

.....
.....

SECTION 4: WAY FORWARD

38. In your opinion, how can your capacity to handle floods be enhanced?(local solutions to flooding)

.....
.....

39. List any other recommendations regarding flood management and climate change adaption for Silanga residents?

.....
.....

40. What kind of Silanga would you wish to live in, in future?

.....
.....

THANK YOU!

APPENDIX -4 KEY INFORMANT INTERVIEW SCHEDULE



UNIVERSITY OF NAIROBI
SCHOOL OF BUILT ENVIRONMENT
DEPARTMENT OF URBAN AND REGIONAL PLANNING
MASTER OF ARTS IN URBAN AND REGIONAL PLANNING
Key Informant Interview Schedule

INTRODUCTION

This household questionnaire is meant to help in achieving the goals of a research entitled: *Flood Management and Climate Change Adaptation in Kibera Informal Settlement; The case of Silanga Village*. The aim of the research is to assess the existing vulnerabilities and flood coping mechanisms in Silanga Village and to evaluate the roles of different agencies in helping the community in times of flood.

Note: The information given herein will be solely used for academic purposes.

N/B separate sheet is provided for filling in the answers.

1. When was your organization created?
2. What is the core function of the organization?
3. Vision, mission, strategies and objectives of the organization?
4. Did the organization think of incorporating climate change issues in its strategies?
5. When did the organization become conscious of the subject climate change?
6. What is the level of understanding/awareness of climate change and its impacts among the staff members of your organization?
7. What roles have each member in your organization played so far in raising awareness on climate change?
8. What is the organization doing in Silanga in terms of raising awareness on climate change issues?
9. Does your organization have a strategy in regard to climate change? What about flooding? Natural disasters?
10. How does your organisation help the slum dwellers of Kibera in flood management?
11. What mechanisms have your organization put in place to help the residents of Silanga cope/adapt with climate change flooding?

12. How do you help the slum dwellers during flood periods?
13. ~~What challenges do you face in carrying out your activities in the slum?~~
14. What are the areas of weakness within the organization in helping the Silanga community cope with flooding?
15. How can the organization be strengthened to better adapt to climate change?

THANK YOU FOR PARTICIPATING!