ASSESSMENT OF FLOOD MANAGEMENT IN SOUTH C WARD OF NAIROBI CITY COUNTY, KENYA

BY

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DECLARATION

This Thesis is my original work and has not been presented for a degree in any other University.

Signature: …… Date: ……

SUPERVISORS' DECLARATION

This Thesis has been submitted for our approval as University supervisors

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DEDICATION

To my daughter, Elsa Rebecca Kanana and all the future generations who shall inherit this city.

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I give utmost honour and gratitude to God, for I have found His grace and provision sufficient for me throughout the course of my study.

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Although the above have helped in the research of this thesis, I accept, as the author, full responsibility for any inaccuracies and mistakes in this work.

ABSTRACT

Floods are hydro meteorological hazards that perennially affect Nairobi City County, often leading to loss of lives, destruction of property and disruption of essential services. This study sought to understand the various aspects surrounding these flood hazards by focussing on South C ward; which has been perennially affected by floods. In this regard, this study first sought to assess the flooding patterns of the ward and subsequent effects of these floods. The second objective was to assess the factors that influence the vulnerability of South C to flooding. Finally, the study examined the policy, legal and institutional framework in place to deal with issues of flooding in the City. Topographical maps, climate data analysis, field observation checklists, interviews, questionnaires and review of literature were used to collect data. According to 48% of the respondents, South C has experienced perennial flooding for the past 5 years with reduced accessibility and destruction of property being among the most significant effects according to 54% and 18% of respondents respectively. In so far as vulnerability is concerned, the study found that geographically, South C is vulnerable to flooding as a result of its being located at a floodplain, where major rivers from the Ngong hills drain. This vulnerability is further exacerbated by poorly maintained solid waste disposal and storm water management infrastructure. The study also found that there are 10 laws and policies that should deal with matters related to flooding but none of them addresses the matter adequately. The draft national disaster management policy groups floods as an environmentally-triggered hazard but gives no specific policy recommendations on dealing with floods in cities; Nairobi city included. The flood mitigation strategy only acknowledges that, in addition to low-lying areas of the country, there is perennial occurrence of floods in urban centres. The document, however, doesn't offer further guidelines on how to deal with the same. This study recommends that in addition to incorporating structural measures such as setting up of sustainable urban drainage systems and control of solid waste dumping, there is a need to include specific flood risk management guidelines into existing regulations, as well as strengthen the institutions tasked with matters of flood disaster mitigation and management.

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CCCI	Cities and Climate Change Initiative
CLUVA	Climate Change and Vulnerability in Africa
IFM	Integrated Flood Management
IFRC	International Federation of Red Cross and Red Crescent societies
IPCC	Inter-governmental Panel on Climate Change
KMD	Kenya Meteorological Department
KRCS	Kenya Red Cross Society
MCA	Member of County Assembly
NIUPLAN	Nairobi Integrated Urban Development Master Plan
UNISDR	United Nations International Strategy for Disaster Reduction
UN-HABITAT	United Nations Human Settlements Programme

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Floods are classified by the United Nations International Strategy for Disaster Reduction (UNISDR) as hydro-meteorological hazards and have been found to be the most frequently occurring natural disaster that results in widespread fatalities globally. (Doocy *et.al*, 2013). Over the last few decades, the incidences and magnitudes of floods have increased considerably as a result of rapid urbanisation and climate change processes which have resulted in warming of sea water and hence a rise in the sea levels. This phenomenon has presented serious risks, such as inundation and flooding, particularly to low-elevation coastal urban areas (UN-HABITAT, 2011). Non-coastal urban areas have also seen the far-reaching effects of climate change through rain-induced land – slides, flash floods and increased intensity and duration of droughts hence fires, decreased water and food supply.

Studies on risk, vulnerability and resilience have found that flooding incidences in urban areas of developing countries are as a result of interplay of predominantly impervious surfaces, inadequate green open spaces for natural filtration and inefficient drainage systems. According to UN-HABITAT (2011), the regularity and severity of flooding has generally increased during the last decade and it is expected that this flood risk trend will remain; particularly in Asia, Africa and Latin America where vulnerabilities to floods are high. High vulnerabilities in these continents are as a result of key indicators such as their urbanization trends, levels of physical exposure, stages of economic development,

conditions of urban governance and planning as well as state of disaster preparedness. A report by CLUVA (2010) observed that in spite of the Inter-governmental Panel on Climate Change (IPCC) acknowledging that Africa is highly vulnerable to climate change and climate variability, climate change studies have not adequately focused on some of the regions in the continent; East Africa included. The report was a culmination of a study whose key objective was to come up with easily applicable methods to be used by the stakeholders of African cities to manage climate risks and to improve the resilience and coping capacity to climate induced risks in the long run.

Five African cities namely Saint-Louis, Ouagadougou, Douala, Dar-es-Salaam and Addis Ababa were selected for the study on the basis of a need to validate the methods for the largest possible range of climate risks and vulnerabilities encountered in the regions where these cities are found. The aspects of climate change taken into account for the project were climate, geographical location and type of risk. Notable is that among the key risks that CLUVA had been focusing on, flooding appeared to be the most devastating, as it was a risk shared by all cities. As an outcome of the study, innovative approaches for climate change vulnerability assessment were developed for the case studies. This was in addition to a definition of new risk mitigation and adaptation strategies that would provide planners and policy formulators with tools for the progression towards increased climate change resilience in cities.

A focus on East Africa reveals that flooding in its major cities continues to be a major challenge. A study of the city of Kampala, Uganda by the UN-HABITAT (2012) found

that the regularity and severity of flooding in Kampala is largely as a result of catchment deterioration due to the nature of urban development that typically leads to increased runoff and the development of low-lying hazard prone lands by both planned and unplanned development. Tsinda & Gakuba (2010) studied the state of hazards in Kigali City and found that a high percentage of the built up zone is situated in low – lying floodplains which prompts the government to construct flood control systems in order to protect the human settlements therein.

In Kenya, the earliest documented flooding events were the Uhuru floods of 1961 (Opere, 2013) that triggered the need for research on the extent and magnitude of flooding. More recently, however, is the El Nino floods of 1997 and 1998 that caused the loss of many lives and massive damage to private property and public infrastructure. The floods led to the disruption of socio-economic activities and severe land degradation. Opere (2013) studied the impacts of flooding in Kenya, focusing on the Budalang'i and Kano plains. The study also examined the vulnerability indices of these flood prone areas and identified the vulnerability factors as lack of or poorly implemented flood management strategies, inadequate flood readiness, dependence on or overutilization of natural capital, lack of adequate financial and infrastructural resources, inadequate technology and technological capacity, as well as conflicts.

In the city of Nairobi, flooding problems can be traced back to the master planning of the city. This is evidenced by the fact that the 1927, 1948 and 1973 master plans were never fully implemented; mostly as a result of inadequate capital outlay (Vogel, 2008) leading

to unplanned urbanization and settlement patterns. Although the master plans were intended to advance social class and racial segregation, they had also been instituted with a lot of regard to the physical structure of the city in terms of traffic circulation, building and density regulations, as well as drainage plans.

A noteworthy study related to flooding in the South C ward of Nairobi County is one by Odhiambo (2015) who undertook a study on the use of GIS for storm water management in South C estate. The study found that South C has 49% cover of impervious surfaces which reduce infiltration of rain water and hence increase storm water volumes. The study further revealed that the area has predominantly poor draining soils. While flooding is a perennial phenomenon in the South C ward of Nairobi County, there have been limited studies on the vulnerability and mitigation measures for the same. In the backdrop of flooding as a serious global, regional and national phenomenon, the overall aim of this research, therefore, is to consider and propose flood management policies that would be instituted in the South C ward of Nairobi City County in order to mitigate against and build the resilience of this area to the effects of flooding.

1.2 Statement of the Problem

The UN-HABITAT (2006) acknowledges that one of the environment - development challenges facing the city of Nairobi is exposure to natural risks, where many areas of Nairobi are prone to flooding at least twice a year during the two main rainy seasons (climatedata, 2017). Within the city, traffic congestion, water contamination and hence accompanying socio-economic and environmental losses have become synonymous with

these rainy seasons. According to a flood reporting website - floodlist.com, there have been reported three serious flooding incidences in Nairobi city during the 2015 and April – May 2016 rainy seasons, with the most recent report having been made by Juma (2016).

The Nairobi City County government (2015), identifies the flooding hotspots in Nairobi as *Highrise* Estate, South C, *Loresho* along the bypass, *Muthangare*, *Kileleshwa* Ring Road interchange, *Maziwa-Ziimmerman Kamiti* Road, Riverbank area along *Baba Dogo* - Outer ring road, *Lavington- Chalbi* Drive, Garden Estate, *Thome*, *Roysambu*, *Kahawa* West, *Donholm, Mbagathi /Langata Road* Round - about, Nairobi West, *Ruai*, *Utawala, Mukuru* slums and *Kibera* slums. Specifically, South C Ward, which is representative of a medium density, lower middle to middle income mixed type development (NCC et.al, 2014b) has experienced floods over the past four years; significantly so in the periods December 2012, April 2013, October 2014, May 2015 and May 2016 (IFRC, 2013; 2016).

This perennial flooding within Nairobi City has prompted scientific studies which have primarily focused on the impacts of flooding on residents of informal settlements (Douglas et.al., 2008), as well as on the engineering and physical infrastructure issues surrounding drainage and flooding within the City (Murambi, 2014 & Odhiambo, 2015). There has, however, been a research gap where the legal, policy and institutional framework governing urban flood management is concerned.

In the backdrop of flooding as a serious global, regional and national phenomenon, the overall aim of this research is to assess and propose flood management policies that would be instituted in South C Ward of Nairobi City County to mitigate against and build the resilience of this area to the effects of flooding, while offering valuable lessons that would guide further research in the topic of urban flood management for the City County.

1.3 Research Questions

The main research question addressed in the study was, what flood management policies would be instituted in South C ward of Nairobi City County to mitigate against and build the resilience of this area to the effects of flooding?

The specific questions that guided the study were as follows:

i. What are the flooding patterns in South C ward of Nairobi City County?
ii. What factors have influenced the vulnerability of South C ward to flooding?
iii. What policy, legal and institutional framework is in place to manage flooding in the Nairobi City County?

1.4 Objectives of the study

The main objective of the study was to assess and propose flood management policies that would be instituted in South C ward of Nairobi City County to mitigate against and build the resilience of this area to the effects of flooding.

The specific objectives were:

i. To assess the flooding patterns in South C ward of Nairobi City County
ii. To assess the factors influencing the vulnerability of South C ward to flooding
iii. To examine the policy, legal and institutional framework in place to manage flooding in Nairobi City County.

1.5 Justification and significance of the study

An analysis by the World Bank, through the global facility for disaster reduction and recovery (GFDRR), notes that floods account for the highest incidence (45%) of the natural hazards that Kenya is exposed to; a large percentage of this occurring within city and urban set-ups of which the Nairobi City County is a part. Human capital is, perhaps the most important for any city to thrive. However, this has been threatened by the floods that wreak havoc in Nairobi city during every rain season. City dwellers, especially in lower middle income, low income settlements and especially informal settlements have suffered the largest brunt of this. From a social perspective, families have been continually displaced from these areas, making it difficult or impossible to access basic services such as hospitals, schools or places of work. The disease burden that comes with the floods makes the situation the more unbearable.

Economically, the city of Nairobi is not only Kenya's but also the Eastern and Central African region's commercial hub. The seasonal flash floods encountered in the city lead to disruption of various economic activities such as transportation and energy transmission, which usually take the city a long time to recover thereafter. They put a

strain on public infrastructure such as roads and bridges, as well as on public health delivery. This is not to mention the massive losses when business premises are flooded, leading to loss of capital. For a long time now, the city has been grappling with the problem of environmental pollution arising from, among other issues, improper solid waste disposal. The floods exacerbate the problem by mobilizing the waste and other pollutants into municipal and natural water sources such as rivers, thereby contaminating clean water supplies and treatment facilities.

The overall objective of this research is to assess and propose flood management policies that would be instituted in South C Ward of Nairobi City County in order to mitigate against and build the resilience of this area to the effects of flooding. This would in turn help to identify the integrated urban flood management strategies that would be instituted to build the resilience of the greater Nairobi City County to the effects of flooding. The findings of the study will be especially important for governance and decision-making at the National and City County level, where urban environmental management is concerned. Further, the study is poised to serve as a useful resource for academia, urban and regional planners, environmental planners, architects, landscape architects, structural and water engineers, students, as well as city residents.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This study seeks to fill a research gap where the legal, policy and institutional framework governing flood management in Nairobi City County is concerned. The study therefore focuses on South C Ward, which is one of the flooding hot spots in the City, as documented by the Nairobi City County Government (NCC, 2015). This chapter thematically presents discussions on various studies undertaken in the area of urban flooding patterns, flood vulnerability assessments as well on flood - related legal, policy and institutional arrangements. The chapter also looks at the theoretical and conceptual frameworks that guided this study.

2.2 Review of studies on assessment of flooding patterns

In order to establish the flooding patterns in the urbanised city state of Singapore, Chow et al. (2016) used a multi - method approach which combined analysis of station precipitation data with archival government and newspaper records. The study also documented changes in flash flood frequencies, coupled with reports on impacts of floods to the affected Singapore residents. It was found that there had been increased flooding incidences in the period under study, and that the incidences coincided with storm events. Despite the fact that the flash floods were found to have low impact on human casualties, they had resulted in huge economic losses arising from insurance damage compensation claims. The study concluded that while Singapore city has low flood vulnerability owing

to holistic flood management and infrastructural development, there are likely to be an increase in future vulnerabilities as a result of climate change and demographic sensitivity of rapid population growth.

In order to offer recommendations on flood risk management for Lagos, Nigeria, Nkwunonwo et. al (2016) undertook a review and analysis of historical flood data for the period 1968 – 2012. Specifically, the study looked at the geographical characteristics of the city, the population densities, population growth rates as well as patterns of flooding events. The study found that the city had experienced floods annually since 1974. It was further noted that these floods coincided with the rainfall season; making them pluvial (rainfall induced) floods. Further, the intensity and severity of these flooding events had increased over the period under review. The research also found that more severe floods had occurred in some areas of the city as compared to others. The researchers attributed this phenomenon to the probability of spatial and temporal distribution of rainfall around the city. This, however, could not be clearly established since there was a lack of adequate documentation relating to hydrodynamics and historical flooding events.

2.3 Review of studies on factors influencing flood vulnerability

A combination of structural and non-structural measures can be used to deal with floods (Sagala 2006). Structural measures comprise a set of works aimed at reducing one or more hydraulic parameters like runoff volume, peak discharge, rise in water level, duration of flood, flow velocity, etc. Non-structural measures involve a wide range of

measures to reduce flood risk through flood forecasting and early warning systems, emergency plans, and posing land use regulations and policies.

2.3.1 Study review of structural factors influencing flood vulnerability

No standard method of vulnerability assessments exists. However, similar studies have applied different approaches to assess the different aspects of the vulnerability of various areas to floods. The most common approach used for vulnerability assessments is the administrative units/boundaries approach, which Roy & Blaschke (2015) faulted for its inadequacy in giving detailed spatial variation of hazards and damages. Further, they argue that this approach suffers a geographical problem – the modifiable area unit problem (MAUP). They go on to say that in comparison with the administrative unit approach, the grid-based approach allows for monitoring of vulnerability over time and instituting new indicators or components. Based on these arguments, Roy & Blaschke (2015) used a grid-based approach to carry out a spatial vulnerability assessment of the Dacope sub-district in Bangladesh. The methodology makes use of varied physical, social, economic, and environmental indicators for spatial vulnerability assessment to floods. It hence solves the problem of data unavailability and enhances transferability and applicability of a spatial vulnerability assessment.

Mustafa (1998) carried out a study that sought to understand the causes of vulnerability and the development of these causes that culminates in disaster. The study was carried out in Central Pakistan with a focus on five villages. The study used a Pressure and Release (PAR) model to understand the progression of vulnerabilities to disaster. The study found out that vulnerability of a community is due to disempowerment; since the

research had focused on vulnerability from the perspective of individual and community defenselessness and not on the structural and non-structural causes of vulnerability to flooding. In addition, this study was carried out in a rural set up and thus cannot accurately offer a possible understanding of the vulnerability factors in the urban set-up.

Theouret *et al.* (2014) carried out a study that sought to assess the physical vulnerability of large cities exposed to floods and debris flow in Arequipa, Peru. The major aim of the study was to consider the physical vulnerability of buildings in flood prone areas. The study used geographic information system to calculate the risks for buildings and bridges in the study site. It was established that a majority of the physical structures in rural Peru are vulnerable to floods. The focus of the study was on physical structures in the rural areas that may be different from the physical structure in urban areas. The study also considered physical infrastructure; which is just one aspect of structural vulnerability. It did not take cognizance of the other structural factors that would increase vulnerability to flooding.

Muller *et al.* (2011) distinguish two approaches to measuring vulnerability; knowledge (expert) - based approaches and participatory approaches. In their study of the flood vulnerability of Santiago de Chile, the authors used an indicator-based approach. In this approach, the factors and variables that make an urban system vulnerable are identified and explored. Thereafter, for purposes of measurement, these are altered into indicators that permit the assignment of values. The use of indices allows for assessment of vulnerability and its comparison amongst places; as well as for an analysis over time in

the same area (Muller *et al*., 2011). This particular study employed only part of this approach; to the extent of identifying and exploring the vulnerability factors of the South C Ward. It did not fully employ this approach to the extent of developing indices, owing to time and resource limitations.

A flood vulnerability assessment undertaken for Dhaka, Bangladesh set out to identify the determinants of vulnerability to floods, assess the impact of floods to the population and analyze the coping and adaptation mechanisms of vulnerability. The study first considered the use of four conceptual frameworks; Bohle's conceptual framework which looks at vulnerability as the outcome of an interface between exposure to an external stressor and the extent to which the affected is able to cope with the stressor. It also considered the Davidson Framework which has physical, social, economic and environmental components of vulnerability. The ``BBC`` framework was also considered. It focuses concurrently on vulnerability, coping capacity and likely intervention tools to minimize vulnerability. Finally, the study considered Turner II *et al.* vulnerability framework, which examines vulnerability within the broader and closely linked human-environment context. It defines exposure, Sensitivity, and Resilience (as coping response, impact response and adaptation response) explicitly as part of vulnerability (UNU-EHS, 2010).

The Turner II *et al*. Vulnerability framework was eventually used since it couples human-environmental system facilitates the identification of critical interactions in the human-environment system that suggests response opportunities for decision makers, and is open

to the use of both quantitative and qualitative data in assessment of flood vulnerability. Therefore, this framework was applied to design the methods and study design of this research. This framework considers exposure, sensitivity and resilience as the main components that should be studied in flood vulnerability assessments. The parameters that are under exposure are people, infrastructure and ecosystems while the characteristics of the exposure vary in terms of frequency, magnitude and duration of floods. When it comes to sensitivity, Turner et.al outlined aspects of human conditions that are sensitive or vulnerable to floods such as economic structure, population pressure and education endowment and aspects of the environment such as land degradation, de-forestation and climate change. In order to give a holistic study, the component on resilience had impacts of floods and coping or adaptation measures as the key parameters. Coping would be analysed at an individual and institutional level while impacts should be considered from the perspectives of life loss, economic damage or environmental damage.

Blaikie *et al*. (1994) developed the Pressure and Release (PAR) model of measuring vulnerability, which was used in Limbe, Cameroon. This model, revised by Wisner *et al*. (2005) is described by Muller *et al*. (2011) as one which looks at the various dimensions that vulnerability encompasses. It not only considers the social and physical characteristics of an individual or household, but also the systemic, institutional and economic conditions that influence vulnerability. In order to set the stage for an integrated approach to flood management in Accra, Amoako & Boamah (2014) explored in detail the varied causes of flood hazards. Particularly, the research sought to assess

intensity of rainfall events, poor management of surface water resources, uncontrolled urbanisation and slum development in flood-prone areas in Accra. This was in addition to examining the perceived impacts of climate variability. The study made use of mixed methods of data collection including interviews with key informants, literature reviews; as well as consulting with representatives from relevant institutions. It was established that the three causes of floods are predominantly structural. The study methodology was purely qualitative in nature and thus had serious limitations in regards to whether the findings could be generalized to any degree. A review of this study thus called for an inclusion of more quantitative methods of data collection in investigating the causes of flooding in an area.

Thecla (2014) carried out a study in Nigeria with the aim to analyse the vulnerability to flooding in Port Harcourt metropolis, Nigeria, by creating vulnerability indices and comparing these indices across the 13 zones that make up Port Harcourt metropolis. The study used the integrated vulnerability assessment approach using indicators which were adopted with principal component analysis and performed to obtain the first component scores which were used to weight the variables before calculating the vulnerability indices of the 13 zones. The spatial pattern of the vulnerability levels increases toward the North West, south west, south, and north east, and decreases toward the central Port Harcourt. The study was a vulnerability assessment that focused on the economic and social features of the area and mapping of vulnerability zones without looking at structural causes in detail.

Opere (2013) sought to establish the causes and impacts of floods. The study was carried out through desk top review and focused on floods in *Budalangi* and *Kano* in Western and Nyanza regions of Kenya. The results indicated that floods in *Kano* and *Budalangi* are mainly caused by lack of defence. This study only focused on structural and non-structural causes of flood vulnerability in rural areas; which are typically riverine. As a result, the study was not deemed particularly relevant to major urban areas such as Kisumu, Nairobi and Mombasa.

Various studies on the flooding situation in Nairobi have focused on the urban poor; mostly informal settlements and the engineering/physical infrastructure issues surrounding drainage and flooding. In particular, a study conducted by the International Institute for Environment and Development (IIED) on *Maili Saba* and *Mathare* slums in Nairobi focused on the urban poor; their perceptions on causes of flooding, the adaptations to urban flooding and their perceptions of solutions to the flooding problem. Further, during the rainy seasons, the Kenya Red Cross Society (KRCS) carries out rapid assessments of the flood affected areas to establish the immediate and recovery needs of the affected population. Other studies have found that flooding in Nairobi is not only related to the city's geography, heavy rainfall and extreme climatic events; it is also related to changes in the built-up areas themselves (Douglas et al., 2008). For instance, in April 2013, a few hours of rainfall rendered the new Thika - Nairobi highway impassable due to dangerous flooding.

In order to develop a flood hazard map for the *Pangani*, *Mathare* and *Muthaiga* areas of Nairobi City County, Murambi (2014) carried out a mapping exercise of these areas using Geographic Information System (GIS) software. The author used Global Positioning System (GPS) to collect data relating to the land use, rivers, roads and Digital Elevation Models (DEM) of the terrain within and around the study area. The study also made use of satellite images of the area, topographic maps as well as rainfall data from the nearest weather station. On analysis, the findings indicated that terrain and land use had exacerbated the area's vulnerability to flooding. The author recommends that there is a need to increase the use of GIS for mapping of flood prone areas as it has increased efficacy in the development of flood hazard maps that would in turn aid in early flood warning.

Odhiambo (2015) carried out a study focussing on Storm Water Management in South C Estate of Nairobi and established that roads quickly get flooded, becoming impassable and houses become flooded causing property loss and damage. The existing storm water infrastructure was investigated using GIS and the role of the surrounding community to this problem was also examined. GPS data collection and field verification was used to establish the status of the existing storm water drainage. Secondary data was used to support the primary data collected. ArcGIS software was used to carry out data analysis. Comparative analysis was carried out using this software. An analysis of the hydrologic conditions of the South C area was also carried out in a bid to understand the interaction of natural topography with the storm water drainage infrastructure. From the maps generated, it was established that majority of the South C area fell within a drainage basin

that drains into the Ngong River. The watersheds generated for the study area showed that not only are upslope areas within the study area responsible for contributing to water flow to common outlets/ outfalls but also upslope areas from outside of the study area contributed to these same outlets/ outfalls. This study specifically focused on storm water drainage, an aspect of structural causes of flood vulnerability thus leaving a gap on the study of other structural causes of flood vulnerability in South C ward.

A study by the Pamoja Trust (n.d.), sought to enumerate and detail various aspects of the slums in Nairobi. According to the document, south C has two slum settlements namely *Mtumba* slum and city cotton. Relating to the parameters under study on factors that have influenced the vulnerability of the south C area to flooding, the inventory finds that while the *Mtumba* slums current location next to the Wilson airport is as a result of a government-led scheme, the residents are not allowed to build permanent houses. This would further exacerbate any impacts as a result of a flooding incidence. This study will therefore sample a few of the residents of the two slums as part of the study, in order to understand how the state of the structures the residents live in, other basic infrastructure and the issue of geographical location all come together to influence the vulnerability of these areas to flooding and related impacts.

2.3.2 Study review of non - structural factors influencing flood vulnerability

Karmakar et al. (2010) performed a risk-vulnerability analysis to flood of the Upper Thames River watershed, South Western Ontario, Canada, with an aim of testing information systems on flood vulnerability. The study evaluated information system on

flood vulnerability using a Geographic Information System (GIS) environment. The proposed methodology estimated the impact on infrastructure vulnerability due to inundation of critical facilities, emergency service stations and bridges. The components of vulnerability were combined to determine an overall vulnerability to flood. The exposures of land use/land cover and soil type (permeability) to flood were also considered to include their effects on severity of flood. The proposed methodology was implemented for six major damage centers in the Upper Thames River watershed, located in the South-Western Ontario, Canada to assess the flood risk. The study found out that the information system that is in use lacks integration with some key stakeholders in flood management. Information systems in developed countries are more advanced than the information system in developing countries where such systems are still at development stage. Thus there is need to understand the information system in developing countries, with a focus on non-structural causes of flood vulnerability and non-structural measures of flood vulnerability.

Kundzewic & Menzel (2010) carried out a desktop review to evaluate non-structural measures that can best work in Germany. This evaluation was done with a case study focus on where natural flood reduction strategies have been successfully implemented with the results presented. The study found out that non-structural measures that best fit in Germany would include zoning and relocation, flood forecasting and warning, as well as a rise in awareness. The focus was on reducing flood vulnerability for inhabitants dwelling along the river beds, with the study solely focusing on non-structural measures

and not on non-structural flood vulnerability thus making it necessary for more studies that will explore the non-structural flood vulnerability factors.

Ajibade *et.al* (2013) conducted a social vulnerability study in Lagos, Nigeria following an extreme flooding event in 2011. The study set out to assess the patterns of vulnerability and resilience to flooding among women in an urban setting, basing its arguments and approaches on the theory of social vulnerability and that of feminist political ecology. A critique of the social vulnerability theory in so far as this study is concerned is that it looked at women as a collective social group that would be affected by a certain phenomenon in a similar way. To minimize such generalizations, the study then adopted the feminist political ecology theory that further dissected this social group and how they would be affected by certain phenomena based on their income levels, education levels, religion, culture, etc. This led to the study taking on a comparative approach where women from households with varying levels of income where studied, in order to give a more accurate picture of the varying vulnerability factors and resilience capabilities. The study was hence conducted using structured questionnaires and focus group discussions. Of relevance to the study on South C, Ajibade *et.al* (2013) found that gender in itself was not a substantial determinant of flood vulnerability, and hence the need to consider other social factors that would increase the vulnerability of an area or people to flood disasters. For this reason, the social vulnerability theory will not be adopted in isolation with other theories. The study also established that it is important to formulate a disaster risk – reduction policy that takes into account the array of roles played by women.

Ramkrishna & Chaudhari (2014) carried out a study in India in cities which are mostly located on the banks of rivers, coasts or in the valleys. In the study, flood exposure analyses was performed by using GIS tools with land use and flood map data integrated in GIS framework to develop flood exposure maps. The existing non-structural flood management measures were evaluated using the flood losses with the study finding out that non-structural measures, unlike the structural measures are in place in India. The study demonstrated the impact of non-structural measures on communities and this led to a search of structural flood management measures such as construction of gabion walls. Though the study was focused on both structural and non-structural measures in cities, there is need for structural measures and non-structural measures in different contexts in order to better understand measures that can be used to control/reduce flood vulnerability.

2.4 Study review of flood – related policy, legal and institutional frameworks

Brown (2005) sought to analyse the institutional impediments that had continued to propagate the application of traditional urban storm water management techniques in Sydney, Australia, despite there being the existence of advanced alternative strategies. By aid of interviews, questionnaires and desk studies, the author undertook data collection within institutions mandated with urban flood management within the city. The research found that there had been a general preference to traditional storm water management techniques as a result of historical technocratic institutional power, values and expertise that entrenched continued impediments to implementation of the advanced strategies. The findings of this study are closely related to the study of South C ward in that the existing institutions that would be tasked with flood management have been in existence for

several decades and would therefore encounter similar challenges of autocracy and resistance to change.

An investigation of the flood disaster emergency preparedness and response for Ibadan, Nigeria during extreme floods experienced in 2011 was carried out by Adejuwon & Aina (2014). They set out to, among other objectives, pinpoint the challenges faced by emergency relief agencies in managing disaster. The study's geographical scope was confined to a few local authorities within Ibadan, which are most affected by floods. Structured questionnaires were used to carry out the research, where respondents included local leaders, local government officials, and media sources. Key informants from institutions tasked with disaster response and management were also interviewed. Such institutions include the Nigeria National Emergency Management Agency (NEMA), Oyo State Emergency Management Agency (SEMA), Nigerian Red Cross Society, and Oyo State branch, Nigerian Meteorological Agency (NIMET). The study found that while inadequate funding was a cross-cutting factor that reduced the effectiveness of flood disaster preparedness and response among the institutions, there was a need for private and public sector disaster management agencies to work together. Another notable finding was that there was need for operative laws and accompanying regulations to guide the flood disaster preparedness and response institutions.

2.5 Analytical Framework

The following study is based on the ecological resilience theory and specifically the theory of urban resilience to floods (Liao, 2012) and the community resilience theory (Norris F.H et.al, 2008).

2.5.1 Theoretical Framework

In crafting the theory of urban resilience to floods, Liao (2012) proposes a flood hazard management approach that is geared towards adaptation and resilience as opposed to hard-engineered structural flood control. Before narrowing down on this theory, the author goes on to distinguish two broad interpretations of resilience as engineering resilience and ecological resilience (Holling, 1996) and defends the ecological resilience interpretation. Wang and Blackmore (2009) as cited by Liao (2012) states that, *'In engineering, resilience is concerned with disturbances that threaten the functional stability of engineering systems, which are often linked with low probabilities of failures or, in the case of failure, quick recovery to normal levels of functionality.* Liao continues to argue that engineering resilience is more concerned with how well a system recovers (bounces back to full functionality after undergoing stress).

On the other hand, there is the ecological resilience interpretation. According to Liao, this interpretation put forward by Holling (1973) disputes the ecological paradigm of equilibrium that assumes that there is a predetermined stable state that every ecosystem has; to which the system returns after a disturbance. It instead agrees with the multi-equilibria/non-equilibrium paradigm that proposes that it is impossible for an ecosystem

to return to a normal state after disturbance or that if it does, it returns to a different state from the original. With the latter paradigm as a foundation, Liao goes ahead to state that Holling (1973) then defined resilience as '*a system's ability to absorb disturbances and still persist*.' Based on the multi-equilibria paradigm, he proposes the ecological resilience concept as a more appropriate framework for flood hazard management.

Building up on the ecological resilience aspect is the operationalization of the theory on urban resilience to floods which then proposes aspects that are pivotal to flood management in South C ward. Such aspects are the ability of residents to 'live with floods' by harnessing the post-flooding opportunities that may arise such as recreation or agricultural opportunities. This would only be practical in areas where flood water depths are high and where the water takes a long time to dry up – a phenomenon that is most common in riverine urban settlements. The other aspect is that of flood adaptation. This calls for retrofitting the built environment and related infrastructure to allow for flexibility and diversity in coping with floods. It would also involve open spaces becoming capable of safely conveying and storing floodwater. Of importance to this study is the fact that the theory on urban resilience to floods takes into cognizance that resilience is a multi-faceted undertaking that would consider the urban area as a system that is not only affected by physical phenomena but also by its institutional, political, economic and demographic conditions. This means that this research is also guided by the community resilience theory; which is further expounded in the subsequent paragraphs.

Resilience in itself is, according to Norris F.H et.al (2007), a concept that has its origins in physics and mathematics but one that has also been applied in describing adaptive capacities of individuals, communities and even larger societies. They go on to state that defining community resilience has to go hand in hand with defining 'community', and as such go on to define it as a unit that shares geographic boundaries and that is subject to similar built, social, natural and economic environments that interact in a complex way to affect how the unit functions.

Patton (2000) as quoted by Norris F.H et.al (2007) explains the concept of community resilience as being the capability that an integrated unit has to recover following contact with hazards. This capability is aided by its efficient use of the physical and economic resources at its disposal. In the same document, Ahmed (2004) is quoted as having defined it as the promotion of residents' by development and utilization of socio – political, material, physical and socio – cultural resources. Going by these definitions, this study takes the South C ward as a community, and bases the research on evaluating measures that would aid the ward in attaining community resilience in so far as perennial flooding is concerned.

2.5.2 Conceptual Framework

Figure 2.1 is a representation of the conceptual framework showing the interaction between the variables of the study objectives. The independent variables were the factors influencing vulnerability of South C ward to flooding. The dependent factors are flood

patterns in South C. The moderating variables are the policy, legal and institutional frameworks in place to manage flooding with Nairobi City County.

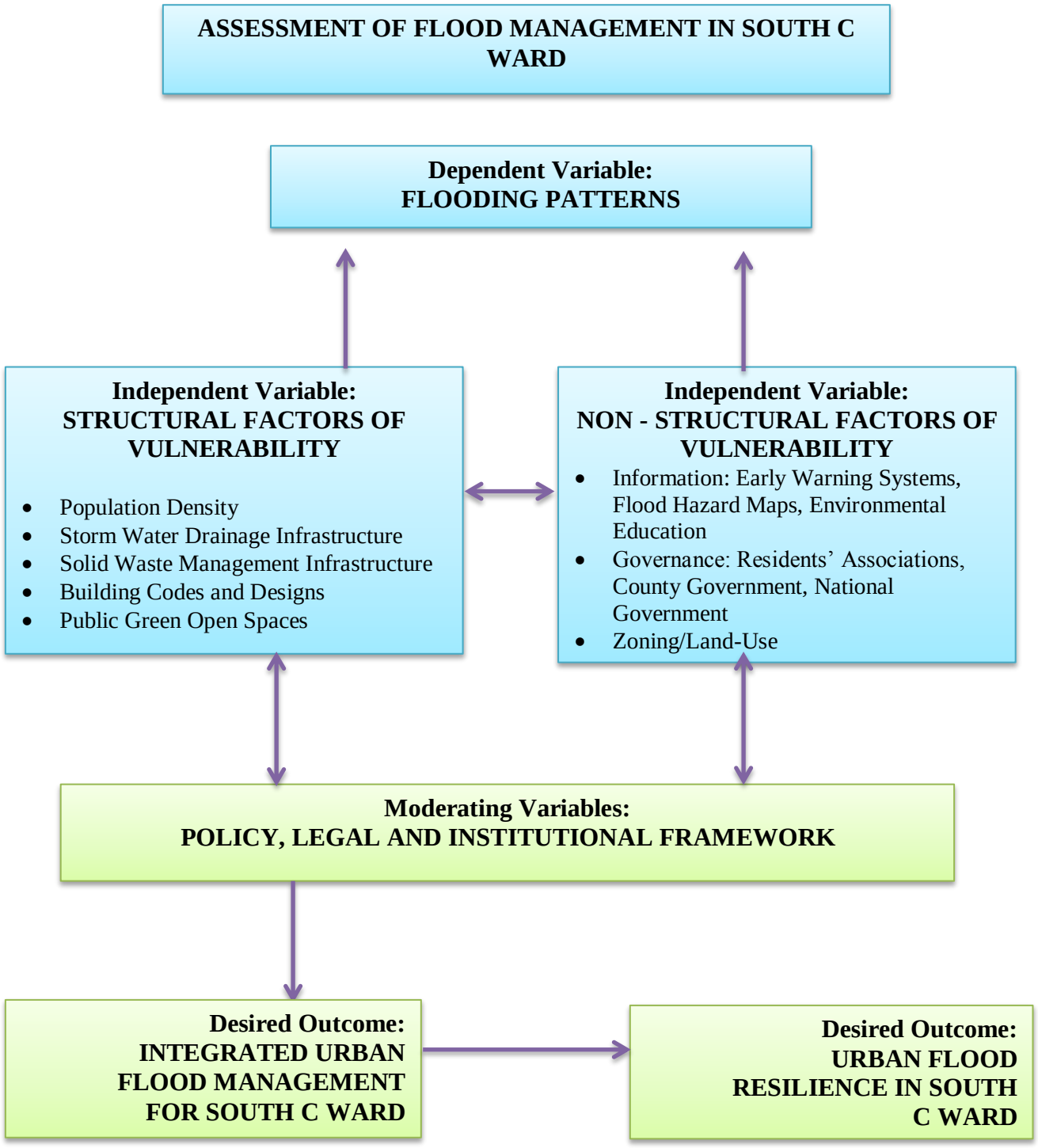

Figure 2.1: A Conceptual framework of the study showing the relationships between the study objectives' variables.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter focuses on the study design and methodology which contains the procedures and methods used to collect and analyze data. The chapter looks at the study site, study design, target population, study sample size and procedure, data collection, research instruments, ethical considerations and data analysis.

3.2 Study Site

3.2.1 Location

The geographical focus of this study is South C Ward located in Lang'ata sub – county, Nairobi City County. It is located in southern Nairobi, flanked by the Nairobi National park to the south, the Wilson airport to the west, Nairobi - Mombasa Highway to the east and *Muhoho – Mai Mahiu* road to the north (Figure 3.1). It covers an approximate area of 4.84 square kilometers.

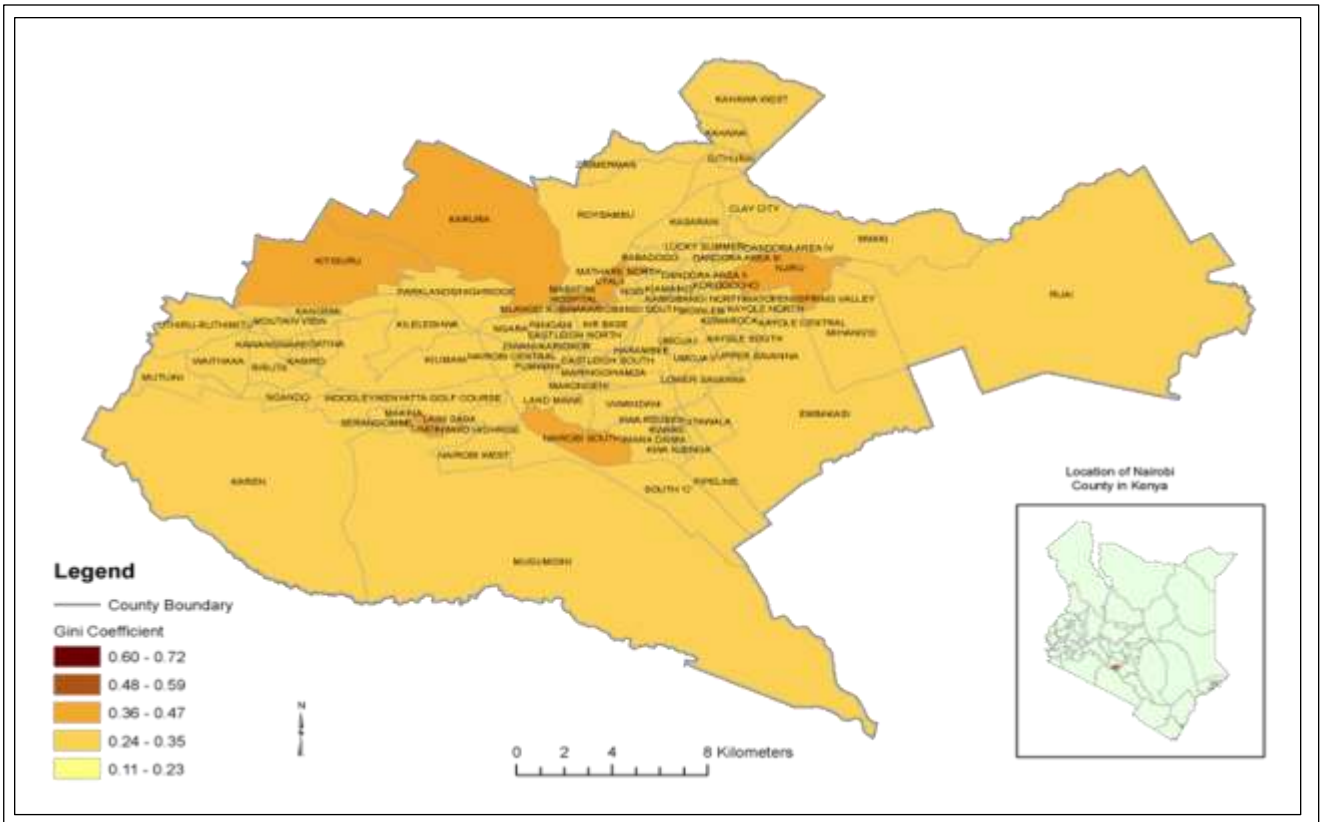

Figure 3.1: *An earth satellite image of the study site.* ***Source:*** *www.google.com/maps/place/Nairobi*

3.2.2 Topography and Terrain Characteristics

An elevation map (Figure 3.2) generated using elevation data from the United States National Aeronautics and Space Administration indicates that South C Ward has elevation ranges of between 1631m to 1661m above sea level. Notable too, is that the Wilson Airport and Lang'ata Road, which are immediately adjacent to it have elevations of 1719m – 1748m above sea level while upper hill has elevations of 1748m – 1778m above sea level (Floodmap, 2014). This infers to South C and the Nairobi National Park being floodplains for a considerable number of areas that are located in elevations above them.

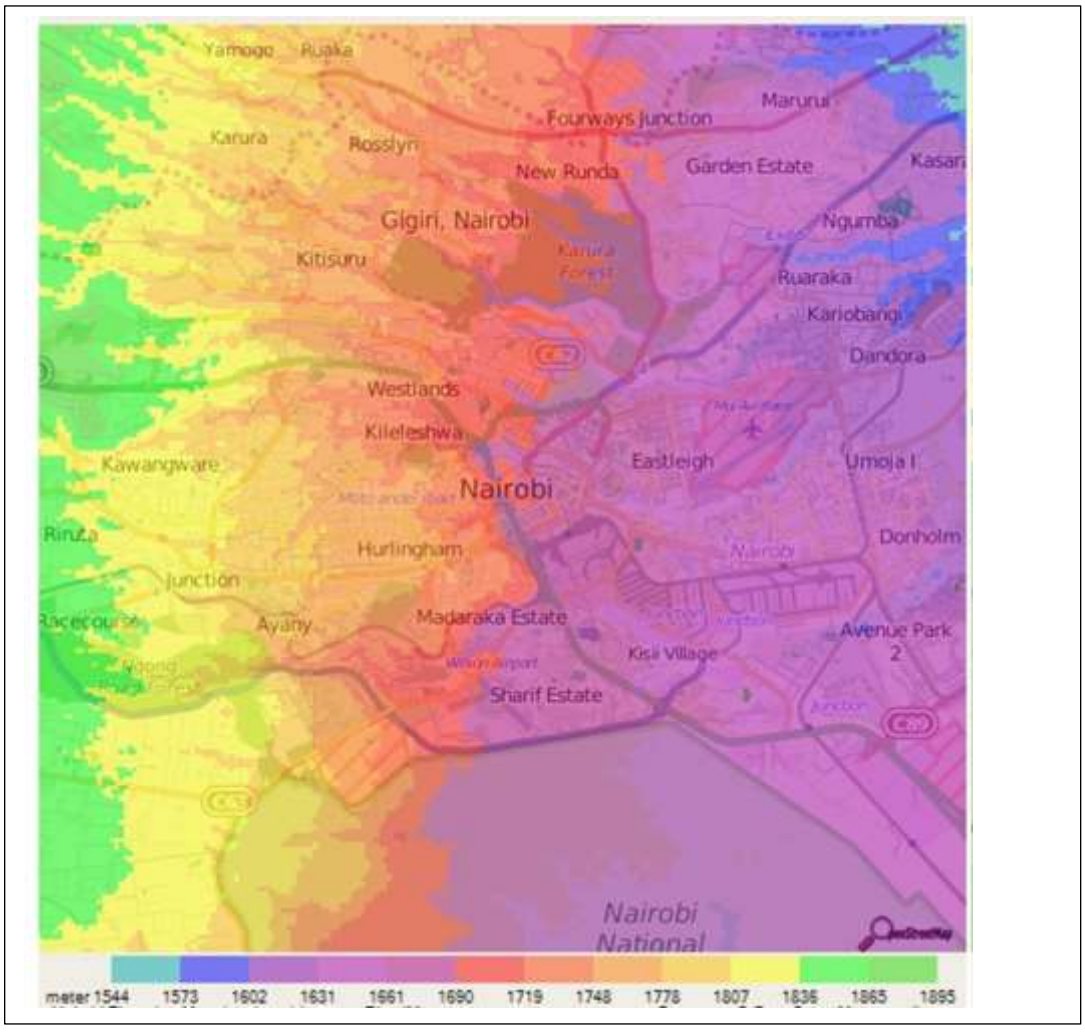

Figure 3.2: An elevation map of Nairobi showing the range of elevation in the different areas of the city. ***Source:*** *http://www.floodmap.net/elevation/ElevationMap/?gi=184745*

3.2.3 Climate and Hydrological Characteristics

The South C ward has been identified as one of the areas that are most prone to flooding within Nairobi city (NCC, 2015). It experiences extreme flooding every rainy season and has been reported to experience flood incidences even in the non-rainy seasons. According to the World Meteorological Organisation (WMO), the South C Ward experiences rainfall in varying amounts with the months April – May and November – December recording the highest amount of rainfall (Figure 3.3). A study conducted by Odhiambo (2015) found that 41% of South C is covered by impervious surface with the soil type in the area ranging from poorly draining to very poorly draining. Data collected by observation found that 50% of the storm water drains are in poor condition while Odhiambo (2015) found that some of the storm water drainage channels are designed in conflict with the natural topography of the area.

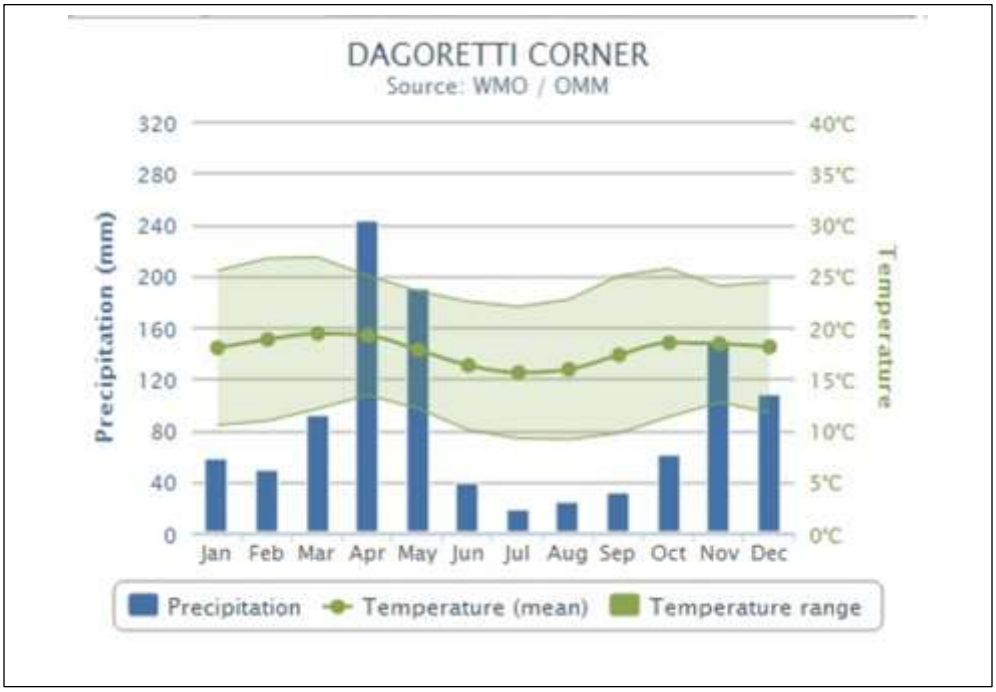

Figure 3.3: A chart showing the climatological data for the Dagoretti corner weather recording station. ***Source:*** *https://www.wmo.int/cpdb/kenya*

3.2.4 Land Use

According to the Nairobi City County Development Ordinances and Zones regulations, South C has permitted ground coverage (GC) of 35% and minimum plot ratio percentages of 75%. The City County further allows for comprehensive subdivision with lower sizes on type plan and development density at 35 units per hectare. The ward is zoned as a medium to high density mixed use development and is therefore characterized by residential developments comprising flats, maisonettes and bungalows with accompanying commercial and institutional developments. A visual examination of satellite imagery (Figure 3.4) in Nairobi City County indicates that over the last 16 years there has been an increase in the percentage built up area, with a considerable increase projected for the year 2025 (Stoicof, 2011). South C ward, which is also indicated on the map shows a considerable increase in the built up area within the same period.

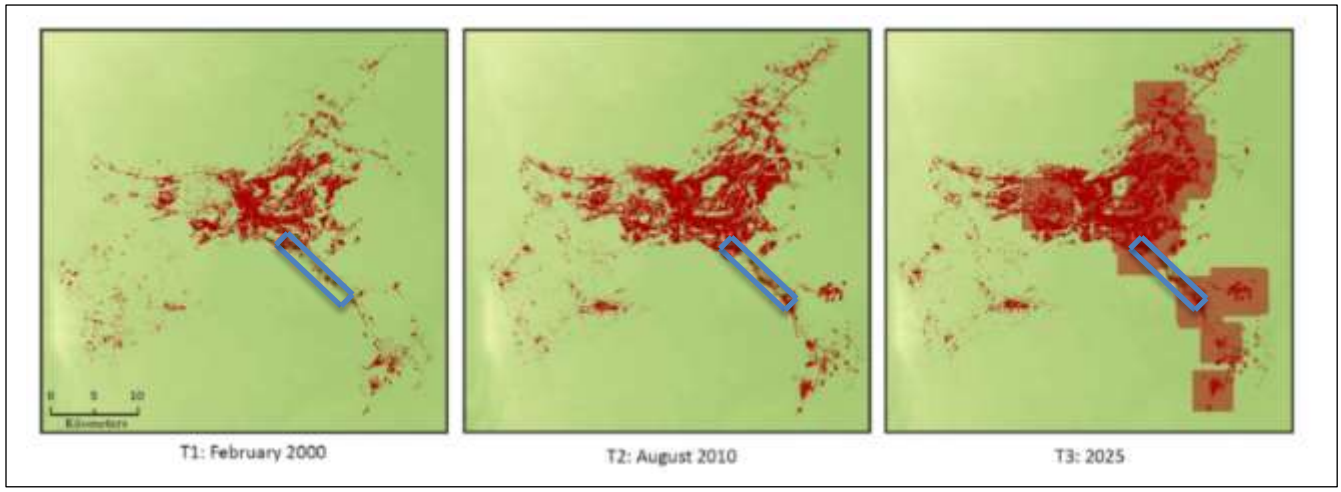

Figure 3.4: *Satellite images of Nairobi City County indicating the built up area in the years 2000 and 2010, and projection for the year 2025. South C Ward is indicated.*
Source: *lagic.lsu.edu/rsgis/2012/Presentations/Stoicof.pdf*

3.2.5 Demographic characteristics

According to the 2009 population census, South C has a population of 47,202 (Independent Electoral and Boundaries Commission of Kenya, n.d.) where 24,028 are male while 23,174 are female. The population density is 3, 126.13 and there are 13, 759 households. The predominant age group that resides in South C is 18 – 45. South C ward is characterized by a varied population demographic with a representative sample of housing, and other built-up infrastructure that was found suitable for the study.

3.3 Research Design

Descriptive study design was used in this study since it seeks to describe the characteristics of research variables. In addition, it has been successfully applied in assessment studies and it is able to provide information from the respondents within the shortest time and at minimal costs. This research hence used surveys in the form of questionnaires and interviews as well as field observation and checklists.

3.3.1 Population and Sampling Design

The total sample size for this study was 335 households drawn from the total population of 13,759 households in the study area. Being a predominantly residential area, the sampling unit was the household, from which a respondent was drawn. The formula used for sample size determination is:

$$N = \frac{P\ (100\% - P)}{(SE)^2}$$

Where;

N = Sample size
P = Estimated Percentage of respondents who will give similar responses
SE = Standard Error.

In order to calculate the sample size, the study first established that the confidence level required in the study is 95%, while the confidence interval allowed for this study was placed at 5%. The Standard Error (SE) was then calculated by dividing the confidence interval by 1.96. Following the pilot study conducted, the estimated percentage (P) was placed at 68%.

Calculation:

$$N = \frac{P\ (100\% - P)}{(SE)^2}$$

$$N = 68\% \frac{(100\% - 68\%)}{(5/1.96)^2}$$

$$N = 68 \frac{(100 - 68)}{(5/1.96)^2}$$

$$N = 68 \frac{(32)}{(2.55)^2}$$

$$N = \frac{2176}{6.50}$$

N = 334.76 = 335 (Rounded upwards)

Sample Size: 335 Households

The study then sought to gather an appropriate representative sample from all the areas that make up south C ward. Cluster sampling was used for this exercise, where South C ward was divided into 3 clusters (Figure 3.5), based on the predominant land-use or type of development in the particular areas. The clusters (zones) were then assigned numerical values and their characteristics summarized as indicated in the Table 3.1. From the zone stratification, systematic sampling was used in selecting every 40^{th} household, with left hand rule that counts every 40^{th} household used. The starting point in each area was located using a handheld GPS device. In the case where there was no respondent in the selected household, the next household after the 40^{th} household was selected.

The systematic sampling interval of 40 was arrived at using the formula:

$$= \frac{\text{Population size}}{\text{Sample size}}$$

$= 13{,}759/335$

$= 41.07 = 40$ (Rounded downwards)

The number of households where questionnaires were issued also varied based on the zone. In Zone 1 and Zone 3, only 100 households in each were involved in the study while in Zone 2, 135 households were involved. This is owing to the fact that the zone has the largest number of residential dwellings.

***Figure 3.5**: An earth satellite image of the study site with the study zones indicated.*
***Source:** www.google.com/maps/place/Nairobi*

Table 3.1: A table showing the three zones in South C ward, as a result of cluster sampling

ZONE	**DESCRIPTION**
ZONE 1	• This zone is characterized by medium density residential and commercial development. • It is flanked by *Muhoho* Avenue to the North, Popo Road to the South, Mombasa - Nairobi Highway to the East and *Muhoho*/*Ole Shapara* Avenue to the West. • It occupies an area of approximately 0.84 square kilometres.

	• Notable landmarks within this zone are South C shopping centre, South C Mosque, Nairobi Muslim Academy, PCEA Headquarters, Mama *Ngina* Children's Home, Ministry of Works Sports Club, CID Training School, Total Filling Station, Mirage Plaza, and Oil Libya Filling Station.
ZONE 2	• This zone is characterized by high density residential development. • Its boundaries are *Ole Shapara* Avenue to the North, *Muhoho* Road to the South and East and the Wilson Airport to the West. • It occupies an area of approximately 1.5 square kilometres. • Notable landmarks within this zone are *Mugoya* Estate, Bellevue Primary School, South C Members Sports club, *Mutumba* Village, Five Star Estate.
ZONE 3	• This is a zone mainly characterized by medium density residential development, as well as a high number of government and non-governmental organisations. • Its boundaries are Popo Road to the North, the Southern By-pass/Nairobi National Park to the South, Mombasa - Nairobi Highway to the East and *Muhoho* Road to the West. • It occupies an area of approximately 2.5 square kilometres. • Notable landmarks within this zone are Kenya Industrial Property Institute, Kenya Red Cross Society, Kenya Bureau of Standards, National Environment Management Authority, College of Insurance, Kenya Re Flats, Bellevue Estate, Nextgen Park, Eka Hotel.

3.3.1 Data needs, types and Sources

As a result of the objectives, this study adopted a mixed method of data collection which included a structured survey in the form of questionnaires and field observation checklists, as well as interviews with relevant key informants, stakeholders and institutions. The quantitative sources of data came from field observations of infrastructure in the area, as well as from documented information from relevant institutions such as the Kenya Red Cross Society (KRCS), the city planning sector of the City County government and the Kenya Meteorological Department.

3.4 Research Instruments

The research instruments in this study were the questionnaires (Appendix 1), key informant interviews and Observation Checklist (Appendix 2). The questionnaire had both open and closed ended questions and was addressed to the residents and business community located in South C. The questionnaire is appropriate for collection of data from a cross-section of respondents. The questionnaire had seven parts. The key informant guides were administered to Key Informants who included a Kenya Red Cross Society official, a Kenya Metrological Department officer, the South C Ward Member of County Assembly (MCA) and an urban planning officer from the Nairobi City County. An observation checklist was used as a guide to collect certain observable parameters of the study site.

3.5 Reliability and Validity of Instrument of data collection

The questionnaire to be used for data collection was pretested for its face validity through a pilot study that was carried out among 20 respondents. This helped gain respondents view on the validity and reliability of the questionnaire. The selected respondents were not allowed to participate in the main study. In addition, the pilot results helped the researcher to fine - tune the questionnaire for objectivity and efficiency of the process. Expert views and suggestions of supervisors were also included in the questionnaire during the development and fine tuning of the questionnaire. Pre-testing also helped to assess whether the respondents are able and willing to provide the needed information. Pre-testing was conducted in circumstances that are as similar as possible to actual data collection and on population members as similar as possible to those that were to be sampled in the main study. As a result of the pilot test, changes in the research instrument were made to improve the reliability and validity of the research instrument. The instrument was then subjected to reliability test using the Cronbach alpha (α) test with an alpha test of 0.815 obtained after pilot tests. This was more than an alpha (α) value of $f = \geq 0.7$ thus indicating the reliability of the instrument.

3.6 Data Analysis

The data collected from the field was entered into the computer and a database structure developed; based on the research objectives. The data analysis used both descriptive (description of the basic features of the data using graphs and tables) and inferential (relation of the basic data with other information gathered from the literature review in so far as flood patterns and vulnerability assessments are concerned) methods to present the

results. Spearman correlation was used to test the relationship between independent variables and floods impact. Analysis of qualitative data was carried out through content analysis that was used to develop categories which were then used to build themes to answer the thematic areas of the study interview guide. Direct reporting was used to present the findings from the interviews with tables, charts and frequencies used to present the findings from the questionnaire. The findings of the observation checklist were referred during discussion of the findings.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter focuses on the results obtained from the analysis of the findings of the study. The number of completed questionnaires is 335, bringing the response rate to 100% of the possible targeted 335. The study data collected was thus considered suitable for analysis. The results are based on the three objectives of the study and are presented in both tabular and graphical formats.

4.2 Respondents' characteristics

4.2.1 Socio – Demographic characteristics

The study results indicated that 63% of the respondents were male with the remaining 37% of the respondents being female (Figure 4.1). In terms of education levels, it was established that 51% of the respondents had tertiary level of education, 28% of the respondents had secondary level of education, 16% of the respondents had primary level of education, while 5% of the respondents had no formal education. The results indicate the high literacy level that was found in South C as indicated in table 4.1 below.

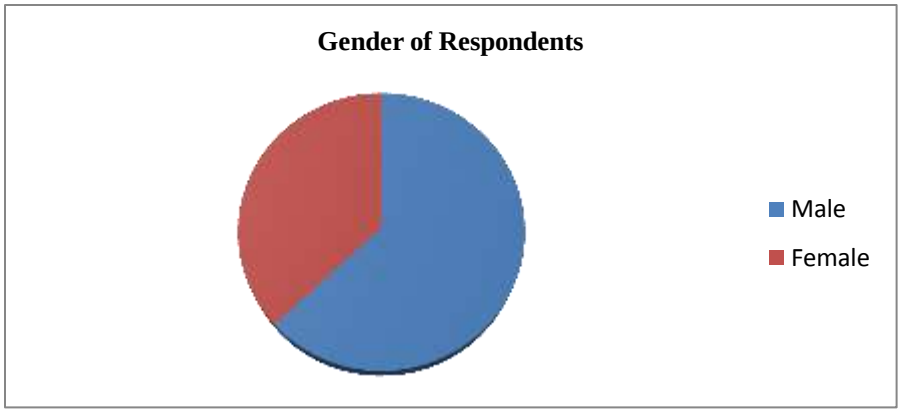

Figure 4.1: *A figure representing the gender of respondents*

Table 4.1: A table representing the respondents' level of education

Characteristic	**Description**	**Frequency**	**Percent**
Highest level of education	None	17	5
	Primary	54	16
	Secondary	93	28
	Tertiary	168	51
Total		**332**	**100**

4.2.2 Type of Occupation

The results of the study as shown in table 4.2 established that 64% of the respondents were engaged in self-employment with the remaining 20%, 5%, and 10%, being permanent employees, contract employees and casual employees respectively. These results are attributed to the fact that while South C is a predominantly residential area, it is also a mixed use development.

Table 4.2: A table representing the occupation of the respondents

Occupation of Respondent	Frequency	Percent
Self –Employed	216	64
Permanent Employment	67	20
Contact / Temporary Employment	18	5
Casual Labour	34	10
Total	**335**	**100**

4.2.3 Net monthly income of the household head

In terms of monthly income, figure 4.2 shows that 27% of the respondents had a net income of between Ksh.30,0001 to Ksh.60,000 with 20% of the respondents having a net income of between Ksh.10,001 to Ksh.30,000 and 20%, 17% and 13% of the respondents having incomes of over Ksh.10,0001, between Ksh.60,001 and Ksh.100,001 and less than Ksh.10,000 respectively. These findings indicate that South C is dominated by middle to high income earners.

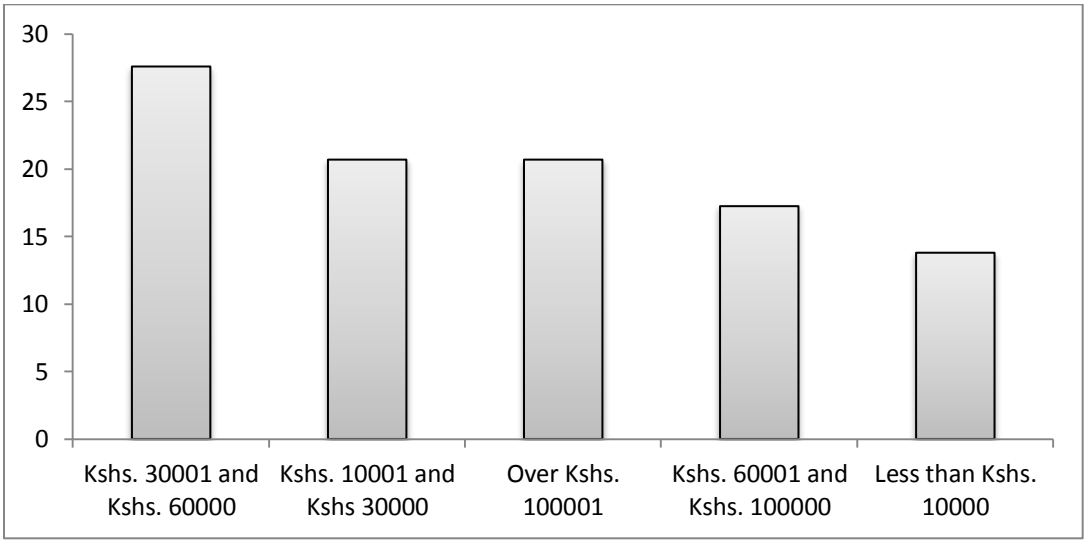

Figure 4.2: A Figure representing the net monthly income of the household head

4.2.4 Tenure-ship of the houses in South C

The results on tenure-ship as presented in figure 4.3 showed that most of the respondents (68%) were tenants while 29% of the respondents were staying in institutional houses and the remaining 3% were the owners of the houses that they were living in.

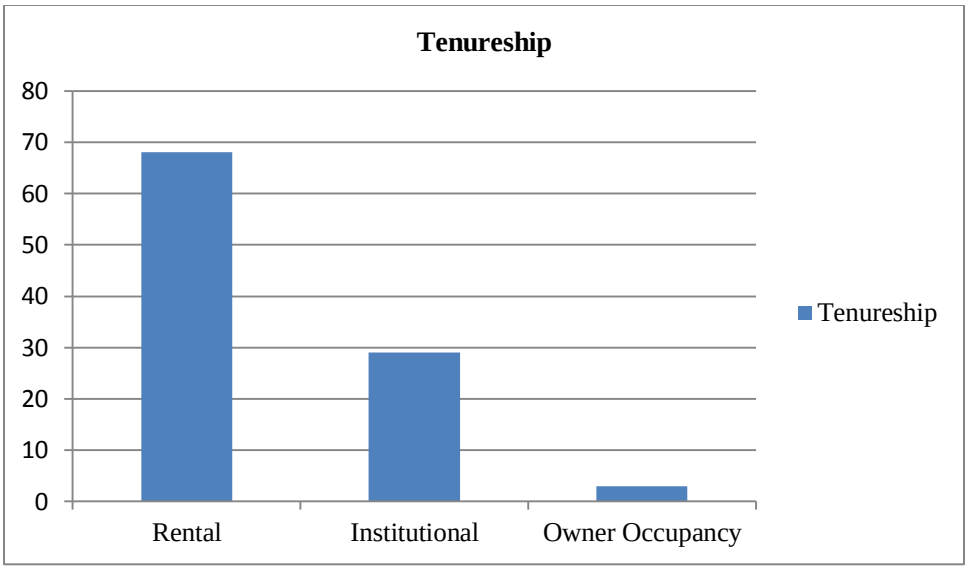

Figure 4.3: A figure representing the tenure-ship of houses in South C

4.2.5 Length of stay of the respondent in South C

From Table 4.3, majority of the respondents (42%) of the respondents had stayed in south C for between 0 to 5 years, 17% had stayed for between 6 to 10 years, 25% had stayed for between 11 to 15 years, 3% had stayed for between 16 to 20 years and 13% had stayed in the area for more than 20 years. These results are explained by the fact that majority of respondents were tenants who are mobile in nature and may not stay in the same residential area for more than 5 years.

Table 4.3: A table representing the respondents' length of stay as residences of South C

Number of years lived in South C	Frequency	Percent
0 – 5 years	140	42
6 – 10 years	57	17
11-15 years	84	25
16 – 20 years	10	3
Over 20 years	44	13
Total	**335**	**100**

4.3 Flood Patterns and Effects of Flooding in South C

4.3.1 Frequency of flooding in South C

It can be ascertained from Figure 4.4 below, that flooding is a problem in South C because majority of respondents (48%) agreed that the area experiences flooding annually, while 41% of the respondents said that the flooding occurs every six months. In the same vein, 7% of the respondents said that the flooding occurs every three months while the rest (5% and below) responded that the flooding occurs monthly or rarely occurs.

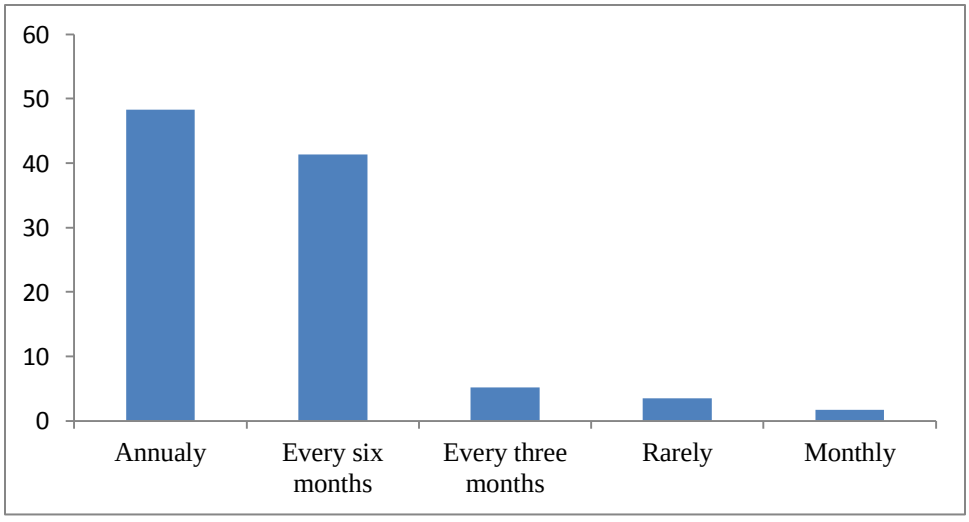

Figure 4.4: A figure representing the frequency of flooding in South C

Frequency of floods has to do with how often flooding occurs in a particular zone. It is also conceived that the more frequently floods occur in a zone, the higher that zone's vulnerability level.

4.3.2 Months when Flood Occurs

Figure 4.5 shows the months of the year when flooding occurs in South C ward. Half of the respondents (50%) said the flooding occurs in the months of March to May and also between October to November. 35% of the respondents said the flooding occurs between March and May while 10% and 5% of the respondents said the flooding occurs in the months of June to September and between October and December respectively.

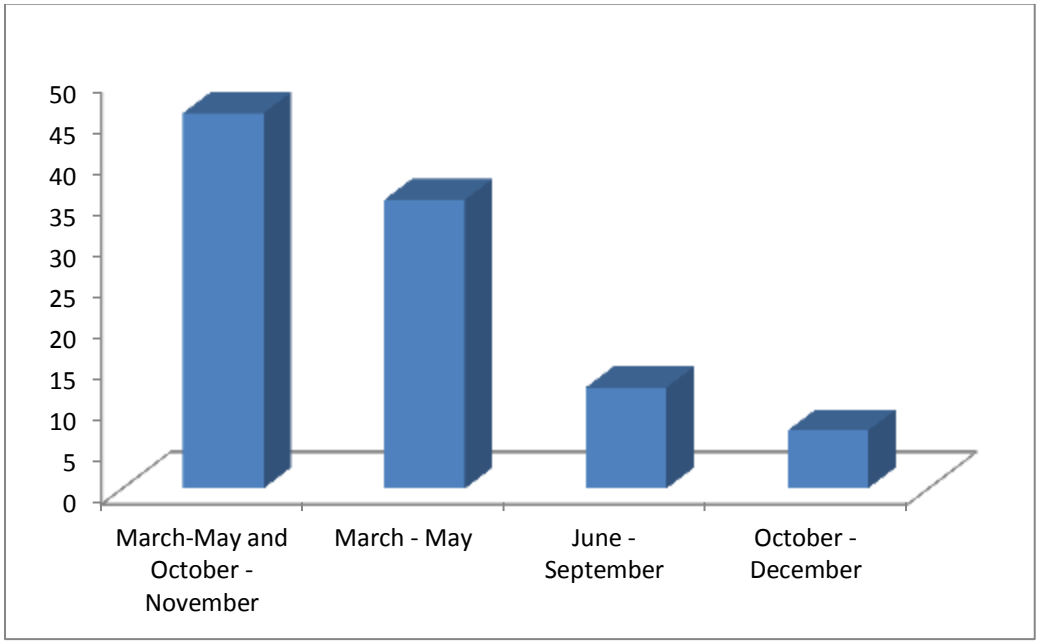

Figure 4.5: A figure representing the months when flooding occurs in South C

The above findings are explained by the reason that the most cited months that floods occur in South C are also the short and long rain seasons in Nairobi.

4.3.3 Number of days flood water takes to subside

Figure 4.6 below indicates that majority of the respondents agreed that it takes 1-2 days for flood water to subside, with 20% agreeing that it takes less than a day for flood water to subside, 15% agreed that it takes between 3-7 days for flood water to subside and 5% agreed than it takes more than 7 days.

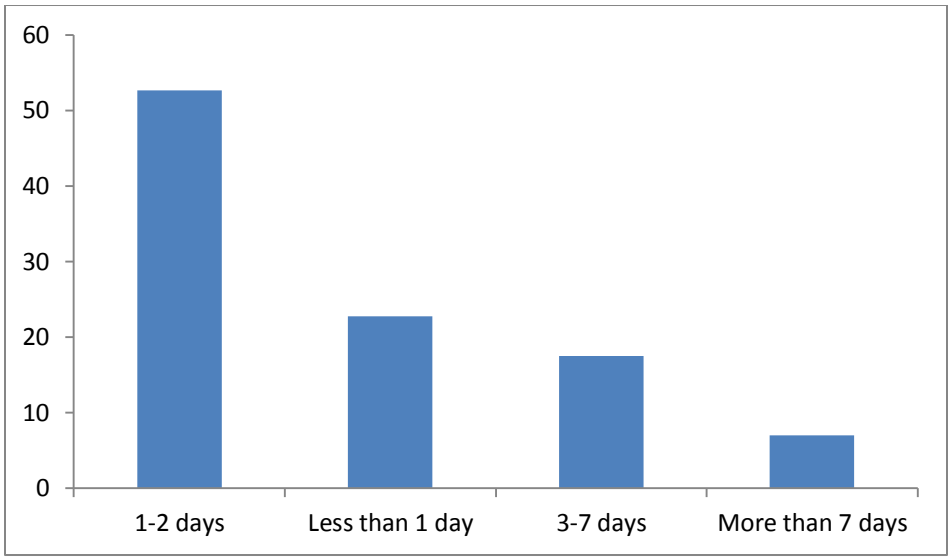

Figure 4.6: A figure representing the number of days it takes for flood water to subside in South C

4.3.4 The perceived trend of flooding in South C

Figure 4.7 below shows the perceived trend of flooding in South C area. According to the results, majority of the respondents (62%) indicated an increase in flooding has increased while 19% indicated that flooding had either decreased or remained constant.

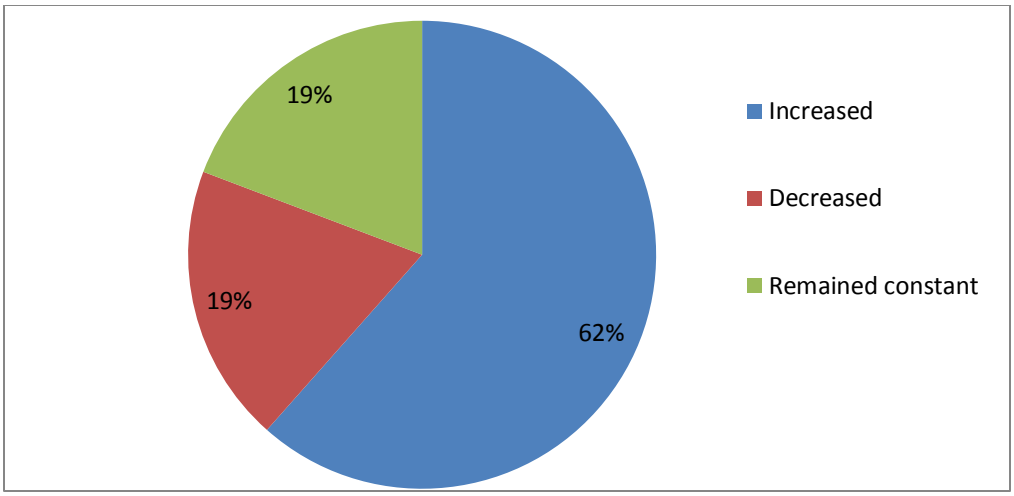

Figure 4.7: A figure representing the perceived trend of flooding in South C

4.3.5 Depth of flood waters in South C area

According to the findings, majority (54%) of the respondents stated that flood water depth is between 0.3 - 0.5m with 25%, 15% and 6% of the respondents mentioning that flood depth is between 0.6 - 1m, over 1.1 m and less than 0.2 meters respectively. This implies that most of the flooding that South C has experienced is low hazard flooding.

Table 4.4: A table representing depth of flood waters in South C area

Flood Water Depth	Frequency	Percentage
Less than 0.2m	17	6
0.3m - 0.5m	156	54
0.6m -1m	73	25
Over 1.1m	44	15
Total	**290**	**100**

How deep flood waters are in any zone has a positive correlation with its vulnerability level, in the sense that the deeper the flood waters, the more the damage and the vulnerability.

4.3.6 Effects of floods to residents of South C

The study found that lack of accessibility to places of work, business or school was the greatest effect (45% of respondents) that floods had on the residents of South C. Power outages (31%), loss or destruction of property (12%) were also found to be significant effects of floods in the area. Water shortages, loss of lives and outbreak of water-borne diseases were also found to be effects of flooding in South C, at 8%, 1% and 1% respectively. These are presented in Table 4.5 below.

Table 4.5: A table representing the impact of floods to residents of South C area

Effect	**Frequency**	**Percent**
Inaccessibility to work/place of business/school	228	45
Power outages	158	31
Loss/Destruction of property	61	12
Water shortages	43	8
Loss of life	6	1
Outbreak of Water – borne diseases e.g Malaria/ Cholera	6	1
Total	**502**	**100**

Floods in South C cause both direct (losses resulting from direct contact with flood water, to buildings and infrastructure) and indirect (Losses resulting from the event but not from its direct impact, for example, transport disruption). There are also tangible (Loss of things that have a monetary replacement value such as buildings) and intangible (Loss of things that cannot be bought and sold, for example, lives and injuries, heritage items, memorabilia). This is as classified by the World meteorological Organisation (WMO).

4.3.7 Sources and forms of assistance to residents after flood events

Table 4.6 below shows the kind of assistance received during or after floods. The study revealed that only 18% respondents received assistance during floods while majority (82%) did not receive any kind of assistance during floods. Out of the percentage of respondents that had received assistance, 75% mentioned that they have received assistance from the County Government, with the major portion of that assistance coming in form of resettlements. Majority of respondents have not received any form of assistance and this is believed to have a direct negative effect on the vulnerability levels of the individuals.

Table 4.6: A table representing the sources and forms of assistance to residents after flood impacts of South C area

Post – Flood Effect Assistance	**Description**	**Frequency**	**Percent**
Source of Assistance	County Government	16	75
	Landlord	6	25
Total		22	100
Form of Assistance	In – Kind Compensation	6	33
	Resettlement	11	67
Total		**17**	**100**

4.3.8 Residents' coping mechanisms and cost of intervention measures

Table 4.7 shows the coping mechanism employed by those affected by floods. The study revealed that 58% of those affected by the floods had to carry out building renovations/modifications; 25% of the respondents relocated while 8% of the respondents employed insurance against flood losses; in addition 4% of the respondents bought in

bulk and another 4% of the respondents missed work until the floods subsided. In addition, majority of the respondents (38%) had incurred costs of interventions ranging from Ksh. 10,000 to Ksh. 50,000.

Table 4.7: A table representing the flood coping mechanisms and cost of intervention measures of South C area

Aspect	Response	Frequency	Percentage
Coping	Building renovations/modifications	79	58
Mechanism	Re-locating	34	25
	Insurance against flood losses	11	8
	Shop in bulk	5	4
	Missed work until the floods subsided	5	4
Total		**134**	**100**
Cost of	Less than Kshs. 10,000	27	31
Intervention	Kshs. 10,001 and Kshs 50,000	34	38
	Kshs. 50,001 and Kshs. 100,000	11	13
	Over Kshs. 100,001	17	19
Total		**89**	**100**

4.4 Factors influencing the vulnerability of South C ward to flooding

4.4.1 Solid Waste Management

4.4.1.1 Method of sewer waste disposal used by residents

Figure 4.8 shows the method of sewer waste disposal used by the residents. The study revealed that 79% of the respondents used municipal method of sewer waste disposal, and 16% used septic tank while 5% of the households used other types (Latrine and Private).

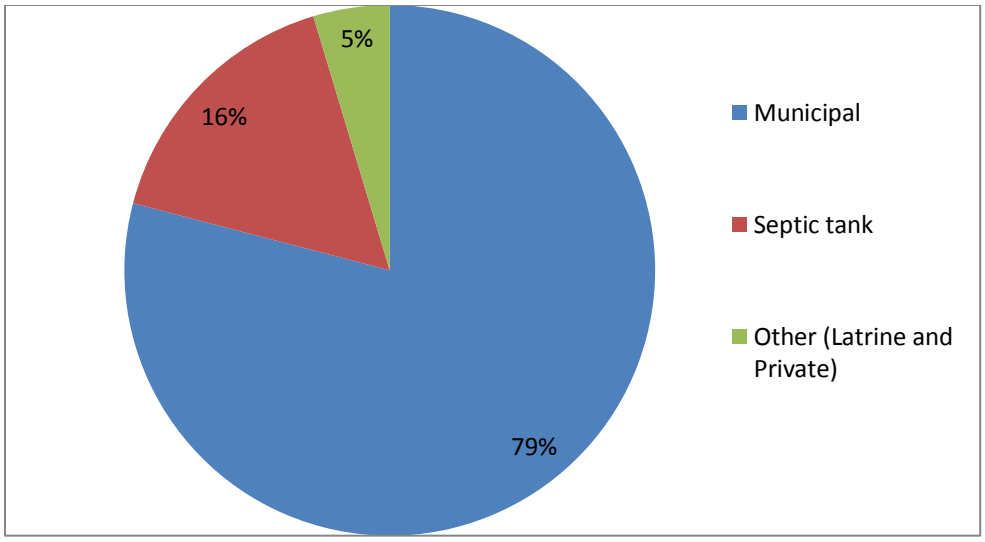

Figure 4.8: A figure representing the method of sewer disposal used by residents in South C

In addition, the study found that as indicated in table 4.8 below, 74% of the respondents mentioned that they experience sewer blockages every rainy season while others experience sewer blockages twice a year (10%), once a year (6%) and other times (10%). This could be attributed to the reason that most respondents use municipal sewers which likely lack regular maintenance and are hence more likely to block as a result.

Table 4.8: A table representing the frequency of Sewer blockage occurrence in South C

Frequency of sewer blockages	Sewer blockages	
	Frequency	**Percent**
Every rainy season	144	74
Twice a year	19	10
Once a year	13	6
Other	19	10
Total	**195**	**100**

4.4.1.2 Relationship between Method of Sewer Waste Disposal and Effect of Flood

The study showed that there exists a positive relationship between method of sewer disposal and vulnerability to floods. This was indicated with a p-value of 0.051 which is significant at 0.05.

Table 4.9: A table representing the Correlation between Method of Sewer Waste Disposal and Vulnerability to floods

Method	**Affected by floods**						
	Yes		No		Total		Sig
	N	%	N	%	N	%	
Municipal	72	75	24	25	96	100	.05
Septic tank	18	86	3	14	21	100	
Other	6	100	0	0	6	100	
Total	96	78	27	22	123	100	

This result indicates that majority of persons with municipal sewerage disposal systems are more exposed to floods. This is possibly attributed to the fact that due to poor maintenance and clogging of municipal sewerage systems respondents using such systems are more vulnerable to flooding due to the possibility of failure of such systems when flooding occurs.

4.4.1.3 Method of solid waste disposal used by residents

On the method of solid waste disposal used by the residents in South C, results in Figure 4.9 show that 72% of the respondents used private collection method to dispose of the solid waste, 23% of the respondents used municipal collection method while the rest of the respondents (below 10%) either dumped waste into the river or burnt it.

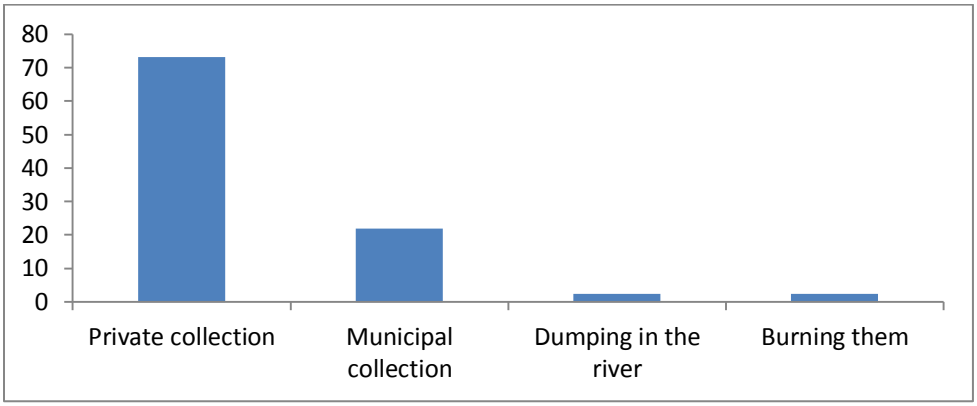

Figure 4.9: A figure representing the method of solid waste disposal used by residents in South C

The respondents' use of private waste disposal is attributed to the inefficient city council/ County Government waste disposal service that has existed over the past few years, making a number of tenants and landlords to turn to private waste disposal. Moreover, the fact that some of the residents cannot afford private waste disposal services, they are more likely to dump this waste haphazardly into the commons, leading to drainage system clogging and hence increased incidences of floods. Improper waste management practices in South C and the incidence of flooding in South C are correlated. This is because the volume of solid waste in the form of silt or rubbish cannot be collected by existing systems. The *mitumba* slums is an informal settlement in South C in which there is improper solid waste disposal, by way of dumping solid waste directly into watercourses, drains, culverts, and other drainage structures which results in reduced flow capacity and therefore causes overflowing; leading to flooding. The capacity of water to flow is thus greatly reduced by the deposition of silt, garbage, and weed-growth in and along the riverbanks. These findings align themselves to the results of Gyekye (2013) who carried out a study in Ghana and found out that improper waste management is a key

contributor to urban floods, more so along the river beds where improper waste has led to increased incidences of floods.

4.4.2 Infrastructural Physical Exposure

4.4.2.1 Typology of housing

Table 4.10 shows the typology of housing. The study showed 55% of the respondents lived in singled-storeyed/bungalow houses, 31% in two-storeyed/maisonette while 14% lived in apartment/flats houses. Similarly, 73% of the respondents lived in houses with ceramic tiling, 10% in wood/parquets tiling while 17% in bare concrete floors. In addition, 71% of the respondents lived in masonry walled houses, and 18% lived in brick walled houses while 8% and 2% lived in corrugated iron sheets and timber walled houses respectively. In the same vein, 71% and 24% of the respondents lived in houses roofed with roofing tiles and corrugated iron sheets respectively, while 4% of the respondents in timber roofed houses.

Table 4.10: Predominant typology of housing in South C

Aspect of housing		Frequency	Percent
Housing	Single-storeyed/ bungalow	151	55
	Two-storeyed/maisonette	84	31
	Apartments/flats	38	14
	Total	**273**	**100**
Floor material	Ceramic tiling	196	73
	Wood/parquets tiling	27	10
	Bare concrete	45	17
	Total	**268**	**100**
Walling material	Masonry wall	194	71
	Brick wall	51	18
	Corrugated iron sheets	23	8
	Timber	5	2
	Total	**273**	**100**
Roofing	Roofing tiles	194	71
	Corrugated iron sheets	67	24
	Timber	12	4
	Total	**273**	**100**

The quality of housing among the respondents indicates that majority of the respondents have high quality structures, which will influence the degree of damage as a result of flooding.

4.4.2.2 Rainwater harvesting and drainage systems

Table 4.11 shows the rainwater harvesting and drainage systems used by the respondents. The study revealed that 28% of the respondents harvest rain water while 72% do not. The study results also revealed that 54% of the respondents use gutters to harvest water while 46% used basins, buckets, and *sufurias*. The results also indicated that 58% of the respondents had external storm water drainage system where open storm water drain

(38%), covered storm water drain (47%) and 15% of the respondents having temporary swales.

Table 4.11: Rainwater harvesting and drainage systems used by residents of South C area

Aspect	Response	Frequency	Percentage
Method of Rainwater harvesting	Building gutters	39	54
	Basins, buckets, *sufurias*,	34	46
Total		**73**	**100**
Type of drainage system adjacent to the house/business premises	Open concrete drain	59	38
	Covered concrete drain	73	47
	Natural/temporary swale	24	15
Total		**156**	**100**

An analysis was carried out through correlation to test the relationship between storm water drainage types and flood vulnerability. The study results indicated that there exists no significant relationship as indicated with a p-value of 0.104. What matters is that a type of drainage suitable for the storm water volumes is installed and well maintained. The survey further revealed that the pathway by which flooding affects the South C Ward is intense rainfall that as a result overwhelms the drainage holding capacity of the area. Other anthropogenic factors, which have an impact on the conveyance of storm water and which decrease the ability of the storm water drainage infrastructure to disperse water, also tend to increase the flood hazard within the South C Ward built urban environment. These findings are similar to the results of Adelekan (2013) who established that poor drainage is one of the major causes of urban flooding. It was also noted that South C has some roads with underground drainage systems. Of importance to this study is that most of the underground drainage within the older roads of South C Ward such as Ole Shapara

Avenue and Muhoho Avenue were blocked and therefore not in use. Those along the newer roads were noted to still be in good condition. Moreover, some of the storm drains in South C are open and small, and have no covers hence people dump waste items ranging from used car tires to household refuse directly into these drains.

Related to the drainage system was the observation that green spaces and roads that do not have tarmac increase rain water permeability; hence minimise flooding. It was evident that green spaces/open spaces are limited in this area; perhaps as a result of illegal construction on spaces designated as public open green spaces or for planned densification. The increasing densification of towns and cities is often seen as desirable in order to meet sustainability targets by reducing transportation requirements and preserving rural land. However, densification implies that every space is utilized to the maximum for the use of urban dwellers. This leads to an increase in hard surfaces and a decreasing permeability of open space left after the construction of buildings thus making the land more vulnerable to flooding.

4.4.3 Level of access to information

4.4.3.1 Mass Media devices used by South C residents

Table 4.12 shows the kind of mass media device used by the respondents. The study revealed that 33% of the respondents used radio, television (TV) and computer for access to information, while 30% and 21% used radio and TV respectively. Similarly 12% and 2% of the respondents used television and TV; computer with internet access; television and computer respectively. These findings show the level to which residents own a form of mass media.

Table 4.12: Mass Media devices used by South C residents

Type of mass media device used	Frequency	Percentage
Radio, TV and computer	105	33
Radio	96	30
Television	67	21
Television and Radio	38	12
Computer with internet access	6	2
Television and computer	6	2
Total	**318**	**100**

The ownership and ability to use any form of mass media source; radio/TV/phone/computer is a measure of access to technology, and this is necessary as a means through which information on impending flood hazards could be disseminated. The study also found that the use of technology and social media has greatly enhanced the level of access to weather and flooding information. The Trilogy Emergency Relief Application (TERA) is a platform that was designed in response to the Haiti earthquake in 2010. The system has been used to send approximately 72 million messages in Kenya, having been launched by the Kenya Red Cross in 2015 (IFRC, 2016).

4.4.3.2 Access to newspapers and the internet

Figure 4.10 below shows the level and frequency of south C residents' access to newspapers and the internet. It is evident that a majority of the respondents (87%) had access to newspapers while 13% do not have access. In addition, 65% of these respondents had daily access to newspapers; 19% had weekly access and only 16% had a monthly access to newspaper. Similarly, the study revealed that 69% of the respondents had access to the internet while only 31% had no access. In the same vein, 79% of the

respondents had a daily access to the internet; 14% had a weekly access and only 7% had a monthly access to the internet.

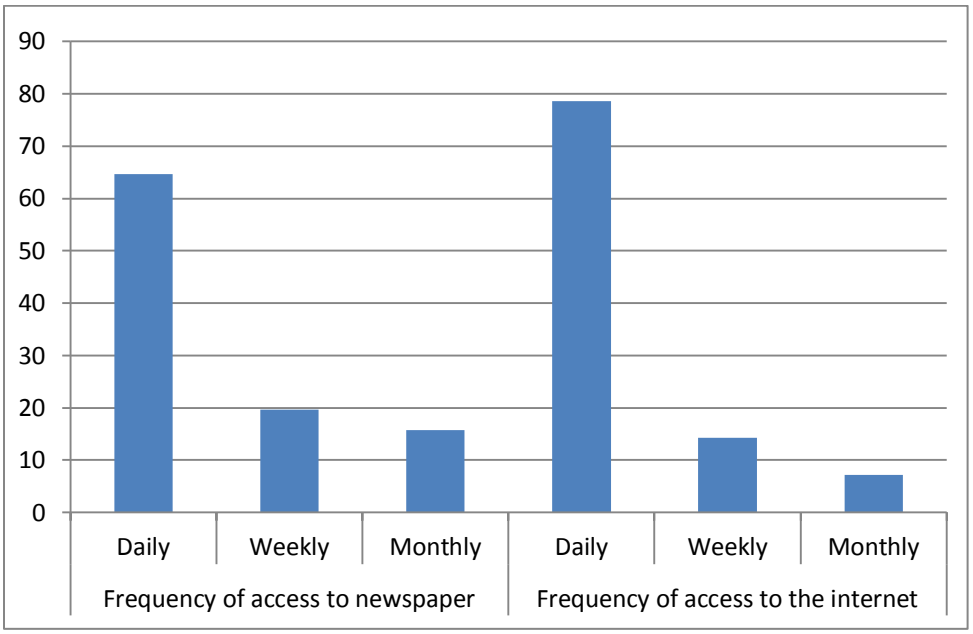

Figure 4.10: Frequency of South C residents' access to newspapers and the internet

4.4.3.3 Level of access to Flood warning information

As indicated in Table 4.13, 41% of respondents received information/warning relating to floods or rains while 59% did not receive such information. The study findings also revealed that among respondents who had received this information, 42% had received such information through the central government agencies/institutions, 20% had received through friends or neighbours, 18% had received through residents' associations, 15% had received through Non – governmental organisations (NGOs) or Community Based organisations (CBOs) and 5% had received it through the Member of County Assembly (MCA). Regarding the usefulness of such information, 61% of the respondents agreed that the information had been useful.

Table 4.13: Level of access to Flood warning information among residents of South C

Aspect	Response	Frequency	Percentage
Source of information	The National Government agencies	73	42
	Friends or Neighbours	35	20
	Neighbourhood Residents' Associations	32	18
	NGO/CBOs	26	15
	Councillor/ Ward Representative/MCA	9	5
Total		**175**	**100**

This study results attest to the role of the National and County Governments as key information providers to the citizens. The findings also attest to the importance of network relationship as seen through friends and neighbours who were also cited as information providers on matter relating to floods. Flood warning information is important as pre-flood awareness influences the place where people reside, flood preparedness, and thereby their exposure to flooding. Therefore, the higher the number of respondents with access to flood information, the lower their zones' vulnerability levels (holding every other factor constant). The study also found out that there was no correlation between type of information source and level to which respondents were affected, with this indicated by a p-value of 0.554. This means that all the sources of information that the respondents rely on provided them with timely, reliable and credible information that could be of help to the respondents.

4.4.4 Forms of governance practices among the residents of South C

4.4.4.1 Residents' Associations

The study showed that only 49% of the respondents know of any residents' association in the area while 51% do not know of any residents' association in the area. In addition, only 31% of the respondents were members of such associations while 69% of the respondents were not members. From Figure 4.11, it is evident that only 13% of the respondents perceived the residents' associations as having a high competency to deal with flood management while 25% felt that the associations had medium competency and 63% indicated that the associations had low competency to deal with the same.

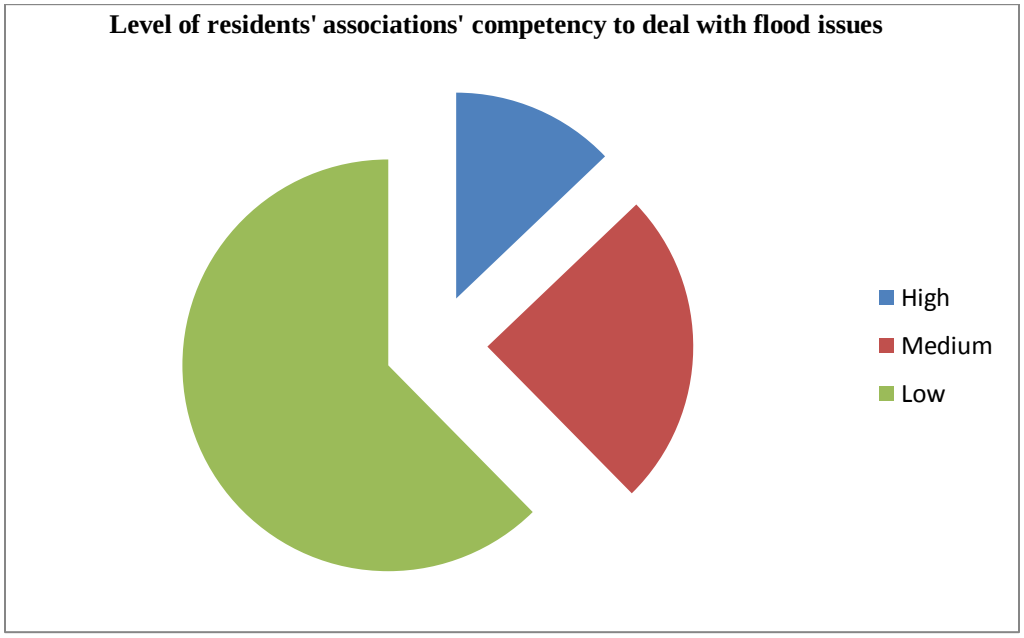

Figure 4.11: Governance practice among the residents of South C

4.4.4.1.1 Relationship between membership to an association and vulnerability to floods

From Table 4.14, it is evident that there exists a significant relationship between membership to an association and the vulnerability to floods. This was indicated by a p-value of 0.000. This signifies that membership to an association exposes one to more information that may be helpful in reducing flood vulnerability. Membership to a support network is also likely to improve social capital of members and thereby, their resilience.

Table 4.14: Correlation between Membership to association and Flood vulnerability

Membership	**Affected by floods**						
	Yes		No		Total		Sig
	N	%	N	%	N	%	
Yes	21	63.6	12	36.4	33	100.0	.000
No	78	96.3	3	3.7	81	100.0	
Total	99	86.8	15	13.2	114	100.0	

The results indicate that there was a significant relationship between membership to an association and impact of floods. This was indicated by p-value of 0.00001 and r-value of -0.438. This means implies that respondents who were members of associations were least affected by the floods, with this been attributed to the fact that in such associations members are provided with information that can help them prepare for the floods unlike members who are not part of such associations. On the contrary the study found out that being a member of resident association does not necessarily help one to cope with the

effects of floods. This was indicated with a p-value of 0.314. These findings indicate that being a member of a residents' association may provide one with information on how to prepare for the floods thus minimizing its effect. However, the same cannot be said about coping that may require financial outlay and that may not be readily available in the residents' association. Majority of the respondents (83%) also mentioned that apart from the residents' associations they are not aware of any institution that deals with floods in the area.

4.5 Policy, legal and institutional framework in place to manage flooding in Nairobi City County.

4.5.1 Policy framework

The study found that there are seven policies and strategic plans relevant to meeting the objectives of the study as they touch on the subject matter of flooding. Of these, only one has specifically discussed flooding in South C ward. Table 4.15 below has given a summary of these.

Table 4.15: Policies and strategy documents that address matters of urban planning and the physical environment

Policy	**Policy Objective**
The National Environment Policy, 2013	A policy that seeks to provide a framework for an integrated approach to planning and sustainable management of Kenya's environment and natural resources.
Draft National Urban Development policy of 2012	The overall objective of the Policy is to provide a framework for sustainable urban development in Kenya.
The Draft National Disaster Management policy, 2010	A policy that seeks to establish the guiding principles for disaster management in Kenya by presenting the institutional structures, roles, responsibilities, authorities and key processes required to achieve a coherent, coordinated, and consistent

	approach.
The National Housing policy of 2004	One of the policy's basic objectives is to protect the environment of human settlements and of ecosystems from pollution, degradation, and destruction in order to attain sustainable development.
The Flood Mitigation Strategy of 2009	A document that outlines a proposed flood mitigation strategic intervention areas and action plans for the river basins in Kenya.
The draft Nairobi Integrated Urban Development Master plan (NIUPLAN)	The purpose of NIUPLAN is to provide a guiding framework to manage urban development in Nairobi City County from 2014-2030, integrate all urban development sectors and realize the goals of Kenya Vision 2030 for the city County of Nairobi.
The Nairobi County Integrated Development Plan (NCIDP), 2014	This is a document that seeks to define Nairobi County's development priorities, strategic policy thrusts and project/programme interventions necessary for the County to achieve sustainable development both in the medium term and in the long run.

The National Environment Policy groups floods as natural disasters occurring as adverse impacts of climate change. The policy goes ahead to offer a policy statement on the need for the government to develop and implement an integrated housing policy and housing master plan that takes into account environmental considerations. This is especially relevant to South C ward as it is a predominantly residential area that requires regulation on housing for flood vulnerability reduction and mitigation through structural requirements such as rainwater harvesting installations in buildings. In so far as climate – related hazards such as floods are concerned, the National environment policy commits that the government shall develop and implement awareness raising strategies and capacity development opportunities for adaptation and mitigation measures, strengthen and enhance early warning and response systems for climate and disaster risk reduction,

as well as involve and empower communities in mitigating and adapting to climate change.

The flood mitigation strategy categorises the Nairobi City County as one of the locations in the country that experiences floods annually. It however makes no further mention of the City County in so far as flood mitigation is concerned. The draft national disaster management policy groups floods as an environmentally-triggered hazard but gives no specific policy recommendations on dealing with floods in cities; Nairobi City County included. The housing policy only offers a recommendation for the promotion of hazard resistant building designs and construction in zones prone to earth movement and flooding by enforcing building specifications and regulations. The draft National urban development policy charges the national and County Governments, and urban authorities to mitigate the effects of climate change by enhancing climate change resilience through infrastructure design and flood protection. There are, however, no stipulated guidelines on how these institutions will go about this.

Of relevance to this study, the NIUPLAN considers Urban Planning, Urban Environment and Urban infrastructure as three separate thematic areas. The urban infrastructure thematic area shall focus on matters of storm water drainage and solid waste management. The study found that these are two areas that have largely contributed to flooding in South C ward. A public and stakeholder consultative workshop held for the Lang'ata constituency, of which South C ward is a apart of found that there exists no drainage plan for the constituency and by extension the South C ward.

The Nairobi County Integrated Development Plan (NCC, 2014a) identifies poor and blocked drainage system, poor sewerage system, poor garbage collection methods, land grabbing and lack of a ward office as some of the main development issues in South C Ward. The document then goes ahead to propose specific projects to counter these issues. These include unblocking and construction of storm water drainage systems along the roads, re-direction and overhaul of sewer lines, land re-capture, contracting of private garbage collection services, as well as construction of ward administration offices.

4.5.2 Legal framework

The study found that there are five Acts of Parliament relevant to meeting the objectives of the study as they touch on the subject matter of flooding. Of these, none has specifically discussed flooding in Nairobi City County or South C ward. Table 4.16 below has given a summary of these.

Table 4.16: Acts of Parliament that address matters of urban planning and the physical environment

Law	**Key provision**
The Constitution of Kenya, 2010	
The National Environment Management and co-ordination Act, (CAP 387 of 1999) and The National Environment Management and co-ordination (Amendment) Act, (No. 5 of 2015)	An Act of Parliament to provide for a regulatory framework for Management and Coordination of the Environment.
The Climate Change Act, (No. 11 of 2016)	An Act of Parliament to provide for a regulatory framework for enhanced response to climate change; to provide for mechanism and measures to achieve low

	carbon climate development, and for connected purposes.
Urban Areas and Cities Act, (CAP 275 of 2011)	An Act of Parliament to give effect to Article 184 of the Constitution; to provide for the, classification, governance and management of urban areas and cities; to provide for the criteria of establishing urban areas, to provide for the principle of governance and participation of residents and for connected purposes
The Physical Planning Act, (CAP 286 of 1998)	An Act of Parliament to provide for the preparation and implementation of physical development plans and for connected purposes

The constitution, under the bill of rights confers upon a person in Kenya, the right to a clean and healthy environment. Under article 69, the state has been tasked with the duty of eliminating processes and activities that are likely to endanger the environment. Under article 70, provisions have been made for the enforcement of the stipulated environmental rights, with there being measures for redress if these rights have been, are being or are likely to be, denied, violated, infringed or threatened. The public has been empowered by the supreme law to take stock of the environmental conditions around them and compel the state to take measures to prevent or discontinue any act or omission that is harmful to the environment; the effects of flooding in the city of Nairobi included.

The Urban Areas and Cities Act, 2011 makes a provision for the preparation of integrated city development plans that would take into cognizance and confer the delivery of various services and infrastructure to the city. Of direct relevance to this study is the preparation of environmental management plans, provision of physical and social infrastructure, disaster preparedness and response, preparation of geographic information system for a city. Further, prior to preparation of the integrated plans, the Act requires

that an assessment of the current social, cultural, economic and environmental situation in its area of jurisdiction is carried out and a determination of community needs is made, aligning them to the requirements of the Constitution. The governance structures under this legislation provide for a citizen fora and representation of various resident associations within the city board. In light of this, it is expected that issues of integrated city flood risk management shall be encompassed in the integrated development plan of Nairobi city. However, the law does not make any direct reference to this.

Urban areas are a significant contributor to a myriad environmental and public health problems being encountered by the country. The Environmental Management and Co-ordination Act, 1999 provided for the preparation of a national environment action plan where one of its functions will be to identify and appraise trends in the development of urban and rural settlements, their impacts on the environment, and strategies for the amelioration of their negative impacts. However, this legislation and its Amendment Act of 2015 have not made provisions that relate directly to flood management in the country's cities.

Of direct relevance to the study is that according to the physical planning Act, local authorities are tasked with the power to prohibit or control the use and development of land and buildings in the interests of proper and orderly development of its area; to consider and approve all development applications and grant all development permissions as well as to ensure the proper execution and implementation of approved physical development plans. This means that the Nairobi City County has mandate to control the

development in South C ward and in so doing, regulate the densities that such development can carry without placing undue pressure on the storm water infrastructure or designated green areas.

The Climate Change Act establishes a climate change directorate at the state department. Of relevance to this study is that the directorate has been mandated by law to establish and manage a national registry for appropriate mitigation actions by public and private entities; and to develop strategies and coordinate actions for building resilience to climate change and enhance adaptive capacity. Further, the law tasks the cabinet secretary to prepare a national climate change action plans that will prescribe measures and mechanisms for adaptation to climate change; for mitigation against climate change; to set out a structure for public awareness and engagement in climate change response and disaster reduction; as well as to identify strategic areas of national infrastructure requiring climate proofing. The Act tasks County Governments to mainstream the implementation of the National Climate Change Action Plan into County Integrated Development Plans, and the County Sectoral Plans, taking into account national and County priorities. While this law does not specifically mention flooding in urban areas, this study proposes that it is against this backdrop that the flood mitigation measures for Nairobi City County and specifically South C ward may be instituted.

4.5.3 Institutional framework

The study found that there are eight institutions relevant to meeting the objectives of the study as their core functions or mandates directly touch on the subject matter of flooding in South C. Table 4.17 below has given a summary of these.

Table 4.17: Institutions mandated to address matters of urban planning, physical environment and disaster management.

Institution	**Key Mandate**
The Nairobi City County - Land, Housing and Physical Planning sector	This sector is responsible for policy formulation and leadership in the areas of, among others, city planning.
The Nairobi City County - Public works, road and transport sector	This sector is responsible for policy formulation and leadership in the areas of, among others, storm water management systems in built-up areas.
The Nairobi City County - Water, energy, forestry, environment and natural resources sector	This sector is responsible for policy formulation and leadership in the areas of, among others, solid waste management.
The National Disaster Operation Centre (NDOC)	This is an office under the state department of interior in the Ministry of Interior and Co-ordination of National Government. It is tasked with managing and coordinating disaster response at a national level.
The Kenya Meteorological Department	It is a government institution tasked with provision of meteorological and climatological services to public and private sectors. This includes weather forecasts and warnings and advisories on heavy rains or storms.
The National Environment Management Authority	A government institution tasked with promoting the integration of environmental considerations into development policies, plans, programmes and projects. NEMA is also tasked with initiating and evolving procedures and safeguards for the prevention of accidents, which may cause environmental degradation and evolve remedial measures where accidents occur e.g. floods, landslides and oil spills.
The Office of the Member of County Assembly (MCA), South C ward	The South C MCA is tasked by the constitution to maintain close contact with the electorate and consult them on issues before or under discussion in the County Assembly. They are also mandated to present views, opinions and proposals of the electorate to the County Assembly.

The Kenya Red Cross Society (KRCS)	This is a humanitarian relief organisation created in 1965 through an Act of Parliament, Cap 256 of the Laws of Kenya. It is mandated to be a humanitarian organization that aids the government on matters of disaster management.

The following is an analysis of the interviews conducted with representatives of the institutions outlined in Table 4.14 above. According to a disaster management officer of the Kenya Red Cross Society (KRCS), Nairobi experiences floods between the months of March- to May where short rains are experienced and the months of October to December/ January. This was also confirmed by an officer from the Kenya Meteorological Department who opined that, "***Nairobi experiences short rains during the month of March to May with long rains experienced during the month of October to December. However, these seasons change to a month less or more over the past five years***"

On the causes of floods in Nairobi, it was established that there were divergent views from different stakeholders as to the cause of floods in Nairobi. However, it was clear that majority of stakeholders who included the Kenya Red Cross Society (KRCS) , The National Disaster Operation Centre (NDOC) and South C Member of County Assembly (MCA) were of the view that floods in Nairobi is caused by a poor urban planning system, that includes drainage systems. This, according to a KRCS official is the cause of floods as evidenced in the following statement; *'**As much as the County Government of Nairobi has tried to minimize the effects of floods through their preparatory activities, it should not be forgotten that most of the flooding occurs in Nairobi due to poor urban planning and this has led to poor structural planning thereby leading to frequents***

floods*'*. The South C MCA stated that, *'**Were it not for the poor planning that has been experienced in Nairobi over the past 20 or so years under the watch of the defunct city council, we would not be having the floods that we experience today'*.

As much as majority of the key informants agreed that poor urban planning was the major cause of flooding, the same could not be said by the County planning officers who on the contrary stated that littering of the environment by the public is one of the major causes of flooding. According to County planning officers, despite the effort of the County Government to open drainage systems, they continue to be overwhelmed by the rate at which people litter. The County planning officer expressed concerns that the existing drainage pipes are completely filled with plastic bags and debate on the ban of plastic bags is still yet to bear fruit despite the fact that plastic bags have been acknowledged as an environmental threat.

There was a general consensus among the key informants on the areas in Nairobi that are most prone to floods, with the following areas mentioned: Highrise Estate, South C shopping centre, *Loresho* along the bypass, *Muthangari, Kileleshwa* - Ring Road interchange, *Maziwa-Ziimmerman-Kamiti* Road, River bank area along *Baba Dogo*-Outer ring road, Lavington- Chalbi Drive, Garden Estate, *Thome, Roysambu, Kahawa* west, *Donholm, Mbagathi /Langata* road Round-about, Nairobi West, *Ruai, Utawala, Mukuru* slums and *Kibera* Slums.

Related to the areas prone to flooding was the probe among the key informants on the existence of a flood prone map. On this, there was a general agreement among the

County Government planning officials, Kenya Red Cross Society and the Kenya Meteorological Department that there exists a flood prone map. It was established that this map is first prepared by Kenya Meteorological Department based on their estimates for annual national rainfall and from these estimates they develop a flood prone map for the whole county. This is shared with key stakeholders such as the County Government, National Disaster Operation Center (NDOC) and the Kenya Red Cross Society, which are then expected to prepare their own flood prone maps. This was indicated through the following statement, **"*As the Kenya Meteorological Department, we prepare reports; among which are the flood prone maps that we prepare through our disaster management department based on annual rainfall estimates. This report is then share with key stakeholders'***

It emerged from the key informants that the County Government, the Kenya Meteorological Department (KMD) and the KRCS all have data on floods, its incidences, impacts, adaptation and mitigation. The KRCS has its data that is kept and updated every 6 months while the County Government and KMD keeps data on floods every three months. The KRCS and Kenya Meteorological Department were established as the only organizations that periodically collect data, with the former collecting data after flood incidences and bi-annually while KMD collects data quarterly. The KRCS officer stated, ***"We collect data during and after flood incidences and carry out mid-year data collection through our respective programmes and projects."***

It was further established that the data collected by the KRCS is shared with stakeholders through reports, media and briefings. One such stakeholder who appreciated the role that the KRCS play in data collection was the MCA who mentioned that they do not collect data on their own but instead rely on the KRCS to provide data. It further surfaced that the data collected by these organisations is shared with the public through the media, workshops, public officials and through public *barazas*. The County Planning officer stated, ***"When we get any data on the near occurrence of floods we usually invite the media for a press conference where any information is communicated to the public."*** While the KRCS official said***, 'As the KRCS, any data that we have in our possession and is important to the public is shared with key stakeholders (such as other NGOs) through workshops and for the public we share such information through public official, barazas and the media.'***

According to the KRCS official, the organisation usually has data on Floods in South C just like on other areas of the county. This data is collected from the KMD, the NDOC the County Government and the general public on a periodic basis. The data is usually shared with the general public through the MCA, ward administrators, chiefs, public *barazas* and the media. This was affirmed through the following verbatim. It also emerged from the KRCS official that communication of information is done on a continuous basis through existing media and with an aim to continually warn and prepare people for the floods. This, the organisation does by sending their volunteers to areas that are prone to floods in South C; urging residents to move to other safe areas. He stated, "***We have Red Cross volunteers in South C who warn people at risk of floods and***

advise them to move to safer areas. However, I must admit that the public sometimes receives this information with scepticismc."

On the question of data availability and sharing, the MCA mentioned that they do not collect any data from the public. They however rely on the data they receive from the County Government, National Disaster Operation Center and the Kenya Red Cross Society. This data is then communicated to the general public through the ward administrators and area chief who are expected to communicate this information through *barazas*. He stated, ***"We currently do not collect any data by ourselves though we have plans do so soon. For now we get data from the National Government, County Government and the Kenya Red Cross Society."***

The South C ward MCA acknowledged that she had not sponsored any bill towards managing floods in the south C though she stated that there are efforts to sponsor a bill specifically targeting south C. Nevertheless she mentioned that there is a bill titled "Nairobi City County Disaster and Emergency Management Bill 2015" that had been sponsored by another member of the County assembly. On the preparedness of the County Government through Planning, the study found that the draft NIUPLAN is the one poised to provide a framework for the development of a Sub - County planning and development framework. The county planning officer said, ***"The Nairobi Integrated Urban Development Master Plan (NIUPLAN) will integrate the infrastructural plans in all the other master plans for the city and its surroundings. It will provide for water***

infrastructure, riparian way leaves and riverine drainage as well as waste water disposal and storm water drainage."

It however emerged that the NIUPLAN is yet to be fully operational with the County majorly relying on the existing Local Government Act. This means that there exist no plans for demarcated zones in Nairobi City County. The County officer also acknowledged that the County Government is mandated to ensure that there is adherence to development plans as provided by the Physical planning Act (CAP 286) to control planning in Nairobi City County. According to the County planning officer, the Physical planning Act (CAP 286) is deficient in addressing the needs of the County and that it is not flexible enough and is unresponsive to address the dynamics of development. It also limits the role of County Governments as they do not have powers to regulate the use of land and buildings as the section refers to the Local Government Act (CAP 265). Moreover, the fines that it imposes on the illegal developments are not prohibitive enough to deter errant developers from undertaking unauthorized developments.

Concerning the early warning systems, the Kenya Meteorological Department generates early warning systems on floods on a quarterly basis. The KMD officer stated that the department had issued an El Nino warning in July 2015 which enabled relevant local authorities and residents of vulnerable areas to plan accordingly. According to the KMD, any information concerning floods is communicated to the public through media press briefings and is also sent to all stakeholders; including the County

Government, the NDOC, and the KRCS. This information is released on a weekly basis to all stakeholders through the disaster management unit of the KMD.

Concerning the financial outlays that key stakeholders have used in preparing for and dealing with impacts of floods over the past 5 to 10 years, it was evident from the participants that only the KRCS and the County Government could give an estimate. According to the KRCS official, information on yearly preparation runs into millions of Kenya shillings, with no fixed estimate. However, the same official estimates that the floods preparation for 2015 El Nino floods was approximately Ksh.10 Million. Information from the County Government on what has been spent on disaster preparedness was scanty, with the official acknowledging that the change from local government to County Government had made it difficult to know what amount of money may have been spent on disaster preparedness over the previous years. Nevertheless, the County planning officer mentioned that approximately 700 Million had been budgeted for use in preparedness for the 2015 El Nino in the budget year 2015/2016.

It also emerged from the interviews that the KRCS in collaboration with the County Government had been able to train more manpower with regards to flood preparedness, through a volunteer programme. This, according to the KRCS official, had been scaled up in preparation for the 2015 El Nino since the organization did not want to be caught unaware as it had during the 1997/1998 El Nino floods. The County Government had also put in place resources and personnel to deal with the expected El Nino effects.

It emerged from the interviews that there has been concerted efforts from the KRCS, the National Disaster Operation Center, and the County Government to manage flood disasters. There was general consensus among the mentioned agencies that measures have been put in place to manage floods, especially in periods preceding rain seasons. Some of the measures include; the development of hotline numbers in all the counties; frequent dissemination of flood management tips through mainstream media and social media; and establishment of Relief Centers in the flood prone areas. Specifically, during the 2015 El Nino warning, the Nairobi City County Government had put in place measures such as; County disaster management committees that were tasked with managing any flood disasters in the County; mapping El Nino flooding hot spots, pulling down of illegal structures on drainage paths, and clearing of solid waste from drainage systems.

In relation to the storm water drainage system, it was acknowledged by the County Government official that design and maintenance of storm water drainage infrastructure is the responsibility of Nairobi City County Government. The Civil Engineering department at the Nairobi City County usually comes up with designs and maintenance solutions. Nairobi storm water and sewer drainage has a national grid, similar to the electricity grid that drains towards Ruai area. This was also supported by the MCA for south C who stated that the responsibility of maintaining stormy water drainage lies with the County Government.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the study findings, the conclusion of the study and the recommendations.

5.2 Summary of Findings

5.2.1 Flooding Patterns in South C Ward

The study has ascertained that flooding is a problem in South C Ward because majority of respondents (48%) agreed that the area experiences flooding annually. It was also found that flooding coincides with the country's rainy seasons of March to May and October to November (according to 50% of the respondents). Further, a majority of the residents (62%) indicated that the trend of flooding had been on the increase and that it takes 1-2 days for flood water to subside (according to over 50% of respondents). Finally, majority (54%) of the respondents stated that flood water depth is usually between 0.3 - 0.5metres and in some instances may even go to beyond 1metre deep.

On the effects of floods in South C Ward, the study results revealed that 83% of the respondents had been affected by floods. Among the respondents who had been affected, 54% of the respondents mentioned that floods had made it difficult for them to access workplace/ business. These findings imply that the greatest impact of floods is on the environment, and particularly on infrastructure, which reduces levels of physical

accessibility. The study also found that most (82%) of the respondents who had been affected by floods had not received any form of assistance or compensation. For those who had received a form of compensation or assistance, 75% of them stated that assistance had been given to them by the Nairobi City County government in form of resettlement after floods. As for the coping mechanisms, the study found that building renovations was the most common coping mechanism (58%) followed by relocation (25%), insurance against floods (8%), shopping in bulk (4%) and missing work (4%).

5.2.2 Factors influencing vulnerability of South C Ward to flooding

Where structural vulnerability is concerned, the study revealed that majority (79%) of the respondents used municipal method of sewer waste disposal. The study findings further revealed that majority (60%) of the respondents had experienced sewer blockages over the past 10 years. Among those who had experienced sewer blockages, a majority (74% of the respondents) mentioned that they experience sewer blockages every rainy season. The study findings also indicated that majority of the respondents (72%) used private collection method to dispose of their solid waste. On the subject matter of solid waste disposal, it is important to note that there is a percentage of respondents (10%) that stated that they either dump the waste into adjacent water bodies or burn them.

On physical infrastructure, the study results showed that majority (55%) of the respondents lived in singled-storeyed/bungalow houses and that majority (73% of the respondents) lived in houses with ceramic tiling. In addition, 71% of the respondents lived in masonry walled houses, and in the same vein, 71% and 24% of the respondents

lived in houses roofed with roofing tiles and corrugated iron sheets respectively. The study findings indicated that only 58% of the respondents had a storm water drainage channel adjacent or as part of their house or business premises. Of the respondents who had this, 39.3% had open drains, 46.3% had covered water drains while 14.3 % had a temporary swale.

In so far as non – structural factors of vulnerability are concerned, the level of access to information was measured and found that majority of the respondents (33%) revealed that they own a radio, TV and computer. Moreover, it was found that majority (87%) had access to newspapers, with 65% of those respondents having daily access to them. The study also revealed that 69% of the respondents had access to the internet, with 79% of those having daily access to it. When it came to early warning of flood hazards, the study also established that 52% of the respondents had received information/warning relating to floods or rains. Of the respondents who had received such information, majority (26%) had received such information from the National Government. Among the respondents who mentioned that they have received information on matters relating to floods, 61.3% of them mentioned that the information had been useful in helping them to prepare for the floods by taking part in such activities as unclogging storm drainage channels and buying gum boots.

The study also tested the role of governance in levels of flood vulnerability and found that majority (66%) of the respondents were aware that there exist residents' associations in the area. However, only 31% of these respondents were actually members of such

associations. These findings indicate the residents' relatively low perception on the importance of such residents' associations or benefits that they would bring to them. This was evidenced from the results that indicated that among residents who are members of such associations, only 22% had received information that they considered useful and helpful in relation to flooding. This was further reinforced through results that indicated that 63% of the respondents who were members of residents association considered that such associations were not competent in dealing with floods in the area.

5.2.3 Policy, Legal and Institutional Framework in place to manage flooding in Nairobi City County

It emerged from the study that policy and strategy documents acknowledge urban flooding as a serious environmental problem. They however have not given specific policy directions on the management of this, especially where Nairobi City County is concerned. The Nairobi County Integrated Development Plan is the only document that specifically addresses the drainage systems shortfalls in South C ward and even goes ahead to propose projects that are geared towards construction and unblocking of such systems. The document however fails to give a detailed roadmap or budgets for how this shall be carried out.

The study found that there is no specific legislation that deals with urban flooding. The existing laws that were analysed were also found to be highly deficient in addressing matters of urban flood management. In so far as institutions are concerned, it was found that the Kenya Red Cross Society (KRCS) and Kenya Meteorological Department

(KMD) collect data weekly, monthly, quarterly, bi-annually and after floods have occurred. It also emerged from the interviews that data is shared among key stakeholders that include the National Government, the Nairobi City County Government, other Non-Governmental Organisation (NGOs), The Member of County Assembly (MCA) and the National Disaster Operation Centre (NDOC). In addition, it was found that the Nairobi City County Government, through its sectors has the highest mandate in so far as flood management in South C ward is concerned. These sectors include the Land, Housing and Physical Planning sector, Public works, road and transport sector as well as the Water, energy, forestry, environment and natural resources sector.

5.3 Conclusion

Floods are a common natural hazard in the South C Ward. Their genesis is mainly linked to poor drainage systems, poor sewerage systems, poor urban planning and un-regulated building and construction. Flooding risk is therefore magnified by anthropogenic intervention (construction in floodplains, improper solid waste disposal and inadequate storm water drainage systems). The condition of the existing drainage system was found to be in moderate to poor condition. This was as a result of solid waste dumping; out-dated drainage system which consisted of small size pipes and drains that are clearly incapable of carrying the growing capacities of storm water runoff that has been occasioned by population and built-up area expansion. It was also found that in some areas of South C, the direction of slope of the storm water drainage system was in the opposite direction to the natural topography which creates conflict in their functioning. In other areas, though the storm water drain flow was in the same direction as the natural

topography, most drains had steeper gradients than the natural topography. This situation would likely cause increased speeds of runoff and in case of any occurrence such as blockage or reduced gradient, localized flooding would likely occur.

The study revealed that there exist structural and non- structural flood mitigation and management measures in South C Ward. Notable structural measures that have been undertaken by the Nairobi City County Government include clearing of the drainage system and unblocking of the sewerage system, as well as pulling down of illegal structures that have been built in areas that are considered to be water course ways. The non-structural measure found to be in existence in South C ward is access to meteorological forecast information. Meteorological forecasts are issued on a quarterly basis and during the wet season the amount of rainfall is also predicted. This information is used in forecasting the water flow so as to assess whether there will be floods. Based on this, the appropriate authorities take the necessary steps to ensure the information is disseminated and the potential victims evacuated before or during the flood events. However, two problems have been noted: the first one is the lead-time between the flood forecast and the flood event. Currently, the models being used for meteorological forecasts can only provide very short forecasts in an accurate form, which may not allow enough time to reduce the impact of the event. The second one is the accuracy of the forecasts. Due to previous false alarms, people no longer take forecasts seriously, as was demonstrated during the prediction of the 2015 El-Nino.

5.4 Recommendations

Integrated Flood Risk Management (World Bank Group et al., 2012) is a key requirement for the South C Ward and the entire Nairobi City County. This would typically be the holistic development of a long-term strategy crafted on a current need and future sustainability basis. This strategy ought to differ with geographical location, size of the urban area and the source or sources of the flood threat. Structural and non-structural measures do not preclude each other. Such interventions have to work together, with the most appropriate measures being selected for implementation at specific locations and situations. It is also crucial to take account of temporal and spatial issues when determining strategy.

Structural measures of integrated flood risk management involve conveyance of flood water, flood storage, drainage systems, infiltration and permeability or urban areas, groundwater management, wetlands and environmental buffers, building design, resilience and resistance, and flood defense. While these measures form a long-term solution to flood risk, they are often very costly to design, construct, maintain and typically take a long time to complete, especially where they are implemented at a large scale. Local communities usually cannot afford the costs resulting from such large mitigation projects; prompting significant investments by governments who are usually in turn budget constrained for implementation of priority projects. There is therefore a need for the Nairobi City County Government and stakeholders to explore private partnership (PPP) in the construction of structural flood control measures for South C ward. In addition, structural flood management measures can occupy large areas and have a strong

impact on urban space development. The most efficient solution hence would be to consider these before urban development takes place. This is a challenge that operationalization of the Nairobi Integrated Urban Development Master Plan (NIUPLAN) is designed to address from a plan and programme perspective.

Non – structural measure of Integrated flood risk management comprise flood awareness campaigns, land use planning and flood zoning, flood insurance, risk financing, compensation and tax relief, early warning systems, evacuation planning, solid and liquid waste management, flood recovery and reconstruction (World Bank Group et al., 2012). Non-structural measures of flood disaster preparedness and management is more effective if there is sufficient, reliable and quality data that is readily shared with all the concerned stakeholders. In addition, non-structural measures are also more effective when the means of information dissemination is trusted by the public and considered reliable and valid. Thus the development of an integrated information system is needed to enhance the effectiveness of data and information sharing in matters climate and flooding in not only Nairobi City County but in Kenya as a whole. Other non-structural flood mitigation measures range from flood forecasting to rescue operations, defining safe areas to settle or re-locate, communication of flood management tips through mainstream media and social media, and establishment of relief centers in areas prone to floods, establishment of functioning hot line numbers.

Community participation in flood prevention, control and mitigation is very important. Residents in south C can be mobilized through residential associations to ensure that

drainage facilities (gutters) are regularly cleaned up to allow the free flow of flood waters. Relevant legislation that would guide this should also be made and enforced. To this end, a policy on community engagement in Integrated Flood Management (IFM) should be instituted as residents' associations have proven to be highly beneficial for residents of South C in matters flood management. The policy could deal with, among other issues, empowerment and capacity building of such associations.

The county government of Nairobi should, as a matter of urgency, prioritize legislation and provision of resources towards flood hazard and flood risk mapping for the whole of Nairobi County. This is the basis of flood risk mitigation framework, which requires all constituting stakeholders to prepare for floods. There is need to harmonize the water, land-use, development planning and disaster response laws as a way of encouraging Integrated Flood Management (IFM). At the moment, the laws seem to be independent of each other. In line with issues of legislation, there should be instituted planning, building and construction regulations on natural flood plain areas; where development on these cannot be avoided. Enforcement of environmental standards and laws is often a key factor towards containing adverse effects of flooding (UNISDR 2007). Indiscriminate waste disposal, construction along drainage causeways among other anthropogenic activities which influence flooding in South C are illegal. In view of addressing these matters, the National Environment Management Authority (NEMA) and the County Government should embark on arrests and prosecution of such offenders as well as proportionately fine urban residents who violate these laws.

There is need to develop a storm water database that gives a full inventory of the storm water infrastructure in South C. This would enable stakeholders such as the Nairobi County Government and Environmental organizations to keep track of the conditions of the storm water infrastructure on what needs to be maintained, repaired or upgraded. A law and policy on construction of sustainable urban drainage systems (SUDs) should be instituted for the various flood hotspots in Nairobi City County, South C Ward included. It is important that there be storm water management regulations that define appropriate design of storm water infrastructure that can accommodate large volumes of water (flood water). Proper construction should accompany proof of as-built documentation as well as periodic inspection and maintenance.

Structures that are built on the pathways of flood waters in all the zones should be demolished, and the Nairobi County urban Integrated Master Plan should be implemented. This would reduce the increased rate of uncontrolled urbanization/urban creep and decongest some areas that are at risk to floods with people encouraged to relocate to unsaturated areas. Further, to reduce structural vulnerability of buildings that have to be constructed in flood prone areas, the matter of flood loads in the design procedure of reinforced concrete buildings and structures should be considered and mainstreamed in the 2009 planning and building regulations document. Moreover, foundation systems for existing buildings in such flood prone areas should be certified by professional structural engineers and architects prior to any extension; either vertically or horizontally.

Awareness and perceptions of a problem shape action or inaction on the problem (Speranza, 2011). Field study revealed that most residents of South C do not have an in-depth understanding of flood problems and its implications. It is essential that residents of the study area recognize flooding as part of their environment and hence as an issue that they need to deal with for improved livelihood. Therefore, it is very important to explain the various causes, consequences, and actions to be taken to reduce the adverse effects of flooding through radio/TV programs. The integration of the knowledge of flood problems, prevention, and protection, as well as mitigation into public primary and secondary education programs, would also go a long way in improving people's resilience to flooding. Effective and efficient sensitization of the residents on early warning signs of floods and what to do before, during, and after flood episodes (i.e., preparing them for the worst case scenario) would help reduce the damages caused by flooding in all the zones. To support these, a policy on early warning systems and flooding information dissemination should be instituted. This should take cognizance of the current technological advancements such as social media and mobile messaging services. This could build on the existing TERA platform that the Kenya Red Cross Society is already using in disaster preparedness and management.

Coping strategies can be categorised into different forms. For example, Twigg (2004) as cited by Dewi (2007) came up with four categories of coping strategies. These are economic/material, technological, social/organisation and cultural. However, most strategies involve elements of all these, so the typology should not be used artificially to place particular strategies under particular headings. This categorisation should only be

used as a framework for reviewing coping strategies and indigenous knowledge as a whole. On the other hand, Dewi (2007) used a similar approach but with a slight modification on the coping categories. Instead of four categories, only three coping categories were used i.e. economic/material, technological, social/organisation. In line with this, a policy on flood damage compensation is important, since communities that are incapable of dealing with the high costs of flood damage are usually left desolate after food events. This would offer guidelines on the criteria for compensation and from whom the compensation should come.

REFERENCES

Adejuwon, G.A., Aina, W. J. (2014). Emergency preparedness and response to Ibadan Flood Disaster: Implications for wellbeing. *Mediterranean Journal of Social Sciences, 5 (8).*Retrieved from http://www.mcser.org/journal/index.php/mjss/article/view/2584/2552

Adelekan, I. (2014). Flood Risk Management by Public and Private Agents in the Coastal City of Lagos. 6th International Conference on Flood Management. Retrieved from http://www.abrh.org.br/icfm6/proceedings/papers/PAP014805.pdf

Ajibade, I., McBean, G., & Bezner-Kerr, R. (2013). Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. *Global Environmental Change,* (23), 1714-1725.

Amoako, C., & Boamah, E.F. (2014). The three – dimensional causes of flooding in Accra, Ghana. *International Journal of Urban Sustainable Development, 7* (1). 109 – 129. doi: 10.1080/19463138.2014.984720

Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At Risk: Natural Hazards, People's Vulnerability and Disasters*. London: Routledge.

Brown, R.R. (2005). Impediments to Integrated Urban Stormwater Management: The Need for Institutional Reform. *Environmental Management, 36* (455). doi:10.1007/s00267-004-0217-4

Chow, T.L.W., Cheong, D. B., & Ho, H. B. (2016). A Multimethod Approach towards Assessing Urban Flood Patterns and Its Associated Vulnerabilities in Singapore. *Advances in Meteorology, (*7159132*)*. Retrieved from http://dx.doi.org/10.1155/2016/7159132

Climate Change and Urban Vulnerability in Africa (CLUVA). 2010. *Climate Change and Vulnerability of African Cities – Research briefs* (Research Report). Retrieved from http://www.cluva.eu/CLUVA_publications/CLUVA_Climate-change-and-vulnerability-of-African-cities-Research-briefs.pdf

Climatedata. (2017). Climate Nairobi – Kenya. Retrieved June 30, 2017, from http://www.climatedata.eu/climate.php?loc=kexx0009&lang=en

Constitution of Kenya 2010 (Kenya).

Dewi, A. (2007). *Community – Based Analysis of Coping with Urban Flooding: A case study in Semarang, Indonesia* (Unpublished master's thesis). International Institute for Geo-information Science and Earth Observation, Netherlands.

Doocy, S., Daniels, A., Murray, S., & Kirsch, T.D. (2013). The Human Impact of Floods: a Historical Review of Events 1980-2009 and Systematic Literature Review. *PLOS Currents Disasters*. (Edition 1). doi: 10.1371/currents.dis.f4deb457904936b07c09daa98ee8171a.

Douglas, I., Alam, K., Maghenda, M., Mcdonnell, Y., Mclean, L., & Campbell, J. (2008). Unjust waters: climate change, flooding and the urban poor in Africa. *Environment and Urbanization*, 2008 (20: 187). doi: 10.1177/0956247808089156

Environmental Management and Coordination Act 1999 (Kenya)

Floodmap. (2014). *Elevation of Nairobi, Kenya Elevation Map, Topo, Contour*. Retrieved June 28, 2017, from http://www.floodmap.net/elevation/ElevationMap/?gi=184745

Flood Mitigation Strategy 2009 (Kenya)

Global Facility for Disaster Reduction and Recovery. (n.d.). *Climate Change Adaptation: Reducing Vulnerability to Natural Hazards*. Retrieved September 22, 2013, from https://www.gfdrr.org/cca.

Independent Electoral Boundaries Commission of Kenya (n.d.). Retrieved June 30, 2017, from http://www.infotrackea.co.ke/services/leadership/constituencyinfo.php?&cinf=wards&t=277

International Federation of Red Cross and Red Crescent societies - IFRC. (2013). Emergency Appeal Kenya: Floods 2013. Retrieved August 4, 2016 from http://www.ifrc.org/docs/Appeals/13/MDRKE025EA.pdf

International Federation of Red Cross and Red Crescent societies -IFRC. (2016). Emergency Plan of Action Final Report. Operation No. MDRK036

Juma, B. (2016). *Kenya – Flash Floods in Nairobi after 3 Hour Storm.* Retrieved June 30, 2017, from http://floodlist.com/africa/kenya-flash-floods-nairobi-storm-april-2016.

Karmakar, S., Simonovic, S.P., Peck, A., & Black, J. (2010). An Information System for Risk Vulnerability Assessment to Flood. *Journal of Geographic Information System, Volume 2*. 129 – 146. doi:10.4236/jgis.2010.23020

Kundzewicz, Z.W., & Menzel, L. (2010). Natural flood reduction strategies - a challenge. *International Journal of River Basin Management 3* (2). 125 – 131. doi: 10.1080/15715124.2005.9635252.

Liao, K.H. (2012). A theory on urban resilience to floods - A basis for alternative planning practices. *Ecology and Society **17***(4): 48. Retrieved from https://www.ecologyandsociety.org/vol17/iss4/art48/#urban7.

Muller, A., Reiter, J., & Weiland J. (2011). Assessment of urban vulnerability towards floods using an indicator-based approach – a case study for Santiago de Chile. *Natural Hazards and Earth system sciences, 11*, 2107-2123.

Murambi, A. (2014). Mitigating flood risk by use of GIS in parts of Nairobi (Bachelor's Research Project. University of Nairobi, Nairobi).

Mustafa, D. (1998). Structural Causes of Vulnerability to Flood Hazard in Pakistan. *Economic Geography, 74* (3), 289 – 305. doi: 10.1111/j.1944-8287.1998.tb00117.x

Nairobi City County - NCC. (2015). Nairobi County ready to deal with El Nino rains. Retrieved December 5, 2015, from http://www.nairobi.go.ke/home/news/nairobi-city-county-ready-to-deal-with-el-nino-rains-2/

Nairobi City County. (2014a). *Nairobi County Integrated Development Plan 2014*. Retrieved June 23, 2017, from *https://cog.go.ke/images/stories/CIDPs/Nairobi.pdf*

Nairobi City County – NCC,. Japan International Cooperation Agency – JICA., & Nippon Koei Co., Ltd. (2014b). *The project on integrated Urban Development Master Plan for the City of Nairobi in the Republic of Kenya. Part II: The Master Plan*. Retrieved from http://www.nairobi.go.ke/assets/Documents/EI-JR14112-Master-Plan-01-1-1.pdf

National Climate Change response strategy 2010 (Kenya).

National Environment Policy (Draft) 2012 (Kenya)

National Housing policy 2004 (Kenya)

National Policy for Disaster Management (Draft) 2009 (Kenya)

National Urban Development Policy (Draft) 2012 (Kenya)

Nkwunonwo, U.C., Whitworth, M., & Baily, B. (2016). A review and critical analysis of the efforts towards urban flood risk management in the Lagos region of Nigeria. *Natural Hazards and Earth System Sciences, 6*, 349–369. doi:10.5194/nhess-16-349-2016

Norris, F. H., Stevens, P. S., Pfefferaum, B., Wyche, K.F., & Pfefferaum, R.L. (2008). Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *American Journal of Community Psychology, 41* (1-2), 127–150. doi:10.1007/s10464-007-9156-6

Odhiambo, L. P. (2015). Using GIS in urban storm water management: A case study of South C Estate in Nairobi (Master's Research Project, University of Nairobi, Nairobi).

Opere, A. (2013). Floods in Kenya. *Developments in Earth Surface Processes 16 2013*. 315 – 330. doi: 10.1016/B978-0-444-59559-1.00021-9

Pamoja Trust. (n.d.). *An Inventory of the slums in Nairobi*. Retrieved April 4, 2015, from http://www.irinnews.org/pdf/nairobi_inventory.pdf

Ramkrishna, S.S., & Chaudhari, P.S. (2014). Evaluation of Non – structural and Structural Flood Management Measures. *International Journal of Innovative Research in Advanced Engineering (IJIRAE) 1* (2).

Roy, D.C., & Blaschke, T. (2015). Spatial Vulnerability Assessment of floods in the coastal regions of Bangladesh. *Geomatics, Natural Hazards and Risk, 6* (1), 21 – 44. doi: 10.1080/19475705.2013.816785

Sagala, S. A. (2006). *Analysis of Flood Physical Vulnerability in Residential Areas. Case Study: Naga City, the Philippines* (Unpublished master's thesis). International Institute for Geo-information Science and Earth Observation, Netherlands.

Speranza, C.I. (2011). Flood disaster risk management and humanitarian interventions in the Zambezi River Basin: Implications for adaptation to climate change. *Climate and Development 2, 2010* (2). 176-190.

Stoicof, A. (2011). *Historical and Future Urban Growth Detection through Remote Sensing: A Pilot Project on Nairobi, Kenya 2000 – 2025*. Retrieved from lagic.lsu.edu/rsgis/2012/Presentations/Stoicof.pdf

Thecla, A. (2014). Determinants of flooding in Port Harcourt Metropolis, Nigeria. *IOSR Journal of Humanities and Social Science (IOSR - JHSS), 19* (11), 64 – 72.

Tsinda, A., & Gakuba. A. (2010). Sustainable Hazards Mitigation in Kigali city (Rwanda). 46th ISOCARP Congress. Retrieved from http://www.isocarp.net/data/case_studies/1829.pdf

UN-HABITAT. (2012). *Inception Report on Integrated Flood Management, Kampala.* Unpublished report.

UN-HABITAT. (2011). *Cities and Climate Change: Global Report on Human Settlements 2011*. London: Earthscan

UN-HABITAT. (2006). *Nairobi Urban Sector Profile.* Retrieved May 10, 2015, from https://unhabitat.org/books/kenya-nairobi-urban-profile/

United Nations Office for Disaster Risk Reduction (UNISDR). (2007). *Disaster Risk Reduction: 2007 Global Review.* Last Accessed July 17, 2017, from http://www.unisdr.org/we/inform/publications/1130

United Nations University Institute for Environment and Human Security UNU- IHE. (2010). *From Vulnerability to Resilience in Disaster Risk Management: Process of Assessing vulnerability to Flood.* Retrieved May 10, 2015, from http://www.ehs.unu.edu/file/get/5233

Urban Areas and Cities Act, No.13 of 2011 (Kenya).

Vogel, M. (2008). *History of Urban Planning of Nairobi.* Retrieved from http://www.studio- basel.com/assets/files/029_NRB_ATLAS_11_planning_dr.pdf

World Meteorological Organisation – WMO. 2015. *Kenya Regional Association: Country Information – Climate Normals 1961 - 1990.* Retrieved from: https://www.wmo.int/cpdb/kenya

APPENDIX I: HOUSEHOLD DATA COLLECTION QUESTIONNAIRE

Date of Interview |___|___|___|

ASSESSMENT OF FLOOD MANAGEMENT IN THE SOUTH C WARD OF NAIROBI CITY COUNTY, KENYA

HOUSEHOLD SURVEY QUESTIONNAIRE (30-40 minutes)

i) IDENTIFICATION
Estate.....…….....HOUSE UMBER.|___||___||___|

CONSENT FORM

My name is Patricia Karamuta. I am a master's student of Environmental Policy at the University of Nairobi. As part of the course, I am conducting a research titled **"*Assessment of flood management in the South C Ward of Nairobi City County, Kenya.*"**

Your household has been randomly selected for the study and we would like an opportunity to administer this questionnaire to an eligible member of your household.

This information is being collected for academic purposes only, and there are no personal benefits or risks to your participation. While some of the questions asked may be of a sensitive nature, please note that your name will not be recorded in the questionnaire. Moreover, any details related to your privacy will be kept confidential. Your participation in this survey is very important as I rely on you to provide accurate information. The interview will take approximately 30 minutes.

For more information about this study, please contact the researcher on 0734 615258 or send an e-mail to pkaramuta@gmail.com

May I have your permission to undertake this interview? Yes ☐ No ☐

If you do not want to participate, kindly explain why……

Signature of the interviewee that a verbal consent was obtained : ☐

	QUESTIONS *Translate only when necessary but effectively without losing intended meaning. Ask appropriately.*	**CHECKLIST** *Do not read to the respondent. Tick or mark the codes appropriately. Retain objectivity as much as possible*	**GUIDE** *Write any notes here*
1.0	**HOUSEHOLD DEMOGRAPHICS**		
1.1	Respondents' Gender	01) Male 02) Female	
1.2	Respondents' Age (in years)?	01) 20-30 02) 30-40 03) 40-50 04) Above 50	Where not sure probe
1.3	What is your highest level of education?	01) None 02) Primary 03) Secondary 04) Tertiary	Probe
1.4	How long have you lived in South C? (in years)	01) 0-5 02) 6-10 03) 11-15 04) 16-20 05) Above 20	
1.5	What type of employment is the household head mainly engaged in?	01) Self employed/Business 02) Permanent 03) Contract/Temporary 04) Casual Labour 05) Un-employed	
1.6	What is the net monthly income of the household head?	01) Less than Kshs. 10,000 02) Kshs. 10,000 – Kshs. 30,000 03) Kshs. 30,001 – Kshs. 60,000 04) Kshs. 60,001 – Kshs. 100,000 05) Over Kshs. 100,001	
1.7	What is your tenure - ship?	01) Rental 02) Institutional 03) Owner occupancy	

2.0	**FLOOD FREQUENCY AND SEVERITY**		
2.1	Do you experience flooding at this neighbourhood?	01) Yes 02) No	
2.2	How often do you experience flooding in this area?	01) Daily 02) Weekly 03) Monthly 04) Every three months 05) Every six months 06) Annually	
2.3	Which months does most flooding occur?	01) Jan – Feb 02) March – May 03) June - September 04) October - December	
2.4	Does it flood /is there water retention even in the absence of heavy rains?	01) Yes 02) No	
2.5	How long does it take before the water dries out?	01) Less than 1 day 02) 1 – 2 days 03) 3 – 7 days 04) More than 7 days	
2.6	In the last 5 years, have the flooding incidences increased, decreased or remained constant?	01) Increased 02) Decreased 03) Remained constant	
2.7	Approximately how deep is the flood water?	01) Less that 0.2m 02) 0.2m – 0.5m 03) 0.5m – 1m 04) Over 1m	
3.0	**STRUCTURAL FACTORS INFLUENCING FLOODING**		
3.1	**SOLID WASTE MANAGEMENT**		
3.1.1	What method of sewer waste disposal does your household use?	01) Municipal 02) Septic tank 03) Bio-digester 04) Other *(please specify)*…… ….	
3.1.2	In the last 10 years, have you experienced any sewer blockages during heavy rainy seasons?	01) Yes 02) No	
3.1.3	If yes, how often does this occur?	01) Every rainy season 02) Twice a year 03) Once a year 04) Once in two years 05) Other *(please specify)*…… ….	
3.1.4	Approximately what percentage does the	03) Plastic paper bags – (_ %)	

	outlined type of waste account for in your household's daily solid waste?	04) Plastic bottles – (_ %) 05) Organic waste e.g kitchen waste – (_ %) 06) Bio-degradable paper – (_ %) 07) Glass – (_ %) 08) Chemical-based waste e.g paints, medicines, aerosols, etc – (_ %)	
3.1.5	What methods of solid waste disposal does your household use?	01) Municipal collection 02) Private collection 03) Dumping in the river 04) Other *(please specify)*……	
3.1.6	What is your primary source of water?	01) The Nairobi water and sewerage company 02) Private suppliers 03) River 04) Rain water 05) Illegal connections	
3.1.7	In the last 10 years, have you experienced water shortage as a result of burst water pipes during heavy rains?	01) Yes 02) No	
3.2	**INFRASTRUCTURE PHYSICAL EXPOSURE ie Buildings and other structures, drainage infrastructure, electrical infrastructure**		
3.2.1	Typology of housing	01) Single-storied/bungalow 02) 2-storied/ maisonette 03) Apartment/flats	Observe and tick
3.2.2	Type of flooring material	01) Ceramic Tiling 02) Wood/parquet tiling 03) Bare Concrete 04) Mud	Observe and tick
3.2.3	Type of walling material	01) Masonry wall 02) Brick wall 03) Corrugated Iron sheets 04) Timber 05) Mud	Observe and tick
3.2.4	Type of roofing material	01) Roofing tiles 02) Corrugated Iron sheets 03) Timber 04) Grass thatching	Observe and tick
3.2.5	Do you harvest rain water?	01) Yes 02) No	
3.2.6	If yes, what method do you employ?	01) Building gutters	

		02) Basins, Buckets, sufurias, etc 03) Other *(please specify)*……	
3.2.7	Do you have any external storm water drainage system in your immediate outdoor space?	01) Yes 02) No	Observe and tick
3.2.8	What type of system is it?	01) Open stone/concrete drain 02) Closed stone/concrete drain 03) Natural/temporary swale 04) Other *(please specify)*……	Observe and tick
4.0	**NON - STRUCTURAL FACTORS INFLUENCING FLOODING**		
4.1	**ACCESS TO INFORMATION**		
4.1.1	What device of mass media do you own? *(Tick all the applicable options)*	01) Radio 02) Television 03) Computer with internet access	
4.1.2	Do you have access to newspapers?	01) Yes 02) No	
4.1.3	If Yes, how often do you access them?	01) Daily 02) Weekly 03) Monthly	
4.1.4	Do you have access to the internet?	03) Yes 04) No	
4.1.5	If Yes, how often do you access it?	01) Daily 02) Weekly 03) Monthly	
4.1.6	In the last 5 years, have you received any information/warning elating to floods or rains in this area?	01) Yes 02) No	
4.1.7	If yes, who relayed this information to you?	01) Friend/neighbor 02) Neighborhood association official 03) Councilor/ward representative/MCA 04) Government institution/agency 05) Non - Government institution/agency	
4.1.8	Was this information helpful in helping you plan/prepare for the rains and floods?	01) Yes 02) No	
4.1.9	If yes, how did you prepare your household or	……	

	business? *(open-ended)*	……	
4.1.10	If not, why was it not helpful?	…… ……	
4.2	**GOVERNANCE**		
4.2.1	Do you know of any residents' association in this area?	01) Yes 02) No	
4.2.2	If Yes, what is the name of the association? Kindly name all of them, if more than one. *(open-ended)*	01) …….. 02) …….. 03) …….. 04) ……..	
4.2.3	Are you an active member of any of these associations?	01) Yes 02) No	
4.2.4	What activities is the association involved in? *(open-ended)*	…… ……	
4.2.5	Who funds the association(s)? *(open-ended)*	…… ……	
4.2.6	Does the association (s) lobby for flood management in the area?	01) Yes 02) No	
4.2.7	Do you know the name of the south C ward MCA?	01) Yes 02) No	
4.2.8	Do you know where the MCA offices for the South C ward are located?	01) Yes 02) No	
4.2.9	Have you ever visited your MCA offices?	01) Yes 02) No	
4.2.10	If Yes, what was the purpose of your visit? *(open-ended)*	…… ……	
5.0	**IMPACTS OF FLOODS TO THE RESIDENTS**		
5.1	In the last 10 years, Have you/a relative/a friend/a neighbor been hospitalized as a result of a waterborne disease (malaria, typhoid, cholera, diarrhea, bilharzia, etc) during flooding incidences in south C?	01) Yes 02) No	
5.2	In the last 10 years, has a relative/friend/neighbor drowned as a result of floods in south C?	01) Yes 02) No	
5.3	In the last 10 years, has a relative/friend/neighbor died of any other cause resulting from the floods other than drowning? e.g electrocution	01) Yes 02) No	
5.4	Which is the nearest health care facility from your residence? *(write the name in the space provided)*		

5.5	What type of health care facility is it?	01) Government hospital 02) Government dispensary/clinic 03) Private Hospital 04) Private Dispensary/clinic 05) Mission/donor funded hospital 06) Mission/donor funded dispensary/clinic	
5.6	What mode of transport do you use to access it?	01) Walking 02) Public transport 03) Private transport	
5.7	Have you lost any property as a result of floods?	01) Yes 02) No	
5.8	If yes, what kind of property? *(Please tick all the applicable options)*	01) Household items e.g beds, mattresses, utensils, sofas 02) Electronic devices e.g TV,radio,laptop, mobile phones 03) Car 04) Boundary/ building walls 05) Gates and other external infrastructure 06) Other *(please specify)*……	
5.9	Did you receive any kind of compensation for the life or property losses?	01) Yes 02) No	
5.10	If yes, from whom?	01) Central Government 02) County/local government 03) Landlord 04) Other *(please specify)*……	
5.11	What kind of compensation was it?	01) Monetary 02) In-kind 03) Resettlement 04) Other *(please specify)*……	
5.12	In the last 10 years, have you been unable to access your place of work/ business/school as a result of any flood incidences in south C?	01) Yes 02) No	
5.13	If yes, for how long?	01) 1 day 02) 2-5 days	

		03) 1 week 04) More than one week	
5.14	In the last 10 years, have you experienced power outages/interruptions as a result of flooding in this area?	01) Yes 02) No	
5.15	If yes, how long did it last?	01) 1 day 02) 2-5 days 03) 1 week 04) More than one week	
5.16	In the last 10 years, have you experienced water shortages as a result of flooding in this area?	01) Yes 02) No	
5.17	If yes, how long did it last?	01) 1 day 02) 2-5 days 03) 1 week 04) More than one week	
6.0	**ADAPTATION/COPING MECHANISMS ADOPTED BY RESIDENTS**		
6.1	In the last 10 years, have you had to move out of your house as a result of flooding?	01) Yes 02) No	
6.2	In the last 10 years, have you had to make any building/structural modifications/repairs to your house as a result of flooding?	01) Yes 02) No	
6.3	If yes, what were the modifications? *(open-ended)*	…… ……	
6.4	Did you consult any building/construction expert while making the modifications?	01) Yes 02) No	
6.5	If yes, which expert?	01) Engineer 02) Architect 03) Specialised contractor e.g electrical, mechanical, etc 04) General contractor 05) Other *(please specify)*…… ……	
6.6	How much did the entire modification process (including consultation) cost? *(Please give approximate cost in Kshs)*	…… ……	
6.7	Have you had to take out insurance against flooding?	01) Yes 02) No	
6.8	If yes, how much does it cost you annually? *(Please give approximate cost in Kshs)*	…… ……	
6.9	Have you had to seek legal representation for uncompensated losses?	01) Yes 02) No	
6.10	If yes, how much did it cost you? *(Please give approximate cost in Kshs)*	…… ……	

6.11	In your opinion, what measures should be taken to deal with the flooding problems in the south c area? *(open-ended)*	…… ……	

Note to Enumerator:
Thank the respondent for dedicating their time participating in this exercise. Re-assure them it is specifically meant for academic purposes only and responses remain anonymous. Ask the respondent if they wouldn't mind giving you their cell-phone contacts for verification purposes only. Tel: …… Remind them that they can also get further information about this research by contacting the key researcher through the contacts provided earlier.

APPENDIX I1: THE KENYA RED CROSS SOCIETY DATA COLLECTION INTERVIEW

Date of Interview |___|___|___|

ASSESSMENT OF FLOOD MANAGEMENT IN THE SOUTH C WARD OF NAIROBI CITY COUNTY, KENYA

CONSENT FORM

My name is Patricia Karamuta. I am a master's student of Environmental Policy at the University of Nairobi. As part of the course, I am conducting a research titled ***"Assessment of flood management in the South C Ward of Nairobi City County, Kenya."***

Your organization has been identified as one of the key informant sources. I would therefore like an opportunity to interview the applicable staff member (s).

This information is being collected for academic purposes only, and there are no personal benefits or risks to your participation. While some of the questions asked may be of a sensitive nature, please note that your name will not be recorded in the questionnaire. Moreover, any details related to your privacy will be kept confidential. Your participation in this survey is very important as I rely on you to provide accurate information. The interview will take approximately 30 minutes.

For more information about this study, please contact the researcher on 0734 615258 or send an e-mail to pkaramuta@gmail.com

May I have your permission to undertake this interview? Yes ☐ No ☐

If you do not want to participate, kindly explain why……

Signature of the interviewee that a verbal consent was obtained: ☐

THE KENYA RED CROSS SOCIETY INTERVIEW (30-40 minutes)

i) IDENTIFICATION
Type of Institution: Mandate: Physical Address: Telephone: E-mail: Name of respondent: Position Held at the Organization: No. of years worked within the organization:

NOTE:

- 'Recorded data' in this interview means any information relating to the incidences, impacts, mitigation and adaptation strategies used in the preparedness and management of flood disasters in the specified area.
- If available, request for most recent data on flooding in Nairobi (deaths, displacements,) if available

1.0 <u>Floods in Nairobi</u>

1.1 What are the most flood prone areas of Nairobi? *(open - ended)*……
……
In your opinion, what are the causes of flooding in Nairobi? *(open - ended)*……
……

1.2 Do you have any recorded data (relating to incidences, impacts, mitigation and adaptation startegies) regarding the flood prone areas in Nairobi?.....
.....

1.3 How often is this data collected? *(open – ended)*……
……

1.4 How is the data collected? *(open- ended)*……
……

1.5 How does this data assist the organization in disaster preparedness and management? *(open -*

ended)……
……

1.6 Is this data/information shared with governmental or non-governmental organizations with a similar mandate to the KRC?.....
.....

1.7 If yes, how is it shared?.....
.....

1.8 Is this data/information available to the public?.....
.....

1.9 If yes, how is it made available to the public?.....
.....

1.10 Who are the KRC's main governmental and non-governmental partners when it comes to matters of flood disasters in Nairobi? (Kindly specify)……
……

2.0 <u>Flood disaster preparedness in South C</u>

2.1 Do you have any data regarding flooding in the South C area of Nairobi?
[ ] Yes [ ] No

2.2 If Yes, has this information been shared with the local authorities in the area?
[ ] Yes [ ] No

2.3 If Yes, how?
……
……

2.4 If No, why not?.....
.....

2.5 Over the last 10 years, approximately what amount of financial resources have been used by the KRCS in flood disaster preparedness for the south C area? (Please answer in Kshs)……
……

Over the last 10 years, approximately what number of personnel and level of skill set have been used by the KRCS in flood disaster preparedness for the south C area?
……
……

2.6 Over the last 10 years, approximately what amount and type of technical resources have been used by the KRCS in flood disaster preparedness for the south C

area??.....
.....

2.7 Who are the KRCS's main governmental and non-governmental partners when it comes to matters of flood disaster preparedness in South C? (please specify)……
……

3.0 <u>Flood disaster management in South C</u>

3.1 Over the last 10 years, approximately what amount of financial resources have been used by the KRCS in flood disaster management for the south C area? (Please answer in Kshs)……
……

3.2 Over the last 10 years, approximately what number of personnel and level of skill set have been used by the KRCS in flood disaster management for the south C area?
……
……

3.3 Over the last 10 years, approximately what amount and type of technical resources have been used by the KRCS in flood disaster management for the south C area?.....
.....

3.4 Who are the KRCS's main governmental and non-governmental partners when it comes to matters of flood disasters in South C? (please specify)……
……

APPENDIX 1II: THE SOUTH C WARD MEMBER OF COUNTY ASSEMBLY - DATA COLLECTION INTERVIEW

Date of Interview |___|___|___|

ASSESSMENT OF FLOOD MANAGEMENT IN THE SOUTH C WARD OF NAIROBI

CITY COUNTY, KENYA

CONSENT FORM

My name is Patricia Karamuta. I am a master's student of Environmental Policy at the University of Nairobi. As part of the course, I am conducting a research titled ***"Assessment of flood management in the South C Ward of Nairobi City County, Kenya."***

Your office has been identified as one of the key informant sources. I would therefore like an opportunity to interview the applicable staff member (s).

This information is being collected for academic purposes only, and there are no personal benefits or risks to your participation. While some of the questions asked may be of a sensitive nature, please note that your name will not be recorded in the questionnaire. Moreover, any details related to your privacy will be kept confidential. Your participation in this survey is very important as I rely on you to provide accurate information. The interview will take approximately 30 minutes.

For more information about this study, please contact the researcher on 0734 615258 or send an e-mail to pkaramuta@gmail.com

May I have your permission to undertake this interview? Yes ☐ No ☐

If you do not want to participate, kindly explain why……

Signature of the interviewee that a verbal consent was obtained: ☐

THE SOUTH C WARD MEMBER OF COUNTY ASSEMBLY INTERVIEW (30-40 minutes)

i) IDENTIFICATION
Type of Institution: Mandate: Physical Address: Telephone: E-mail: Name of respondent: Position Held at the Organization: No. of years worked within the organization:

1.0 <u>Floods in South C</u>

1.1 What are the most flood prone areas of the south C ward? *(open - ended)*……
……

1.2 In your opinion, what are the causes of flooding in South C? *(open - ended)*……
……

1.3 Do you have any recorded data regarding the flood prone areas in South C?.....
.....

1.4 If yes, did the South C ward administration collect this data? [Yes] [No]

1.5 If yes, how is the data collected? *(open-ended)*……
……

1.6 If No, how does the ward administration obtain this data?

1.7 How does this data assist ward administration in its flood disaster preparedness and management? *(open - ended)*……
……

1.8 If collected by the ward administration, is this data/information shared with governmental or non-governmental organizations?
[ ] Yes [ ] No

1.9 Is this data/information available to the public? [ ] Yes [ ] No

1.10 If yes, how is it made available to the public?.....
.....

1.11 Who is tasked with the duty of installing storm water drainage and litter bins infrastructure in the ward?.....

1.12 Who is tasked with the duty of maintaining storm water drainage and litter bins infrastructure in the ward?.....

1.13 How often are these systems maintained?.....
.....

1.14 During the last 10 years, has the ward administration allocated any financial resources to flood disaster preparedness and management in this area? [ ] Yes [ ] No

1.15 If Yes, approximately how much (Kshs) annually?
……
……

1.16 During the years 2005 – 2012, did the ward administration table a bill or other form of legislation in the National Assembly regarding flood disaster preparedness and management in the south C area? [ ] Yes [ ] No

1.17 If yes, please give more information on this……
……

1.18 During the last 2 years, has the ward administration tabled a bill or other form of legislation in the county assembly regarding flood disaster preparedness and management in the south C area? [ ] Yes [ ] No

1.19 If yes, please give more information on this……
……

APPENDIX IV: THE CITY PLANNING SECTOR OF THE NAIROBI CITY COUNTY - DATA COLLECTION INTERVIEW

Date of Interview |___|___|___|

ASSESSMENT OF FLOOD MANAGEMENT IN THE SOUTH C WARD OF NAIROBI

CITY COUNTY, KENYA

CONSENT FORM

My name is Patricia Karamuta. I am a master's student of Environmental Policy at the University of Nairobi. As part of the course, I am conducting a research titled **"*Assessment of flood management in the South C Ward of Nairobi City County, Kenya.*"**

Your department has been identified as one of the key informant sources. I would therefore like an opportunity to interview the applicable staff member (s).

This information is being collected for academic purposes only, and there are no personal benefits or risks to your participation. While some of the questions asked may be of a sensitive nature, please note that your name will not be recorded in the questionnaire. Moreover, any details related to your privacy will be kept confidential. Your participation in this survey is very important as I rely on you to provide accurate information. The interview will take approximately 30 minutes.

For more information about this study, please contact the researcher on 0734 615258 or send an e-mail to pkaramuta@gmail.com

May I have your permission to undertake this interview? Yes ☐ No ☐

If you do not want to participate, kindly explain why……

Signature of the interviewee that a verbal consent was obtained: ☐

THE CITY PLANNING SECTOR OF THE NAIROBI CITY COUNTY INTERVIEW (30-40 minutes)

ii) IDENTIFICATION
Type of Institution: Mandate: Physical Address: Telephone: E-mail: Name of respondent: Position Held at the Organization: No. of years worked within the organization:

1.0 <u>Physical Planning in South C</u>

1.1 Do you have physical development plans for the south c ward of Nairobi county?
[ ] Yes [ ] No *NB: If yes, request for copies of the plans*

1.2 If yes, when were these plans prepared?

……
…

1.3 If yes, what zones have been demarcated in the area?

……
……

1.4 Are these plans available to the general public? [ ] Yes [ ] No

1.5 Who is tasked with ensuring that the plans are adhered to during any developments in the area?

.....
.....

1.6 What are the penalties for non-adherence?.....
.....

2.0 <u>Flood Management in South C</u>

2.1 If there are physical development plans for the south C ward of Nairobi county, did they take into consideration the geographical predisposition of the area to flooding?
[ ] Yes [ ] No

2.2 If yes,
how?.....
.....

2.3 If No, why not?

……
……

2.4 Have the flooding problems in the south C area been documented by the county physical planning department? [ ] Yes [ ] No

2.5 If yes, when?

……

2.6 If yes, what measures have been put in place to manage the flooding?.....
.....

Note: check for measures such as solid waste management installation and plans, landscaping for natural storm water, preservation of ecological buffers, abandonment/moving of infrastructure that is in hazardous areas, revision of building codes, preparation/updating of flood maps, designation of safe zones in the case of disasters

2.7 If No, what are the reasons for there not been any measures put in place?.....
.....

2.8 Who is tasked with installing storm water drainage infrastructure in the south C ward area?

……
……

2.9 How often do you replace/maintain roads within the south C ward area?*(open - ended)*……
……

APPENDIX V: THE KENYA METEOROLOGICAL DEPARTMENT - DATA COLLECTION INTERVIEW

Date of Interview |___|___|___|

ASSESSMENT OF FLOOD MANAGEMENT IN THE SOUTH C WARD OF NAIROBI

CITY COUNTY, KENYA

CONSENT FORM

My name is Patricia Karamuta. I am a master's student of Environmental Policy at the University of Nairobi. As part of the course, I am conducting a research titled ***"Assessment of flood management in the South C Ward of Nairobi City County, Kenya."***

Your organization has been identified as one of the key informant sources. I would therefore like an opportunity to interview the applicable staff member (s).

This information is being collected for academic purposes only, and there are no personal benefits or risks to your participation. While some of the questions asked may be of a sensitive nature, please note that your name will not be recorded in the questionnaire. Moreover, any details related to your privacy will be kept confidential. Your participation in this survey is very important as I rely on you to provide accurate information. The interview will take approximately 30 minutes.

For more information about this study, please contact the researcher on 0734 615258 or send an e-mail to pkaramuta@gmail.com

May I have your permission to undertake this interview? Yes ☐ No ☐

If you do not want to participate, kindly explain why……

Signature of the interviewee that a verbal consent was obtained: ☐

THE KENYA METEOROLOGICAL DEPARTMENT INTERVIEW (30-40 minutes)

iii) IDENTIFICATION
Type of Institution: Mandate: Physical Address: Telephone: E-mail: Name of respondent: Position Held at the Organization: No. of years worked within the organization:

1.0 Climate Data for Nairobi /South C

1.1 Request for Nairobi's rainfall data (frequency, duration, depth) for the last 10 years

1.2 Request for Nairobi's evaporation data for the last 10 years

2.0 Flood risk maps for Nairobi county/South C

2.1 Are there flood risk maps for the city of Nairobi? [ ] Yes [ ] No

2.2 If yes,

2.2.1 When were they generated?.....
.....

2.2.2 How were they generated?
.....
.....

2.2.3 In what format are they?
.....
.....

2.2.4 How are they disseminated? Periodicals/newsletters, media (TV, radio, Newspapers, magazines), reports (annual, quarterly, semi-annually, monthly, weekly, daily), internet, stakeholder seminars/workshops.....
.....

2.2.5 To whom are they disseminated? All city residents, city residents in flood prone areas, higher education institutions, other govt agencies, members of parliament,
……
……

2.2.6 How often are they disseminated?

……

2.3 If No,

2.3.1 Why are there not any flood risk maps?

.....

.....

3.0 Presence of early warning systems for Nairobi county/South C

3.1 Is/Are there early warning systems for the city of Nairobi? [ ] Yes [ ] No

3.2 If yes,

3.2.1 When were they generated?

.....

.....

3.2.2 How were they generated?

.....

.....

3.2.3 When were they last updated?

.....

.....

3.2.4 In what format are they?

.....

.....

3.2.5 How are they disseminated? Periodicals/newsletters, media (TV, radio, Newspapers, magazines), reports (annual, quarterly, semi-annually, monthly, weekly, daily), internet, stakeholder seminars/workshops.....

.....

3.2.6 To whom are they disseminated? All city residents, city residents in flood prone areas, higher education institutions, other govt agencies, members of parliament,

.....

.....

3.2.7 How often are they disseminated? Hourly, Daily, weekly, monthly, etc

3.3 If No,

3.3.1 Why are there not any early warning systems?

.....

.....

APPENDIX VI: PHYSICAL ENVIRONMENT FIELD OBSERVATION DATA

Date of Observation |___|___|___|

ASSESSMENT OF FLOOD MANAGEMENT IN THE SOUTH C WARD OF NAIROBI CITY COUNTY, KENYA

CONSENT FORM

My name is Patricia Karamuta. I am a master's student of Environmental Policy at the University of Nairobi. As part of the course, I am conducting a research titled ***"Assessment of flood management in the South C Ward of Nairobi City County, Kenya."***

I would like to have permission to observe the listed physical parameters that will be used for the study. This information is being collected for academic purposes only. While it is possible that some of the parameters under observation are of a sensitive nature, details related to this area will be kept confidential.

For more information about this study, please contact the researcher on 0734 615258 or send an e-mail to pkaramuta@gmail.com

Permission to undertake the field observation: Yes ☐ No ☐

If you do not want to participate, kindly explain why……

Signature of the subject caretaker/owner that a verbal consent was obtain ☐

GENERAL PHYSICAL ENVIRONMENT FIELD OBSERVATION DATA

AREA IDENTIFICATION
Area name e.g Shopping centre, Mitumba, etc.....……..... Acreage (in square kilometres): ……. Approximate population/ population density…….

	VARIABLE	RELEVANCE	STANDARD VALUE/PARAMETERS	FIELD – OBSERVED VALUE/PARAMETERS	COMMENTS
1)	**Topographical data**	**To assess the natural floodplain character and effects of any built-up forms along the natural floodplain**			
2)	**Natural wetlands (rivers, streams, etc)**	**The existence of natural wetlands means that these would be good natural flood water management features if their riparian reserves are kept clear of human settlement or activity. Their conditions shall be observed to assess whether they serve this purpose.** **The proximity of human settlements to rivers or streams affects the vulnerability of the people and infrastructure in these settlements**			
3)	**Built – up area**	**The percentage of built-up areas vis - a - vis open spaces would be used to determine whether there is a higher likelihood of storm water retention as a result of inadequate natural filtration spaces.** **Secondly, when measured against the type and number of storm water drainage systems, the adequacy of these, and hence physical vulnerability of the area would be measured.**			
4)	**Main construction material for walls and floor**	**Determines the physical fragility towards flood events and indicates the resistance to damage and also the social status of the residents** **Some types of construction material allow humidity to remain in the walls or floor after flood events which can lead to health problems**			
5)	**Position of buildings in relation to the street level**	**During flooding incidences, the ease of water flowing into the buildings as a result of poor street drainage**			

		infrastructure may be assessed by this variable			
6)	**Water table data**	**When measured against the existing storm water infrastructure, the efficiency of the infrastructure in handling the storm water is approximated.**			
7)	**Soil data**	**To assess the type of soil predominant in the area and how this would aid water retention**			
8)	**Average flood water depth in the area**	**This variable would be used to assess the population's vulnerability to the effects of flooding, as well as measure the deficit in storm water management. This would further enable evidence-based formulation of policy and regulations relating to flood control infrastructure.**			
9)	**Storm water drainage infrastructure installed**	**An assessment of the number, size and condition of open drains, swales, covered drains, and water channels within the area would enable in measuring the vulnerability of the area to flooding**			
10)	**Public open spaces**	**The acreage, number and condition of public open spaces within the area would be useful in finding out whether there are adequate natural filtration spaces and whether there is likelihood of these spaces being used as temporary evacuation areas for displaced persons in case of extreme flood events**			
11)	**Private open spaces**	**If the open spaces available are predominantly private, then these are not reliable in offering solutions that would be offered by public open spaces.** **This is because of the ownership issues that would arise if they were to be used as such.**			

12)	**Public Litterbins/sqkm**	**To assess whether there are adequate litterbins for the population and whether their level of use is optimum** **Solid waste blocks drainage systems and may be a big contributing factor in flooding incidences**			
13)	**Electric lines**	**The number of exposed and/or vandalized electricity lines would be used in assessing the level of exposure and hence the population's vulnerability to the effects of flooding**			