



UNIVERSITY OF NAIROBI

**ENHANCING ADAPTIVE CAPACITY OF COMMUNITIES IN
INFORMAL SETTLEMENT TO FLOODING: THE CASE OF
MUKURU KWA REUBEN IN NAIROBI, KENYA.**

BY

WENTLAND NGALUSHI MUHATIAH

I58/81731/2015

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Master of Climate Change Adaptation of the University of Nairobi**

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Signature:

Date: 05/07/2021

Wentland Ngalushi Muhatiah

I58/87513/2015

Institute for Climate Change and Adaptation

University of Nairobi

DECLARATION

This thesis is my original work and has not been presented for Degree in any other University.

Signature: 

Date: 05/07/2021

Wentland Ngalushi Muhatiah

I58/87513/2015

Institute for Climate Change and Adaptation

University of Nairobi

This Thesis is submitted for examination with our approval as Research Supervisors:

Dr. Gilbert Ouma

Institute for Climate Change and Adaptation

University of Nairobi

P.O Box 30197-00100

Nairobi Kenya

gouma@uonbi.ac.ke



Date: 5th July 2021

Dr. Ali Adan Ali, PhD; MSc.; MEIK, FASI; NEMA Lead Expert

Senior Research Fellow & Registrar,

Research, Innovation and Outreach Affairs

Umma University

P.O Box 713-01100, Kajiado, Kenya

aadan@umma.ac.ke



Date: 5th July 2021

Dr. Jacinta Mwende

Institute for Climate Change and Adaptation

University of Nairobi

P.O Box 30197-00100

Nairobi Kenya

jacinta.mwende@uonbi.ac.ke



Date: 5th July 2021

DEDICATION

This work is dedicated to my parents who have been supportive throughout my study.

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ABSTRACT

Mukuru Kwa Ruben informal settlement is located within the industrial area of Nairobi County. It is characterized by poor dilapidated housing exacerbated by poor drainage conditions and flooding in the area. According to the 2019 census projections, Mukuru kwa Ruben has a population of 527,526. This study aimed at developing a framework to enhance adaptive capacity of communities at the Mukuru kwa Ruben informal settlement to flooding. The study objectives entailed: To determine the drivers and impacts of flooding in Mukuru kwa Ruben, to identify the coping strategies to flood risks, establish their challenges and opportunities in Mukuru kwa Ruben and to develop strategies that will enhance Mukuru kwa Ruben adaptive capacity to flood risk. The study started by reviewing relevant literature on flood vulnerability in urban areas and most specifically in informal settlements of Nairobi. Rainfall data was obtained from Kenya Metrological Department for the period 1985-2017 and various flood management policies and strategies were critically reviewed. Household questionnaires, observation checklists and Key Informant Interview guides were used to collect data from the community. The data collection process was undertaken, followed by the analysis of the data collected. The methods of analyses used for this study entailed: content analysis, trend analysis and desktop reviews. The study findings show that flooding in Mukuru kwa Reuben isn't necessarily caused by heavy down pour of rainfall but ineffective structural and non-structural measures that if addressed can enhance the adaptive capacity of the community to flood risks. It was also evident that residents of Mukuru kwa Ruben have put more premium on structural adaptation measures that are externally facilitated to soft adaptation measures that can easily be conducted by the community members. Shortcomings in the legislation, policies and strategies on urban settlement flooding were highlighted and appropriate means to tighten the loose ends proposed. The study therefore recommends Integral community stakeholders should conduct mass sensitization on effective low cost adaptive strategies to floods in Mukuru kwa Ruben, form Mukuru kwa Ruben residents association so as to have a representative at the Nairobi disaster committee to represent their plight and relook implementation of flood management strategies especially in urban informal settlements.

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ACRONYMS AND ABBREVIATIONS

EA – Environmental Audit

EIA – Environment Impact Assessment

EMCA - The National Environment Management and Coordination Act

ENSO - El Nino Southern Oscillation

FME – Flood Management Entity

GoK – Government of Kenya

ICCA – Institute for Climate Change and Adaptation

ITCZ - Inter-Tropical Convergence Zone

KMD – Kenya Meteorological Department

KRCS – Kenya Red Cross Society

MAM – March- April-May

MCA – Member of County Assembly

NaMSIP – Nairobi Metropolitan Services Improvement Project

NCIDP – Nairobi County Integrated Development Plan

NDOC –National Disaster Operation Centre

NEMA – National Environment Management Authority

NIUPLAN – Nairobi Integrated Urban Development Master Plan

OND - October-November-December

PVC - Polymerizing vinyl chloride

SOE – State of Environment

WRA – Water Resources Authority

CHAPTER1: INTRODUCTION

1.1 Introduction

Floods can be defined as an accrual of water in areas that are typically not submerged (Kundzewicz et al., 2014). They normally assume different forms such as fluvial floods which occur as a result of rivers exceeding their capacity during heavy rainfall events (Haque & Nicholls, 2018), flash floods that happen during high short intensity period (mostly within 6 hours) rainfall events (Schumacher, 2017), and glacial lake outburst floods which result from glacier dammed failure (Emmer, 2017). Other types of floods include pluvial floods resulting from heavy down pours saturating drainage systems and bringing about surface water flooding (Houston et al., 2011), coastal floods which occur when seawater floods the adjacent low lying areas (Toubes, *et al.*, 2017), and sewer floods that mostly come as a result of blockages of sewer lines during rainy seasons.

The United Nations and World Bank (2010) indicate that floods are the most common natural disasters and are ranked third after storms and earthquakes in terms of the damage they cause. In 2010, China recorded the highest annual damage by fluvial floods in a single country at the US \$ 51 billion (Kundzewicz et al., 2014), while in 2010 and 2011 significant parts of Asia and some parts of Africa were ravaged by floods and over 2,000 people were reported to have either succumbed to death, displaced or had severe material damage to their houses (Syvitski and Brakenridge 2013; Kundzewicz et al. 2012). In Africa, Tropical Storm IDAI claimed over 300 lives in Mozambique, 98 in Zimbabwe, 56 in Malawi and 3 in Madagascar in the year 2019. The storm also injured more than 580 people and displaced over 100,000 (European Commission Joint Research Centre, 2019). The severe damage caused by the floods from the storm is comparable to those caused by Cyclone Leon-Eline which hit Mozambique in the year 2000 and caused 800 loss of lives (Insurance Journal, 2019). Closer to home, the Government of Kenya reports that, in the year 2010, 73 human and 1,864 livestock lives were lost, while over 3,375 households were displaced as a result of floods that ravaged the country as a result of the 2009 El Nino event (GoK, 2009).

Studies on the rainfall seasons in East Africa show that the seasonal rains of March-April-May (MAM) and October-November-December (OND) depend on the Inter-Tropical Convergence Zone (ITCZ), while the OND season is further impacted by El Nino Southern Oscillation (ENSO) events (Ogou et al., 2015). According to (Wolff et al., 2011) ENSO has a significant influence on the variability of rainfall by intensifying the ITCZ. This has in turn led to increased OND precipitation in East Africa Regions during El Nino years. Increasing global temperatures have been observed to catalyse the cyclic El Nino phenomenon with the anticipated results being increased severe flooding in the region (Wang et al., 2019). Kenya got to experience the brutal impacts of El Nino effect during the 1997-1998 floods (United Nations, 1998). In November 2015, floods brought about by El Nino affected Narok, Meru, Kisumu, Kilifi and Nairobi Counties (floodlist, 2015). However, it's important to note that floods haven't always been brought about by El Nino events. Kenya experienced heavy flooding in April 2020 that brought about over 100 fatalities and displacement of 1,800 people (Benaim Rachel, 2020).

Informal settlements are unplanned settlements where houses are not built in consideration with the building and planning regulations of a city , and more often than not are located in environmentally sensitive areas (Avis, 2016). Informal settlements are by-products of rapid urbanization taking place in developing countries. These settlements are characterized by tenuous shelters, dense population, limited access to appropriate sanitation facilities and clean water. Informal settlements lack adequate infrastructures that can enable them effectively cope with flooding risks. This is mainly due to the high cost of such structures, often out of reach of the community, and also as a result of inadequate support and lack of political will to develop adequate infrastructure in those areas (Fox, 2014). Other issues that affect the informal settlements include numerous environmental issues such as encroachment of riparian land, poor sanitation as a result of indiscriminate dumping which make them susceptible to significant harm in case of natural or human-made disasters (White et al., 2017).

Informal settlements in developing countries are often affected by floods because of heavy reliance on natural drainage systems which are easily overwhelmed. Effective land-use management and continuous incremental adjustments that can enable

informal settlements to handle the flood water capacity are methods that remain conspicuously missing in these areas (Sakijege et al., 2014). Coupled with rapid urbanization in urban cities (Kaburu et al., 2019) and its characterization of illegality and unplanned land-use (John, 2020) contribute largely in making informal settlements susceptible to flooding.

Nairobi, the capital city of Kenya, has more than 30 informal settlements with no meaningful organized effort towards ensuring the protection of those communities from climatic hazards. These informal settlements host a large portion of Kenya's internal migrants who have moved from rural areas to the urban areas to look for better opportunities. Among these is Mukuru informal settlement which consists of Mukuru kwa Njenga, Mukuru Kayaba, Mukuru kwa Reuben and Sinai. The settlements are situated about 8 km on the South Eastern side of Nairobi Central Business District, within the Industrial area part of the city.

Mukuru kwa Ruben is the most affected section of the larger Mukuru informal settlements during flooding events. It is spatially segregated and gets very little benefits if any from the development of the more affluent areas surrounding it (Ruben centre, 2017). The residents face multiple burdens of pollution, accessibility of potable water, inadequate toilets, and significant health and environmental risks that are likely to be exacerbated by climate change (UC Berkeley & University of Nairobi, 2017).

1.2 Problem Statement

The location and biophysical characteristics of informal settlements make them an easy prey to climate induced disaster events such as floods. The unplanned nature of Mukuru kwa Ruben and poor housing structures, have made the residents susceptible to adverse risks during floods. Gatope, Kisumu, Feed the children, Kosovo, Rorie and Mombasa villages in Mukuru kwa Ruben are hotspots that are always adversely affected by flood events.

The mushrooming of settlements in Mukuru kwa Ruben aimed at meeting the high demand of tenants who have migrated to the city and need affordable housing has made people to put up housing structures all over Mukuru kwa Ruben without taking consideration of the harm that it may cause in the long run whenever the area

experiences a rainfall event. The rampant unplanned land-use and the blind eye given by the authorities who are tasked with ensuring proper adherence to building codes and provision of vital services such as those of enhancing drainage systems in the area, have exposed the community in Mukuru kwa Rube to floods. A pattern has emerged on how the community of Mukuru kwa Ruben has been reacting to flood events. From various sources where their plight has been highlighted, what has been clear is that they seem to have taken a “let’s wait and see” approach. As a result, they have been subjected to the adverse risks that are brought about by flooding events. The vicious cycle of the recurring of adverse risks in Mukuru kwa Ruben every time there is a flood event doesn’t conform with the sustainable development goal 11 which focuses on sustainable cities and communities. Hence there is need to come up with a transdisciplinary approach to flood risk management in informal settlements to make those settlements and communities more sustainable. The study therefore sought to strengthen community social networks and structures in Mukuru kwa Reuben informal settlement to mitigate against the current reactionary approach to the recurrent flooding in the area.

1.3 Research Questions

The research questions that will guide the research include:

1. What are the drivers of floods in Mukuru kwa Reuben?
2. How do the communities currently respond to the risks and actual impacts of floods in the area?
3. What are the challenges and the opportunities that can be derived from, the current response strategies?
4. What adaptation strategies can be promoted to reduce vulnerability of the residents of Mukuru kwa Reuben exposed to flooding risk?

1.4 Objectives

The overall objective of this study is to enhance the adaptive capacity of flooding in Mukuru kwa Ruben informal settlement in Nairobi County through strengthening of community social networks and structures.

Specific Objectives

1. To determine the drivers and impacts of flooding in Mukuru kwa Ruben.
2. To identify the coping strategies to flood risks, establish their challenges and opportunities in Mukuru kwa Ruben.
3. To develop strategies that will enhance the Mukuru kwa Ruben adaptive capacity to flood risk

1.5 Justification and significance

The purpose of this study was to establish how the adaptive capacity in Mukuru kwa Ruben informal settlement can be enhanced through strengthening of community social networks and structures. Numerous studies have been conducted on the management of floods in informal settlements in Nairobi. However, most of those studies have solely focused on Kibera informal settlement. Getting relevant flood management studies in other informal settlements within Nairobi County always proved to be an exercise in futility. Following a project conducted by Maji na Ufanisi and the Institute of climate change and adaptation (ICCA) on the resilience of urban informal settlements to climate change in Nairobi County, was the basis of this study founded.

Flood events in Mukuru kwa Ruben have not happened without bringing about devastating effects. To enhance the adaptive capacity of flood prone communities in urban informal settlements, relevant policies on flood management have to be critically looked at. The study identified the policies and strategies governing flood management and the loopholes that render them ineffective. Community's behavioural pattern during floods has a direct correlation to their adaptive capacity to floods. This study sought to comprehend how the residents of Mukuru kwa Ruben behaved during flood events and why they behaved in that particular manner. All this was aimed to help

understand how the adaptive capacity of Mukuru kwa Ruben informal settlement could be enhanced.

The results of the study provided vital insights to community stakeholders and practitioners to get to comprehend the drivers of floods in these regions. The reasons ranged from structural to behavioural in accordance to the results that emanated from the study. The study brought out the impacts that these inhabitants are exposed to during flood events. The study findings eventually contributed to the body of knowledge in academia and provided some useful insights on flood adaptation in informal settlements for further academic research.

CHAPTER TWO: LITERATURE REVIEW

This Chapter examines the available literature on urban informal settlements, climate variability and extreme events that they are exposed to. It also outlines what similar communities have done to cope with extreme events such as floods in their areas and sustainable frameworks that could be adopted.

2.1 Climate variability and extreme events

Generally, the climate is the statistical average of prevailing weather condition over a considerable length of time in a given area (IPCC, 2007). According to (Shepherd, 2014) Climate variability is the variation of climate dynamics on all temporal and spatial scales beyond individual weather events. The variability is brought about by natural causes or anthropogenic causes (Dodman & Soltesova, 2015). The escalating quantities of carbon dioxide in parts per million in the atmosphere since the industrial revolution era, seem to attribute that climate variability has to a more considerable extent been brought about by anthropogenic causes. The severity and frequency of the climate variability have brought about consequences such as increased flooding events, increased incidences of drought and heat stress which have had a toll on the human and natural systems (Kuleshov et al., 2014; Thornton et al., 2014).

Studies conducted by (Shongwe et al., 2011) reveal that there is a positive likelihood of increased rainfall and heightened intensity in the East African region. The increased rates of rainfall and intensity will birth detrimental impacts to urban poor in informal settlements, whose population seems to be ever ballooning because of the pressure of migrating into the urban cities in search of better opportunities (Institute for Climate Change and Adaptation (ICCA), 2016). The informal settlements come with an array of its challenges, exposing its inhabitants to severe impacts from increased rainfall and its intensity.

Concerns raised on whether the severities of these extreme events are as a result of anthropogenic climate change or other natural factors that are non-climatic. Increased

solar output, earth's orbital changes and volcanic eruptions are some of the natural factors that bring about climate change but are non-climatic. (Lankao, 2011; Shepherd, 2014) Suggest that climate attribution cannot be squarely pegged on anthropogenic factors without assessing the fraction of attributable risk in several climate models. They are of the school of thought that most studies relate the event and the phenomena to the weather pattern and not the actual cause. This thought has also been supported by (Ghil, 2002; IPCC, 2012) who stated anthropogenic forces to climate change can't be tied to the extreme climate events such as floods, wildfires, droughts, etc. on its own however, he expressed his acknowledgment of both natural and anthropogenic processes could be linked to the extreme climatic events.

Whether climate variability is caused entirely or partially by anthropogenic processes or natural processes, one thing that there seem to be a common understanding is climate change is taking place. As a result, change in frequencies, intensity, duration of extreme weather and climate events are being experienced and visualized (IPCC, 2012).

Palaeoclimatological studies have shown how global temperatures have risen sharply in the 20th century as compared to the past years (Blake et al., 2018). These studies have elicited keen desire amongst researchers to unravel causes of the past climate change and how much of the 20th century warming could be attributed to natural factors and human influences to climate change. Extreme climatic events across the world seem to be taking place and in some cases in increased frequencies. Where the challenge lies are on the scientific projections of the extreme weather events that are as a result of climate change. There's no sufficient backing of the exact amounts of data from the natural processes that affect climate variability hence the extreme weather conditions projected by the climatic models may not necessarily give the desirable forecast for planning.

2.2 Floods in informal settlements

Floods, flash floods, storms and all other forms of climatic hazards that come in the form of precipitation are caused by natural factors but are augmented by socioeconomic and cultural systems of a society to make them into disasters (Hambati & Gaston, 2015). The effects of floods in the informal settlements are hugely felt by the people residing in the flood plains which have high populations and has a favourable topography that can support putting up of affordable housing structures that are within the proximity of

industrial parks within the city centres (E.M.Tucci, 2002). However, this should not be the case. The National Land Commission of Kenya (NLC), has the constitutional mandate to monitor and have oversight responsibility over land-use planning throughout the country (The Government of Kenya, 2010). Furthermore, the policy that inhibits putting up of any structure within 30 metres of a riparian zone was said to be unattainable by the implementing body National Environmental Management Authority (NEMA) because of its huge costs of implementation (Institute for Climate Change and Adaptation (ICCA), 2016) If the NLC was keen on its mandate, development in floodplain areas wouldn't be taking place and hence reduce the effects of floods being felt by the current inhabitants of those areas.

Various studies by (Cho & Chang, 2017; Tucci, 2002; Hambati & Gaston, 2015; Sakijeget. *al* 2014) all point out the fact that environmental factors play a significant role in determining the vulnerability of an informal settlement to flooding disaster. Increased impermeable areas and indiscriminate dumping of wastes into drainages have alleviated the already susceptible condition of a flood plain to increased rates of fatal flooding to the vulnerable communities residing in the informal settlements. Informal settlements have houses made of iron sheets that put up the roof, plastered floors, and verandas. The runoff flows that come from the impervious surfaces mentioned above increase the rate of overland flow and decrease the water infiltration rate of the land in the informal settlement. The solid wastes covering the drainage systems and in some cases the constructions that have taken place in the drainage system acts as blockages that interfere with the flow of the runoff water from reaching the streams or rivers in which they were designed to get into (Tucci, 2002). The amalgamations of all these processes bring about change in the hydrological cycle, and they end up causing flooding in the informal areas.

Comparisons done between developed countries and informal settlements found in developing countries by (Abhas *et. al*, 2012; Climate, n.d.; Tucci, 2002) show a wide range of principles that are not being applied in informal settlements and hence the reason for cyclic flood disasters in some informal settlements. The principles mentioned can be summarised here below:

- Urban drainage controls should take into consideration scenarios based on future city developments.
- Runoff should be dealt with at the source to avoid transfer of impact downstream for areas that have settlements downstream.
- Pollutants from other places transported by the runoff realized by floods should be reduced from the source so that they don't become a problem in the downstream.
- Lots of attention should be put in non-structural measures such as; flood forecasting, flood insurance, flood zoning, etc. for flooding control in flood plains.
- Urban drainage management plans should be available and must be implemented as they have been put down in the drawings to accomplish the flood control in the cities.
- Increased public participation in urban drainage management to promote bottom-up interaction between the community and the government.
- Urban drainage development should be based on recovering the cost of investment

According to (Tucci, 2002) the above-mentioned principles do not work in the informal settlements of developing countries. This is because of spontaneous growth of urban cities and the settlements therein and ignoring of the regulations that govern the urban centres especially those on unregulated developments and invasion of riparian areas. Other reasons apart from the two highlighted may also play a part like lack of appropriate technology and funds to conduct flood forecasting in the informal settlements, and lack of political will by the ruling class (Fox, 2014) have made it hard for floods to be controlled in the informal settlement areas.

(Blaikie *et. al*, 2003) Brings out the lens that he called the disaster crunch model as illustrated in figure 2.1; at which disasters such as flooding should be looked at: root causes, dynamic pressures, and unsafe conditions that when exposed to the flooding hazard it turns out to be a disaster. Informal settlements that have similar

characteristics to Mukuru kwa Reuben have identical attributes that fit into the disaster crunch model for instance:

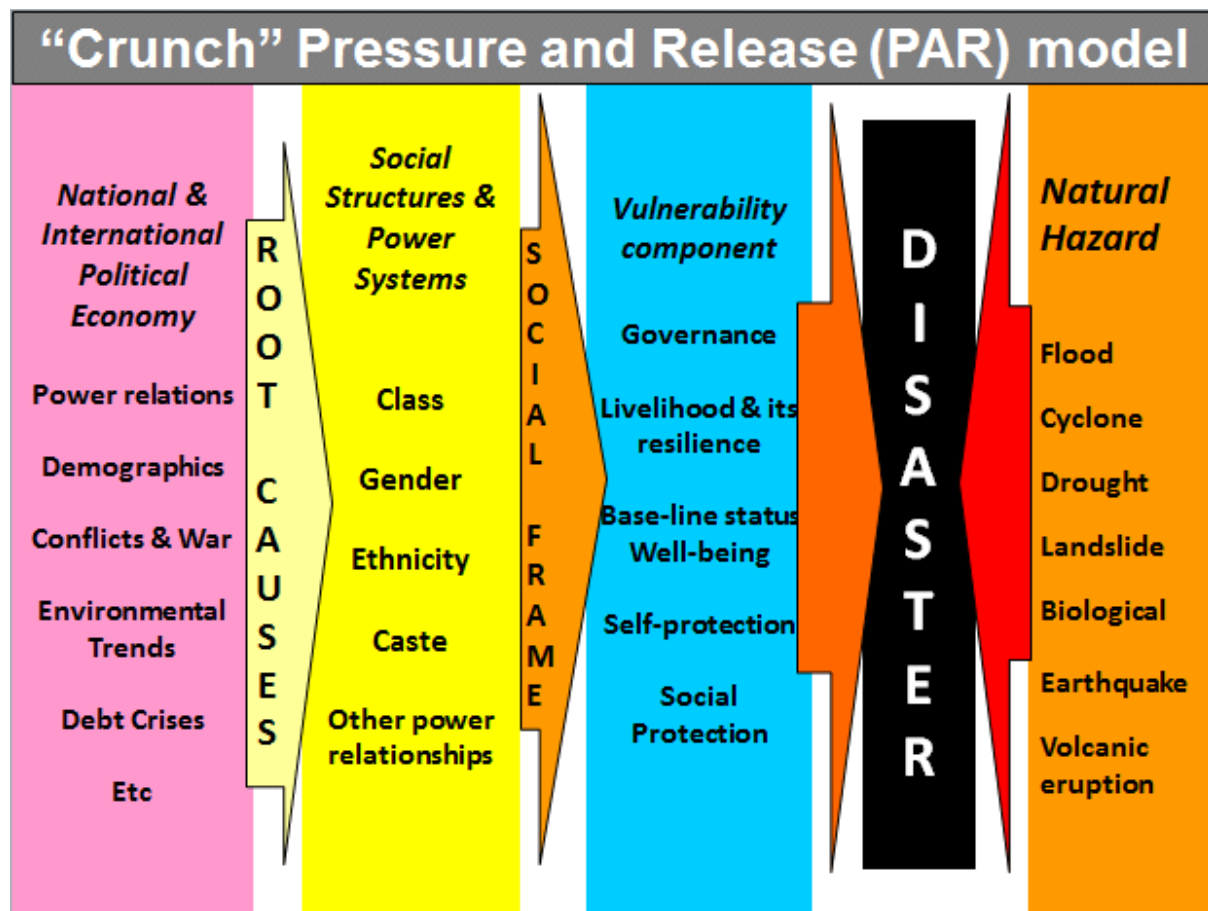


Figure 1-1: Disaster crunch model (Macalandang, et.al 2016)

As much as this can be the most appropriate way of classifying the flood disaster, it still doesn't capture all the vulnerabilities that could be factored in the disaster release model that was fronted by Blaikie *et al.*, 2003. According to Vu Minh Hai & Smyth, 2012, they proposed an inclusion of gender perspective in the previous models for disaster crunch model and disaster release model that was fronted by (Blaikie *et al.*, 2003). The inclusion of the gender perspective gives it a broader lens to be able to assess the vulnerability that the inhabitants are exposed to in the informal settlements.

The gender disaster crunch and release model may go a long way in trying to help disaster practitioners understand why conservative measures are experienced during flood disasters in informal settlements and try come up with lasting solutions that will help in reducing the impacts.

2.3 Coping and adaptation strategies

Coping strategies and adaptation strategies are two terms that have different meanings but have been used interchangeably for a long time. As much as they may have a similar goal which is to protect the community from adverse impacts from climate extreme events such as floods, they have some differences that put them apart. The table below adopted from CARE international vividly shows the differences between the two.

Table 1-2: Key differences between coping strategies and adaptation strategies

Coping strategies	Adaptation strategies
Geared towards short term and immediate results for survival.	Oriented towards longer term livelihoods security.
It's not a continuous process.	A continuous process between community and relevant stakeholders.
It's a reactionary move.	Interventions are designed to be long term in nature hence lots of planning.
Often degrades resource base	Interventions are designed to be sustainable hence resources are used efficiently and sustainably.
Prompted by lack of alternatives	Focused on finding alternatives

Communities in informal settlements in flood prone areas have learnt how to deal with floods hazards whenever they strike. The summary provided in (Table 2-1) shows the different methods communities can take up to protect themselves from the adverse impacts of extreme climatic events such as floods. It's since established coping strategies are short term interventions that are more often than not reactionary move. As a result, they can't be used effectively over and over again to avert flood risk in communities. On the other hand, adaptive strategies can be broadly categorized as either hard adaptive measures or soft adaptive measures (Forneck et al., 2015) . Hard adaptive strategies refer to strategies that put emphasis on infrastructure while soft adaptive strategies put emphasis on management practices and institutional arrangements (Christiansen, 2011).

Communities that are exposed to floods, respond to the particular flood in peculiar ways while learning useful lessons to help them deal with them better during future occurrences (Amoako, 2017). The communities capability to effectively respond to flood events is affected by social networks and the level of awareness on flood patterns (Amoako, 2014, 2017). There is a heavy reliance on mental records, experiences and general knowledge that these communities have to tap into so as to come up with adaptation strategies that will help them cope to floods better. Coping and adaptation strategies from various informal settlements prone to floods have been summarized in (Table 2-2) below:

Table 2-1: Common responses to floods in urban informal settlements

RESPONSES TO FLOODS IN VARIOUS INFORMAL SETTLEMENTS			
Responses	Activity	Period	Actor
Experiences with flood events	Reconstruct and reinforce their houses	Before floods	Individual household level
	Raising the walls foundations and entry points of houses	Before floods	Individual household level
	Putting sandbags in expected storm water runoff paths	Before floods	Individual household level
	Relocating to stay with friends and relatives in non-flood prone areas and also moving valuable items to safer areas.	Before and During floods	Individual household level
Structural responses	Clearing silt materials on drainages,	Before floods	Individual house levels; Community social networks (youth groups)
	Filling muddy areas with gravel and stones		
	Clearing solid wastes at open areas in the community.		
Non- structural responses	Community education on flood updates and intensity;	Before floods	Non-Governmental Organizations (NGO's), Civil Society Organizations (CSO's) and Religious groups
	Engaging city authorities for provision of flood management infrastructure		

2.4 Frameworks and strategies that have enhanced community adaptive capacity

To effectively respond towards the threat climate change has posed to communities in informal settlement areas especially in the developing countries a considerable amount of concerted adaptation actions will be required to be put in place. Several adaptive capacity measures have been fronted but they all end up under a massive umbrella of a local adaptive capacity framework that involves both the generic adaptive capacity and the specific adaptive capacity. For adaptation strategies to work effectively, core functions such as management of climate information, vulnerability assessment and coordination of various adaptation actors have to be thoroughly looked into (WRI, 2009).

According to (Maria *et al.*, 2007) the importance of generic adaptive capacity and specific adaptive capacity cannot be undermined. She defines generic adaptive capacity as the necessary assets and entitlements that enhance the ability of different systems to cope and respond to stress stimuli directed to them. She also defines specific adaptive capacity to be the conditions that prepare a particular order to be able to cope and recover from a climate-related impact. From her studies, she points out to the fact that for a community to have an enhanced adaptive capacity from climatic disasters such as floods, a combination of the two approaches are a prerequisite. However, merging the two isn't as straight forward as one would want to think of. If not done well or as a result of external factors such as lack of political will the process can quickly mutate to create rigidity traps and facilitate poverty in the long run and bring forth maladaptation (Maria *et al.*, 2007).

Various sustainable livelihood frameworks available from the different works done before, aim to enhance community's adaptive capacity in developing countries, put more emphasis on characteristics and indicators development at the national level at the expense of community and household levels (Jones *et al.*, 2010). This could partly be the explanation towards the behavioural attitude of people in flood-prone communities who appear to be always waiting for flood events to strike for them to act. The lack of involvement in the formulation of the guiding framework doesn't motivate them to have any sense of ownership of the framework. A Local Adaptive Capacity (LAC) framework have characteristics that both stand out and are interrelated hence making it a complete

framework to deal with the alleviation of the community's adaptive capacity (ACCRA, 2012). The characteristics include asset base, institution and entitlements, knowledge and information and flexible, forward-looking decision. These parameters touch on the needs that a community is pegged on and not only amplifies the community's vulnerabilities but also gives room for innovation that is informed by the scientific world and the community to develop a comprehensive tool that will have them as the end users.

(Table 2-3) below summarizes the frameworks and strategies that were critically analysed for enhancing adaptive capacity of flood risks in developing countries.

Table 2-2: Summary of frameworks and strategies critically reviewed for enhancing adaptive capacity to flood risk

Author, year	Study area	Core concept	Hazard Type	Geographic Unit	Analytical approach
Clifford Amoako, 2017.	Accra , Ghana	Socioeconomic vulnerability	Floods	city	Mixed methods
Fanny Frick-Trzebitzky, 2017.	Densu delta, Greater Ghana.	Socioeconomic vulnerability	floods	District	Mixed methods
Burton et al, 2004	Netherlands, United States, Australia, Kenya.	Social vulnerability	floods	Countries	Mixed methods
WRI,2009	General	Social Vulnerability	Floods	Global	Theory driven

The mixed approaches used for reviewing the frameworks entailed theory driven approaches and data driven approach. Theory driven approach heavily relied on conceptual frameworks to guide selection of indicators while, data driven approach obtained its results from available datasets.

Comprehension of the linkage between climate variability and extreme events is crucial for future planning. Climate change scenarios have continuously shown that extreme events in East Africa such as floods should be expected under the context of climate change. Informal settlements which happen to defy all the urban planning development regulations stand to be affected most because of the poor infrastructure in the area and poor environmental management practices. The frameworks and strategies to enhance adaptive capacity should be people centred to promote sustainability and positive behavioural change amongst the community members. The following areas should be taken up for further research so as to seal the research gaps noted from the review: the definite climate attribution of anthropogenic factors that bring about climate variability and how gender disaster crunch and release model can be transformed to be a more people centred approach so as to empower communities to develop sustainable solutions that can help them avert climate related disasters such as floods.

CHAPTER 3: STUDY AREA, DATA AND METHODS

This chapter discusses the study area, research design, population size and sampling design, data collection methods, research procedures and data analysis methods.

3.1 Study area

3.1.1 Location

Mukuru kwa Reuben is located at the south eastern side of Nairobi County and is part of the larger Mukuru informal settlement that constitutes of 7 other sections. The sections include Mukuru kwa Njenga, Sinai, Paradise, Jamaica, Kingstone, Mariguni and Fuata Nyayo. It's situated at Embakasi South as illustrated on Figure 3.1, Mukuru kwa Reuben informal settlement has been in existence for over 35 years in the Nairobi industrial District (Centre, 2017). The land titles for the area were issued to private developers for construction in the early 90s but development of the area never took place as stipulated by land laws which require state industries be put up within two years of being acquired (The University of California., 2014). Eventually, families occupied the vacant land and created the informal settlement for industrial workers who landed jobs in the Nairobi central business district and adjacent industrial zone that borders the informal settlement.

According to the 2009 Kenya Population and Housing census, Mukuru informal settlement has an estimated population of 228,585 people and 84,451 households (Kenya National Bureau of Statistics, 2010). However, population projections place the population to be at 527,526 people and 193,539 households (KNBS, 2019). Mukuru kwa Reuben is located in the vicinity of the industrial area, and it is frequently exposed to the challenges of rampant insecurity, fire, floods, sanitation, hygiene and diseases according to Ruben centre strategic plan for Mukuru community.

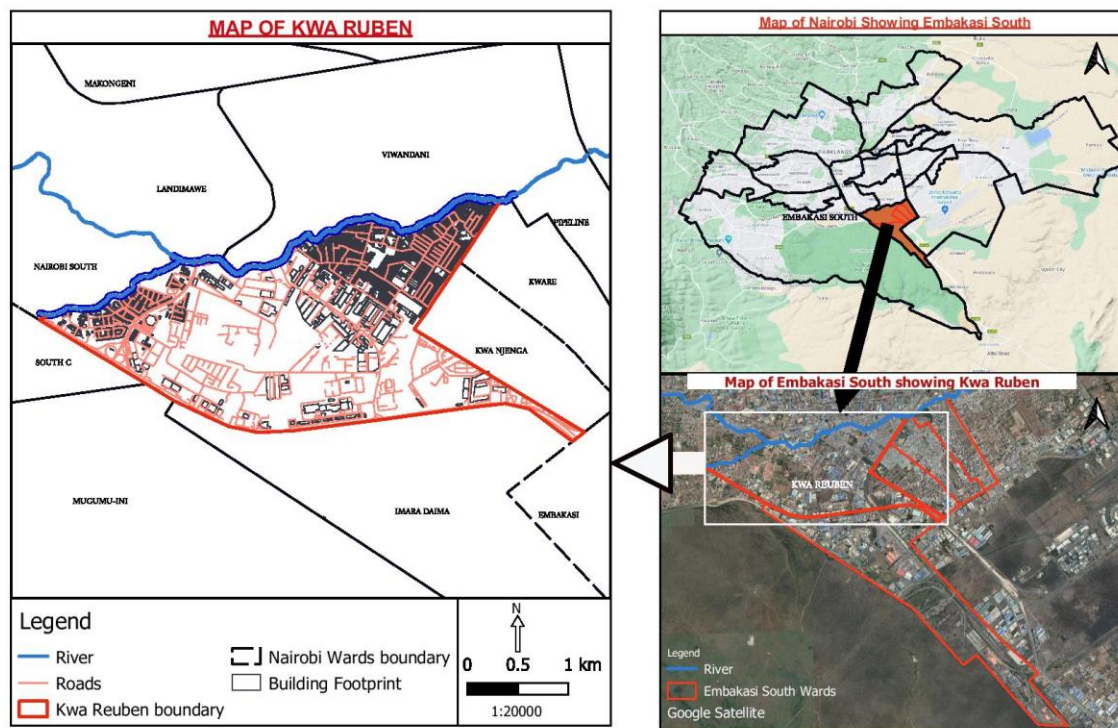


Figure 3-1: Map of Mukuru kwa Ruben (Author, 2019)

3.1.2 Biophysical Setting

3.1.2.1 Climate

Mukuru kwa Reuben receives an average rainfall of 900 mm per annum (Otiende, 2009). However, under the context of climate change scenarios in East Africa region, the 900 mm per annum average and rainfall intensity are likely to go higher (Cook & Vizi, 2013). The area also experiences two seasons of rainfall; the long rains that occur in March to May and the short rains that take place from October to December. Both seasons bring about adverse impacts from flooding in the area. Some years such as 1997/1998 have had the area experience above normal rainfall hence more flooding (Owuor, 2015).

3.1.2.2 Vegetation

The area is scarcely covered by natural vegetation. This can be attributed to the construction of rental structures in the area to cater to the large population in the locality (Sharon & Etich, 2010). The lack of substantial vegetation cover has extended to the riparian lands that are normally covered with vegetation. As a result, it has become increasingly difficult to mitigate flood impacts to the residents. Vegetation help in

reducing the velocity of the storm water runoff. However, the desire to settle as many people as possible in the area has deprived the residents there of a very vital natural flood mitigation measure.

3.1.2.3 Land uses

Mukuru kwa Reuben is characterized by urban farming, human settlement and quarrying sites which are being converted to open dump sites for all manner of waste streams. Urban farming in the area mainly rotates around pig rearing and some food crops such as vegetables that are grown mostly in selected schools. Due to the nature of the housing structures, Mukuru informal settlement has one of the most affordable house rates in the entire Nairobi City, tenants pay between 700 Kenya shillings to 1200 Kenya shillings for house rent per month (Ruben centre, 2017), therefore, the dense population in the area is attributed to the affordable housing rents. When flooding occurs in the densely populated areas, communities suffer high risks of displacement, death, loss of properties and diseases outbreak.

Affordable housing is the most popular land use activity that is widely practised. Plots go for sale for as low as 5,000 kshs, and people put up rental structures that can accommodate the large numbers of people flocking the area. They are one-roomed houses, and they don't have proper sanitation.

3.1.2.4 Physiography and Drainage

Since Mukuru kwa Reuben slowly began to grow into a settlement in the 90s, the planning for its drainage infrastructure has not been included in the Nairobi City plans. It is only until recently, that some of the drainage infrastructure has been put in place so as to accommodate the huge population residing there. The area has an undulating landscape. The undulations aren't natural; most have been artificially formed. These formations are common in sections where they experience lots of flooding, hence distorting the natural topography of the area. The affluent areas at Mukuru kwa Reuben have been elevated by soil to make them higher than the rest of the places so as to avoid the devastating impacts of floods. This method has successfully created artificial hills and valleys in the area. The Ngong River, which is a tributary of Nairobi River and forms part of the border between Mukuru kwa Reuben and Sinai informal settlements, suffers high waste discharge. Inadequate drainage systems make it hard for excess water to

flow towards Ngong River that would make it possible for the area to avoid flooding. The gentle slopes heading to the river coupled with the structures adjacent to it on most cases tend to be greatly impacted by floods.

3.1.2.5 Water resources

Results from water studies reveal, less than a quarter of the population of Mukuru kwa Reuben had access to clean piped water (Drabble, 2018). Nairobi City Water and Sewerage Company (NCWSC) is the body responsible for water distribution within Nairobi County. Most of the treated water by NCWSC could not be accounted for once it got to the Mukuru informal settlement network. This could be attributed to the numerous illegal connections that exist within the area.

3.1.2.6 Biophysical vulnerabilities

The high population of residents along the river exposes the people living there and adjacent areas to flood hazard. Riparian land adjacent to the river is meant to act as a buffer and first line of defence in stopping the pluvial floods. Settlement in the riparian reserves and other areas with ecological fragilities such as steep slopes and former quarrying sites only tend to expose the community more to the vulnerabilities of natural disasters such as flooding. The occupation of the hazardous spots within the area, hinder the population from accessing some vital services for their wellbeing such as health services or even hinder aid organizations from reaching them in good time whenever flood events occur.

3.1.3: Socioeconomic Setting

3.1.3.1 Political, administrative context and regulatory framework

Mukuru kwa Reuben has a single County ward; Kwa Reuben County Assembly ward that elects a representative to represent them at the County Assembly. It is also an administrative zone by itself, and is served by a Chief who looks into the matters of the residents in the location. The Chief is assisted by two Assistant Chiefs who head the sub-locations. There is also the presence of elders and chairmen or chairladies at the village level. Each village has three elders, a chairman/chairlady and a youth representative elected by the community to administer issues at the village level mostly concerning security, housing infrastructure and maintenance of internal rules (Centre for Urban Research and Innovation, 2013). During flood events, the governance hierarchy have to work in harmony to ensure their constituents are not affected adversely by the impacts

of the floods. Through the hierarchy systems in place, it's easy to lobby for help from government to set up projects that can reduce flood risks (World Bank, 2012).

The governance hierarchy of the study area is headed by the Chief who falls under the Office of the President. He has two Deputies who lead the sub-locations and are further assisted by the community leadership consisting of the village elders, village chairmen/chairladies and youth representatives. Their role during floods is to mobilize the community and share flood warnings through village barazas and help in evacuation and distribution of relief aid whenever there is a flooding event (Centre for Urban Research and Innovation, 2013). The area is also represented at the legislative level by Member of County Assembly (MCA) at the County Assembly and by a Member of Parliament at the Parliament as a representative for Embakasi South constituency. Their roles are in the formulation of laws pertaining disaster risk reduction both in the National Assembly and the County Assembly (The Government of Kenya, 2010).

3.1.3.2 Economic setting

Figures contained in the 2015 Economic Survey of Kenya pointed out that the economy of Kenya shrunk and as a result, the cost of living went up. The proximity of the industrial area to the settlement has increased the opportunity for job absorption rate of the residents especially the seasonal jobs that award wages. However, during flood events, the devastating impacts such as destruction of vital infrastructures such as roads and bridges make it difficult for those employed to access their workplaces. For those who are self-employed, it becomes difficult to carry on with their livelihood as usual (The University of California., 2014). The predisposed condition that they find themselves in can only amplify their problems, since they will be lacking a source of income to cater for needs such as purchase of potable water, food and even access to health care for their households.

3.1.3.3 Health setting

The dense population in Mukuru kwa Reuben in a small area has led to increased waste generation. The negative repercussion that occurs as a result of the waste generation and poor waste disposal is the pollution of clean water of Nairobi River. This compromises the water quality in the area. Being an informal settlement, the basic

sanitation measures such as clean water, sufficient working toilets and proper drainage systems for the waste are not fully established (Sharon & Etich, 2010). As a result, the area is prone to water-related diseases such as dysentery, cholera, and bilharzia. Flood events are more likely to exacerbate the intensity of water borne diseases within that community. The common health facilities in Mukuru kwa Ruben are chemists and clinics. An increase in the intensity of the water borne diseases as a result of floods may overwhelm the formal health system in the locality (The University of California., 2014).

3.1.3.4 Socioeconomic vulnerabilities

Hydro geologically speaking, Mukuru kwa Ruben lies along Nairobi river tributary called the Ngong River which flows southeast and cuts across Nairobi industrial area. It has a hilly terrain that creates a conducive environment for some areas to be converted into illegal dumpsites due to inadequate environmental and public health policies, regulations and laws by Nairobi City. Poor housing structures have been put up, just few meters from the river and others in the valleys and the hills available in the area. This exposes the people residing there to the impacts of floods whenever there is a flood event. Disrupted livelihood means during flood events further expose residents to health vulnerabilities (The University of California., 2014). This creates a huge burden for the community to manage some of the impacts brought about by floods.

3.2 Data

The study used primary and secondary data. The secondary data comprised of rainfall data, while primary data were from a household survey and observations and pictures taken during a transect walk.

3.2.1 Secondary Data

3.2.1.1 Climate data

Monthly rainfall data was obtained from Kenya Metrological Department (KMD) for the period 1985 to 2017 from Jomo Kenyatta International Airport (JKIA) meteorological station. JKIA is the station closest to the study area, Mukuru kwa Ruben.

3.2.1.2 Policies data

Existing National and County policies and gazetted legislations such as: The National Environment policy of 2013, Draft National urban development policy of 2012, The Draft National disaster management policy of 2010, The draft Nairobi Integrated urban development master plan, The Kenya constitution of 2010, The National environment

management and coordination act , The Nairobi city county disaster and emergency management act of 2015 and Urban areas and cities act were obtained from the relevant institutions' websites.

3.2.2 Primary data

The primary data was collected through household surveys and key informant interviews (KIIs).

3.2.2.1 Household Surveys

The total population of the households in the study area was 228,585 (Kenya National Bureau of Statistics, 2014). A representative sample was used in the study. The size of the sample, n , was calculated using the (Yamane, 1967) formula given in equation 1.

Equation 1

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size and e is the level of precision (0.05). This gave a sample size of 399. Out of the 399 household surveys done only 396 were completed. The other 3 were incomplete hence could not be used for this research.

The cluster sampling technique was used to ensure all the villages in Mukuru kwa Ruben were represented in this research. Gatope, Mombasa, Kisumu, Feed the children Kosovo and Rorie were then purposively selected for the study because they were identified as the most affected villages whenever it floods. Sixty six households were randomly selected for interviews in each village so as to get a representative outlook of the entire settlement.

The household survey was conducted using a questionnaire during the field visit (Appendix B). According to (Kothari, 2006), a questionnaire can be defined as a list of questions typed and printed in a certain manner and used on selected audiences to get feedback on a particular study. The questionnaire took a mixed approach whereby it had both closed and open-ended questions. To validate the questionnaire it was pretested with 30 households before the main research exercise, to determine whether the respondents resonated with the terminologies used on the questionnaire and also to confirm whether it was in line with the objectives of the study.

3.2.2.2 Key Informant Interviews

Twelve (12) key informants' interviews with local leaders, civil society representatives and executive committee members of the villages in the community, were done at the same time the household questionnaires were being administered. (Appendix C). The KII's were carefully selected amongst the community stakeholders who interact with the community in ways that may help avert flood risks in Mukuru kwa Ruben.

The key informants' interviews were held at various locations depending on the availability of those being interviewed. The data collected was transcribed and used during analysis.

3.3: Methods of analyses

3.3.1 Content Analysis

The qualitative data collected from the interviews and questionnaires was analysed by coding and searching for repetitive patterns and themes in the data using Microsoft Excel and SPSS (Abbott, 2017) All the repetitive themes were grouped together and their codes merged to make it easier for the analyst to make meaningful conclusions from the findings. The findings were represented in tables, charts and graphs. The charts and graphs were extracted from MS Excel toolkit, after feeding it with data from the questionnaires administered to the 396 households. 3 of the administered questionnaires weren't dully filled hence making them inadmissible for the research. The results revealed what the community perceived to be the drivers of flooding.

3.3.2 Trend Analysis

The trend in mean annual rainfall was established for the period 1985 to 2017. Trend analysis was done using the Mann Kendall test (Mann, 1945) and Sen's slope estimator (Sen, 1968) to help determine whether the existing trend is positive or negative. According to this test, the null hypothesis H_0 assumes that there is no trend (the data is independent and randomly ordered). This is tested against the alternative hypothesis H_1 , which assumes that there is trend. The M-K statistic is computed given in equation 2:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^n \text{sign}(x_j - x_i) \quad \text{Equation 2}$$

Note that if $S > 0$ then later observations in the time series tend to be larger than those that appear earlier in the time series, while the reverse is true if $S < 0$.

A positive value of S is an indicator of an increasing trend and a low negative value indicates a decreasing trend. The presence of a statistically significant trend is evaluated using Z value. The magnitude of a trend in a time series can be determined using a nonparametric method known as Sen's slope (Equation 3). A Sen's slope is defined as:

$$\text{Sen's slope} = \text{Median} \left\{ \frac{x_j - x_i}{j - i} : i < j \right\} \quad \text{Equation 3}$$

A $1-\alpha$ confidence interval for Sen's slope can be calculated as (*lower*, *upper*) where

$$\begin{aligned} N &= C(n, 2) & k &= se \cdot z_{crit} \\ \text{lower} &= x_{(N-k)/2} & \text{upper} &= x_{(N+k)/2+1} \end{aligned}$$

Here, N = the number of pairs of time series elements (x_i, x_j) where $i < j$ and se = the standard error for the Mann-Kendall Test. To estimate the true slope of an existing trend such as amount of change per year, Sen's nonparametric method was used and the test was performed using R software. A positive value of Sen's slope indicates an upward or increasing trend and a negative value gives a downward or decreasing trend in the time series.

3.3.3 Graphical approach

Graphical methods were used to display results obtained from statistical tests of trends in the time series. The huge quantity of information that can be displayed compactly makes it an appealing methodology for the display of statistical tests (Moses, 1987).

3.3.4 Desktop reviews

All the institutions that handle flood management in the County of Nairobi were identified from previous flood studies around the country and their roles documented. All the legislations; including Acts of parliament, policies strategies and framework were critically reviewed. Linkages were made between various institutions managing floods and the guiding legislations that they are supposed to adhere to. Gaps that hinder some of the community's efforts to cope with flooding from the legislations were identified. Opportunities that would enhance the coping strategies for the community were also explored and used to review the existing strategies to make them more effective to the community.

3.3.5 Developing strategies to enhance community's adaptive capacity to flood risk.

All the participants were asked to share their opinions on how best to enhance the community's adaptive capacity to flood risk in the household questionnaires and also during the KII's. Since the responses were qualitative in nature, they were grouped and themed together. MS Excel toolkit was used to facilitate the data entry and subsequent grouping of the themed responses to bring out some of the strategies that would enhance the community's adaptive capacity to flood risk.

Various strategic flood risk management frameworks were critically reviewed and compared to what the respondents had suggested from the Key informant interviews held during the study period.

Below is a table summarizing the methods and data that will be used for each objective.

Table 3-1: Summary of the data and methodologies used for this study

Objectives	Data	Methods
To determine the drivers of flooding in Mukuru kwa Ruben.	Household questionnaire and key informant interviews. Climate data: Monthly rainfall data was obtained from Kenya Metrological Department (KMD) for the period 1985 to 2017 from Jomo Kenyatta International Airport (JKIA) meteorological station.	Content analysis: Excel, SPSS toolkit. Trend analysis: Graphical approaches, Mann kendall and sen slope tests.
To identify the coping strategies to risks and flood impacts and establish their challenges and opportunities in Mukuru kwa Ruben.	Household questionnaire and key informant interviews. Policies: Existing National and County policies : The National Environment Policy of 2013, Draft National Urban Development Policy of 2012, The Draft National Disaster Management Policy of 2010, The National Housing Policy of 2004, The draft Nairobi Integrated Urban Development Master Plan (NIUPLAN), The Nairobi County Integrated Development Plan (NCIDP), 2014, The flood mitigation strategy of 2009	Content analysis: Excel, SPSS toolkit. Desktop reviews.
To develop strategies that will enhance the Mukuru kwa Ruben adaptive capacity to flood risk.	Household questionnaire and key informant interviews.	Content analysis: Excel, SPSS toolkit. Desktop reviews.

3.4 Conceptual Framework

Conceptual framework is an interlinked set of ideas showing the interconnectedness of parts of a particular idea. The framework helps to give an overall understanding of the causal patterns of interlinkages across events, knowledge, observation and other elements of experience (Svinicki, 2010).

The dispensation of climate change has brought about negative impacts that threaten human wellbeing and ecosystems. One of the negative impacts that some areas have been exposed to is the increased floods as a result of increased rainfall and its intensity. According to Amoako (2017), informal settlements, poor urban governance, socio-economic marginalization, rapid population growth and inhabiting of hazardous spaces in the urban spaces have been the main driving agents of informal settlements.

According to UNISDR (2016), flood vulnerability can be defined as the propensity of a particular community to be affected adversely by floods because of their exposure, susceptibility and lack of coping capacity. Flood vulnerability is prevalent in informal settlements of Kenya. To effectively deal with the flood risk in informal settlements, it's prudent for the communities to be able to enhance their adaptive capacity towards floods. This can be achieved by communities changing their perception on floods and invest more on preparing for it other than react to it.

Sustainable flood risk adaptation is the right mix of interventions taken by flood prone communities to ensure that the flood risk have been lowered (Bulti et al., 2019; Jongman, 2018). The interventions may include: structural flood protection, risk informed land planning, nature-based solutions, enhanced early warning systems, social protection and introduction of risk financing instruments.

Flood risk management strategy is a set of well thought plans that aim at minimizing the probability and consequences of the floods in a particular area. A flood risk management strategy that will be participatory and representative, will be sorting to address the issues pointed out and come up with a sustainable framework that will increase the community's adaptive capacity to floods.

Figure 3-2 below illustrated the conceptual framework from the study. It's been adopted from (Brooks & Adger, 2005; Daramola et al., 2016) who have conducted similar studies that have demonstrated factors that make a community to be vulnerable

to flooding disasters are a function of exposure, susceptibility, and resilience. The key drivers of climate change were determined by rainfall data of the area observed over a period of over 30 years and narratives from community members sharing their perception of climate change in the area and impacts from flood hazard they have been exposed to over time. This study looked at creating a sustainable flood risk adaptation as a way of enhancing the adaptive capacity for the community. To achieve this, the root causes, dynamic pressures and unsafe conditions are exhaustively discussed so as to know the severity of the flood risk in informal settlements of the project area. Thereafter, a framework is to be developed to evaluate the effectiveness of the interventions (Bulti et al., 2019). The results from the comparisons are to be compared against best practices that have excelled in communities with similar challenges so as to be refined further through a participatory approach to promote its sustainability.

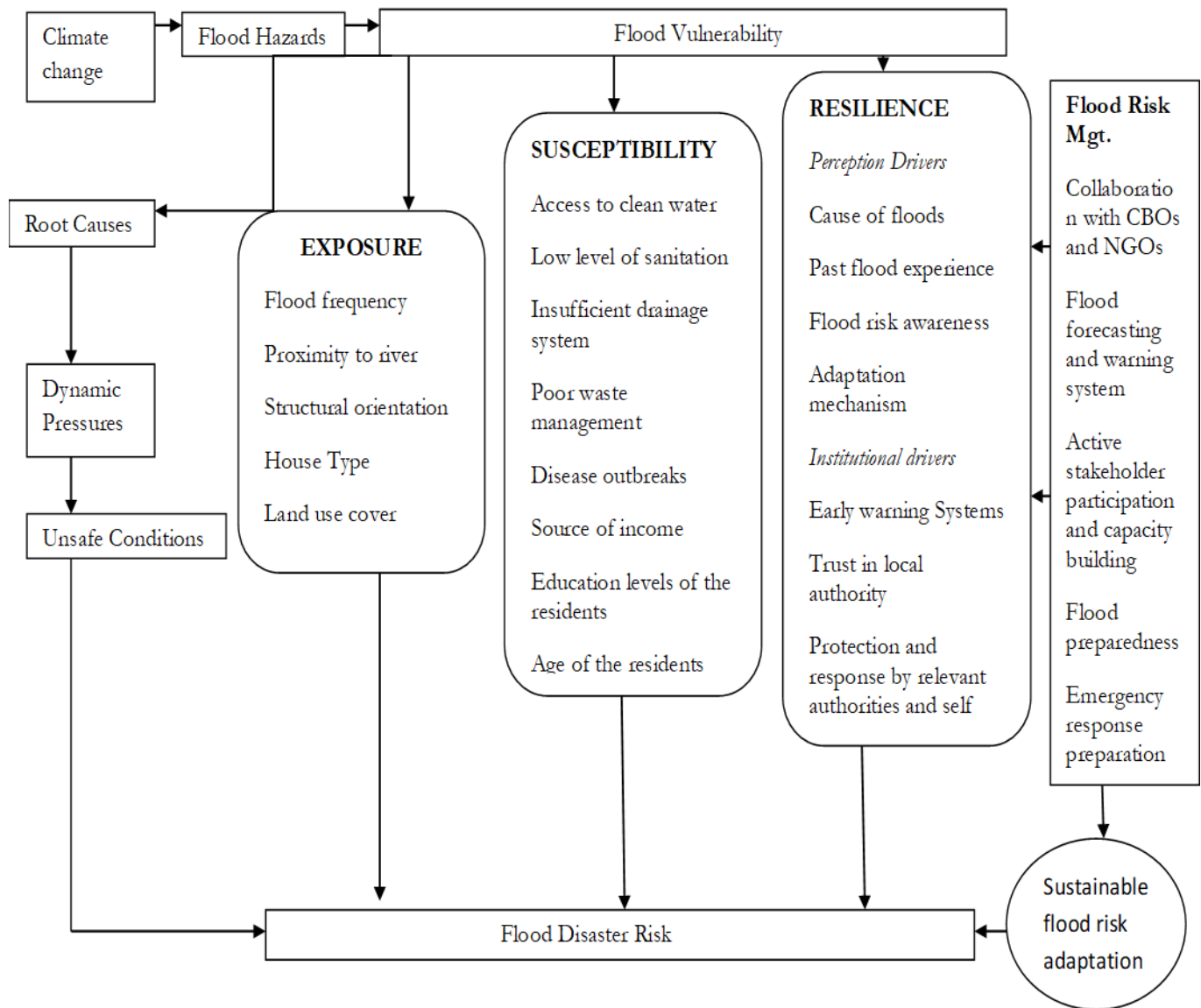


Figure 3-2: Conceptual framework of the study

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter focuses on the results obtained from the interpretation of the findings of the study. The number of questionnaires conducted to the community household was 396, bringing the response rate to 99.2% of the possible targeted of 399 respondents. The results and discussions are based on the three objectives of the study and are presented in both graphical and tabular forms.

4.2 Drivers of floods in Mukuru kwa Ruben informal settlement

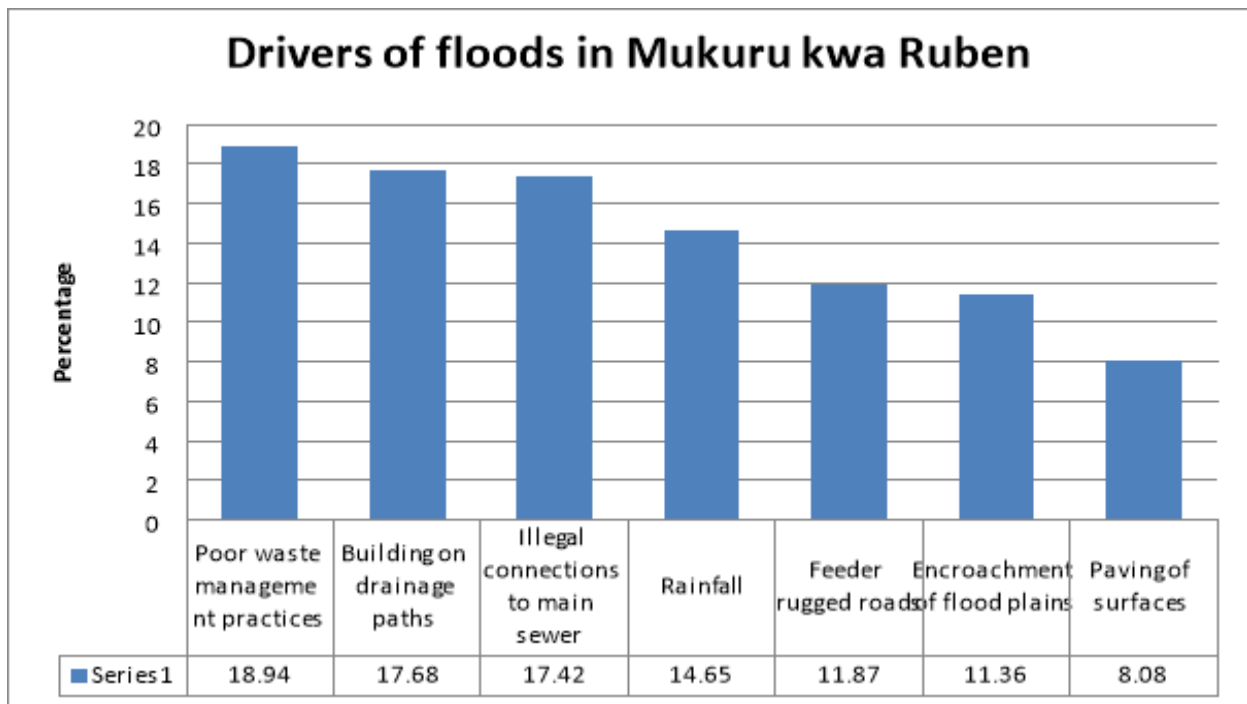


Figure 4-1: Drivers of floods in Mukuru kwa Ruben

Poor waste management practices in Mukuru kwa Ruben is the major driver of floods as shown in (Figure 4-1). 17.4% of the respondents identified illegal connections to the main sewer line while 17.7% are of the opinion building on drainage paths are also drivers flood in Mukuru kwa Ruben. The other highly ranked driver to floods in the study area was illegal connections to the main sewer 17.4%. The main sewer in the study area is quite narrow and can't effectively serve the current population that

resides there. As a result, emergencies of illegal connections have sprouted up which channel household wastes towards the main sewer. Whenever the sewer is overwhelmed it brings about sewer floods as explained in section 4.2.1.3.

4.2.1.1: Poor waste management practices.

The designated dumpsite for Mukuru kwa Ruben is stationed at Bins. However, due to the increased population, the dumpsite can't accommodate all the waste. Results from the survey conducted revealed huge chunks of the designated dumpsite had been taken up by wealthy local leaders who convert it from a dumpsite to a more profitable venture like settlement structures. As a result, haphazard dumping in Mukuru kwa Ruben has become the new norm. The haphazard dumping has led to clogging of available drainages, which in turn block the storm water when passing through them hence resulting to floods.

4.2.1.2: Building on drainage paths

Some of the housing structures in Mukuru kwa Ruben have been built on drainage paths. This blocks the storm water from flowing freely towards the river where it's normally drained. Instead, the storm water piles up and results in flooding of the adjacent areas nearby. Interviews with key informants disclosed that, some village chairpersons and government officials collude to permit construction of structures on drainage paths for a fee.

4.2.1.3: Illegal connections to the main sewer

Mukuru kwa Ruben does not have a proper sewer system that is protected from flooding. Most landlords in the area have created makeshift drainage pipes and tunnels from the houses which are connected illegally to the main sewer. When the gutter is full, it tends to force the storm water back to the drainage pipes and tunnels which take them back to the source of origin which is the houses.

4.2.1.4: Rainfall

Rainfall is the source of floods in Gatope, Mombasa, Kisumu, Feed the children, Kosovo, and Rorie villages in Mukuru Kwa Ruben. However, rainfall doesn't bring about the floods in Mukuru kwa Ruben. However, other factors such as building on drainage paths, encroachment of floodplains and poor waste management practices they bring about conducive environment for flooding when exposed to rain. As much as excessive

rainfall that is recorded as above normal seldom occurs, respondents indicated that normal rainfall in Mukuru kwa Ruben still manages to trigger floods in the area.

The MAM rains have not been consistent over the years. The highest ever recorded rainfall amount as obtained from the graphical analyses of the time series of rainfall records was 525 mm in the year 1986. 1997 and 1998 were the other years that high rainfall was recorded, 433.7 mm and 490.2 mm respectively. This heavy rainfall could be attributed to the El nino rains that took place during the 1986/87 and 1997/98 in Kenya. The lowest recorded rainfall during the period of study was 76.7 mm in 1993 due to the 1992-93 drought (Huho & Mugalavai, 2010) Similarly, the OND rains have had an intermittent occurrence over the years. The highest recorded rainfall during OND rains was 567.7 mm in 1988, 572.7 mm in 1997 and 453.6 mm in 2015. The 1997 and 2015 high rainfalls could be attributed to the El Nino rainfall that took place around that period in the country. The lowest recording was at 73.3 mm in the year 2005.

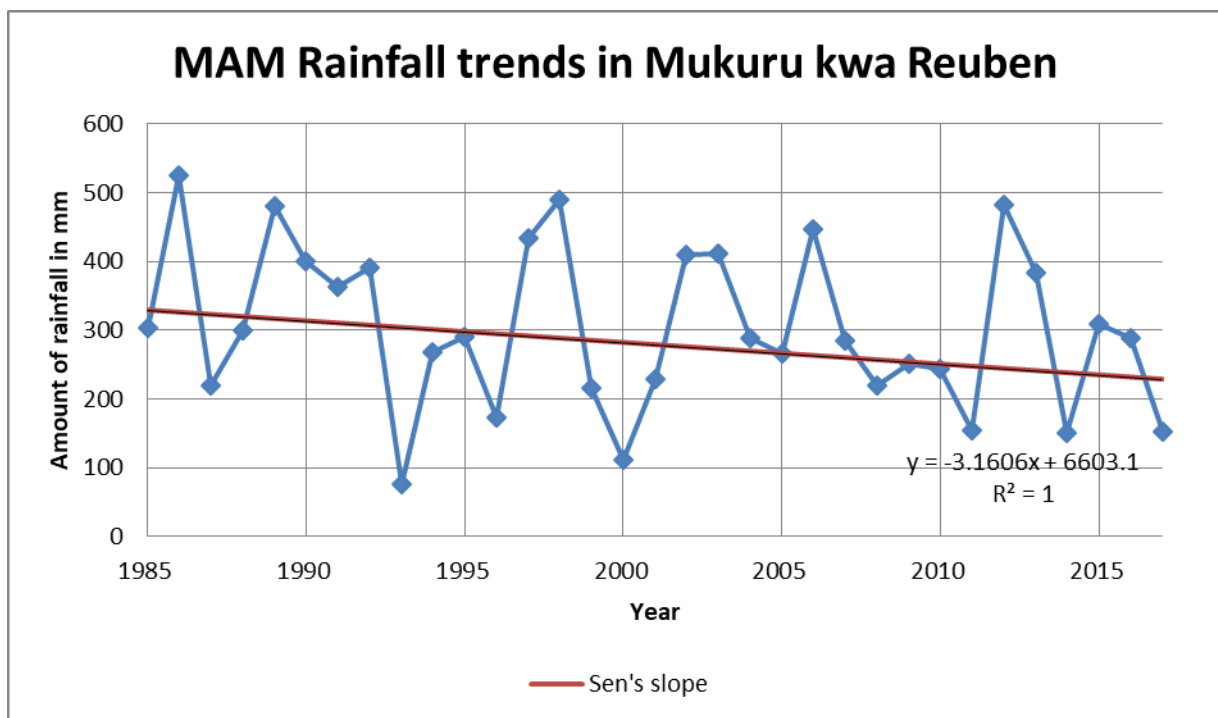


Figure 4-2: Time series showing the trend of MAM rainfall in Mukuru kwa Ruben

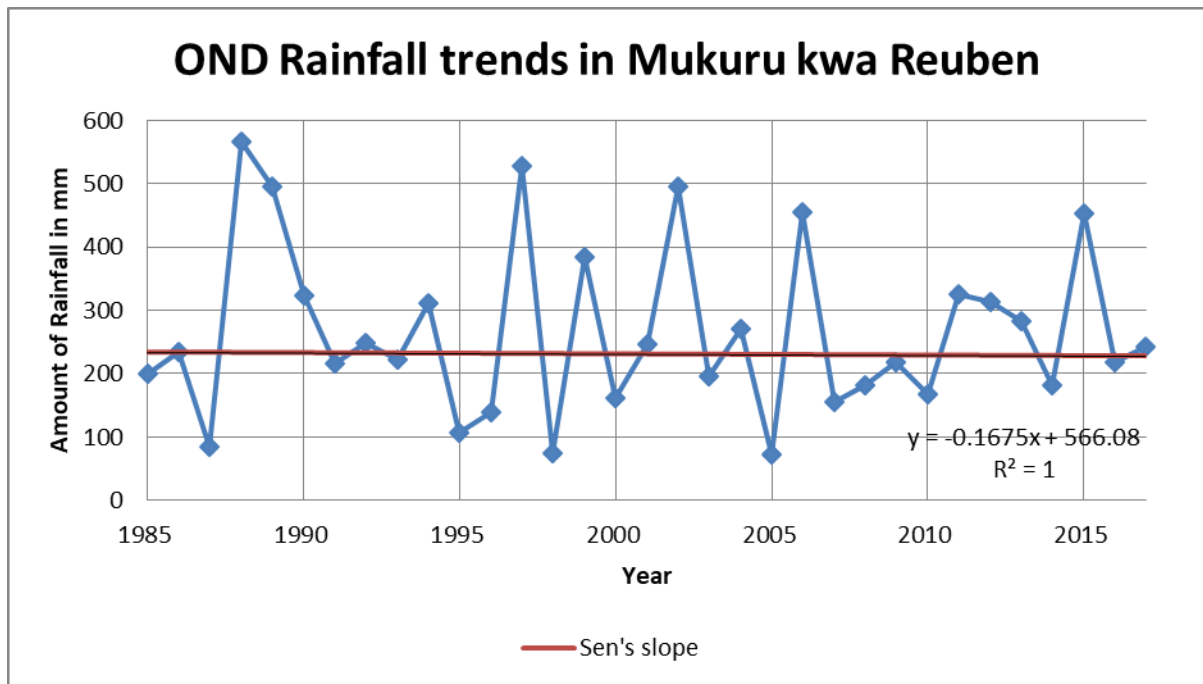


Figure 4-3: Time series showing the trend for OND rainfall in Mukuru kwa Ruben

The results of the trend analyses are presented in Figures 4-2 and 4-3 and Table 4-1. If the p value is less than the significance level ($\alpha=0.05$), then the trend is significant. Table 4.6 shows that the rainfall for both seasons had a non-significant decreasing trend ($p = 0.159$ for MAM, $p = 0.938$ for OND). This is confirmed by the Sen's slopes shown in Fig. 4.3 and Fig.4.4. These results compare with the results of Cabral Júnior & Lucena (2020) which infer that the variability in precipitation may be attributed to an inherent characteristic of different conditions (geographical location, oceanic influence, and atmospheric conditions), typical of the tropical climatic region and not necessarily a change in the rainfall's behavior; some years are rainier and others less so, and there is a slight monthly and annual temporal variability.

Table 4-1: Mann-Kendall tests for MAM and OND rainfall in Mukuru kwa Ruben

	Sen's slope	S	Var (s)	P value	Tau	Alpha	Interpretation
MAM	-3.161	-92.000	4165.3333	0.159	-0.174	0.05	Accept H_0
OND	-0.167	-6.000	4165.3333	0.938	-0.011	0.05	Accept H_0

4.2.1.5: Feeder rugged roads

Flood events may be exacerbated by the numerous feeder rugged roads that have been created as a result of the several structures that have been put haphazardly. The respondents believed broader and smoother roads aided the storm water downwards towards the river. However, rugged trails that had sprout everywhere gave the rainwater some form of a reroute and led the storm water directly to the structures destroying their property and in extreme cases force them to leave their houses to stay alive. Vehicles can rarely get access to these roads and when floods do take place reaching to these sites can be extremely problematic considering the high heights the water levels get.

4.2.1.6: Encroachment of flood plains

The geographical location of the informal settlement squarely places it adjacent to the downstream side of the Ngong River. Increased population pressure in Nairobi County has forced developers to look for more prime areas such as Langata and Madaraka estates to set up their developments. Floodplains are sensitive ecosystems due to their unique ability of acting as storage for flood waters. Development in this area tends to reduce the storage capacity of the flood waters and as a result causes displacement of the floodwaters by causing higher peak flows and potentially redirecting the excess waters downstream. According to the responses noted during the interviews with respondents and key informants, the downstream of Ngong River tends to break its walls and cause floods whenever heavy rains are experienced in Nairobi County.

4.2.1.7: Paving of surfaces

Most of the sidewalks in Mukuru kwa Ruben are paved. This makes it impossible for the storm water to percolate. As a result floods are generated and depending on the topography of the area it can either affect the immediate surrounding or go further down to settlements put up in the lowly placed areas.

4.2.2: Impacts of floods in Mukuru kwa Ruben

4.5.2.1: Duration of the floods

65.5% of the respondents stated that generally the duration of floods exceeded 5 days as shown in the figure 4-4. The duration of floods in this study was the period storm water and in some cases water mixed with waste in the case of sewer floods, remained suspended on the surface.

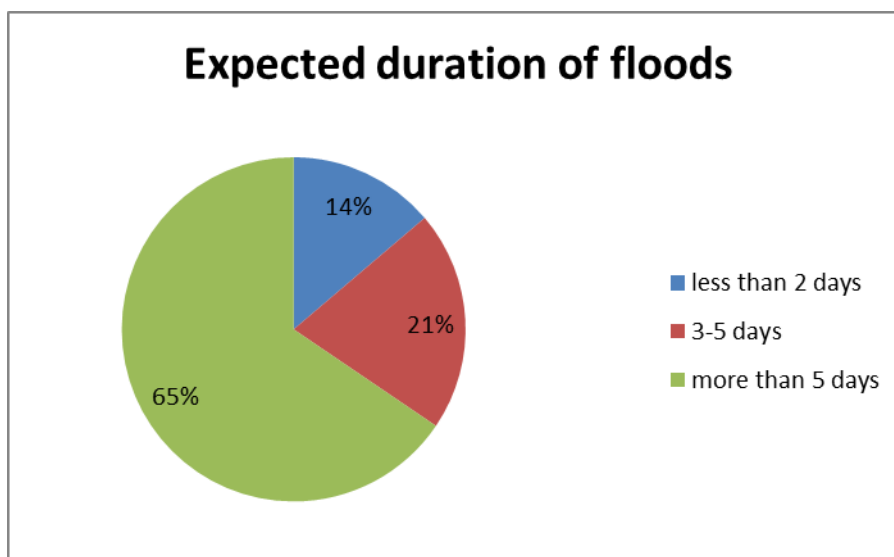


Figure 4-4: Expected duration of floods in Mukuru kwa Ruben

This may partly explain why aid from both the local authorities and even some non-governmental institutions who have a mandate of coming to the rescue of people affected by flood disasters takes relatively a long time to reach the residents of Mukuru kwa Reuben, or in some cases don't seem to offer any help to the affected community the flood prone villages in Mukuru kwa Ruben don't have a direct access because of poor road infrastructure. (Table 4-6). Findings from the study confirmed that the length of time that aid during floods disasters took before it got to the community was at least a week. According to the international safety standards, flood-prone areas with more extended flood duration must have infrastructure that makes it accessible to enhance the safety of the inhabitants (FEMA, 2010).

4.5.2.2: Economic Losses

Table 4-2: Occupation of Mukuru kwa Ruben residents

Occupation of Respondent	Frequency	Percentage
Self Employed	205	51.77
Employed	119	30.05
Unemployed	72	18.18
Total	396	100

Floods in Mukuru kwa Ruben bring about devastating economic impacts to the residents. As shown in (Table 4-2), 80% of the population engages in some sort of trade to help them meet their living standards. A huge number of the jobs undertaken by those who reside in the area are paid in form of daily wages. Those unemployed are dependents in the community but grab every opportunity they can get to try and generate some income for their survival. When flood events take place and cover all the roads that they would use to get to work in good time, they end up losing on the opportunity they would have made for that day. Depending on the period flood stays, it makes it hard for businesses to operate as usual. Those who are self-employed end up not getting customers to clear their stock. As a result the propensity to spend for many families is negatively affected.

4.5.2.3: Outbreak of diseases

Water borne diseases such as typhoid, cholera and malaria are the most prevalent diseases in Mukuru kwa Ruben whenever flood events occur (Table 4-3). Scarce sanitation structures and close proximity of potable water pipes and sewer lines explains the prevalence of typhoid and cholera across various households in Mukuru kwa Ruben.

Table 4-3: Frequency of disease outbreak during flood events

Diseases that come about during flood events	Frequency of their infections in percentage
Typhoid	38.79
Cholera	36.21
Malaria	12.07
Pneumonia	9.48
Flu	6.90
Diarrhea	4.31
Skin infection	3.45
Swollen feet	2.59
Itching legs	2.59
Coughing	1.71
Bilharzia	0.86

Malaria was also ranked as one of the common diseases in Mukuru kwa Ruben whenever flood events occur, Table 4-3. This could be attributed to conducive breeding grounds for the mosquitoes to hatch during floods. Lack of sufficient protective material such as mosquito nets exposes the residents to the exposure of the disease.



Figure 4-5: Potable water pipes passing through a waste leachate in Mukuru kwa Reuben (Author, 04/18/2017)

Most of the potable water consumed at Mukuru kwa Reuben is tap water that is placed at designated places, where residents go and purchase for 5 Kenya shillings per 20 liters. Findings from some key informants disclosed that most vendors use electric pumps to pump water into the storage tanks that store the water that is then sold to the residents of Mukuru kwa Reuben. Most potable water pipes that fill the water storage tanks have been installed alongside sewer lines of Most of the residential houses in the area. More often than not, the potable water pipes are broken and shoddy repairs administered to them entail sealing the broken parts with rubber bands. After sometime, the rubber loses its firmness and makes it easy for the sewer water which is contaminated to infiltrate the pipes. When this water reaches the user at the household level who rarely treats it before drinking, they get exposed to diseases such as typhoid and cholera. With access to health facilities almost impossible during flood episodes in the area, the residents of Mukuru kwa Reuben are subjected to acute suffering and in some instances loss of lives of those affected because of the effects that have been brought about by the diseases.

4.3: Current coping strategies to flood risks employed by the community.

Responses from the household surveys and key informant interviews coupled with observation during the transect walk transect confirmed that there is some use of fundamental practical improvements within the houses and the surrounding that help reduce the impacts of the expected floods.

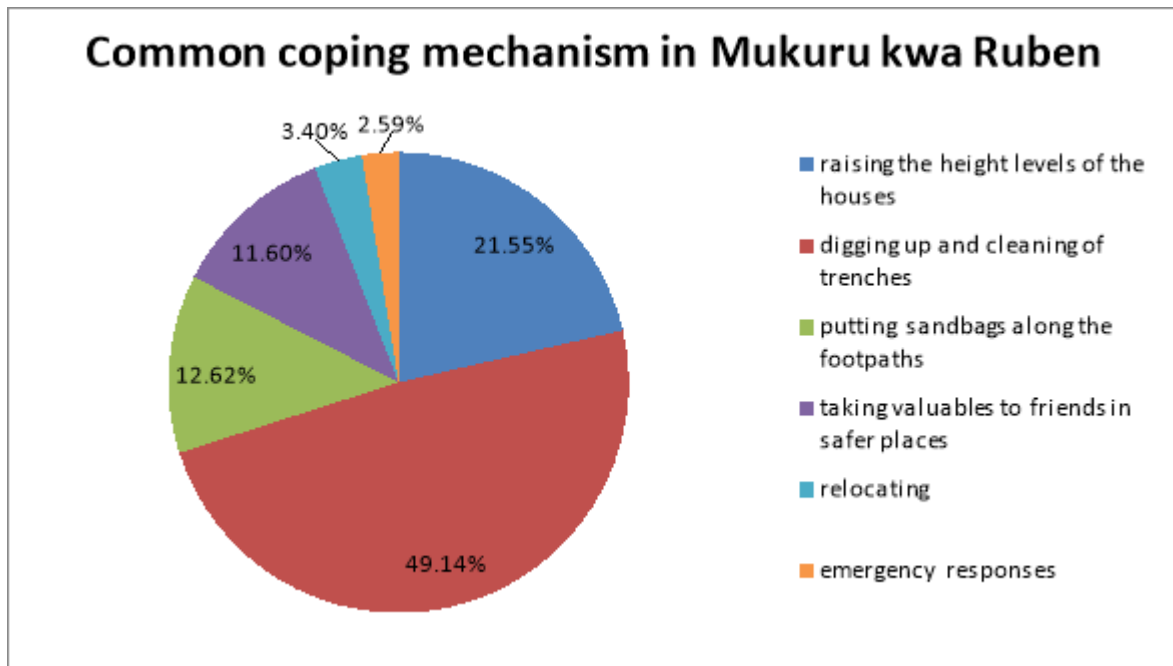


Figure 4-6: Common coping mechanism in Mukuru kwa Ruben

4.3.1: Raising the level of houses

Most houses are put up on very fragile soils which are characterized as those with a high susceptibility to mass movement. Continuous exposure to floods makes them sink (Fig 4-7) and as a result make them susceptible to being affected by storm water whenever there is a flood event.



Figure 4-7: One of the house structures in Mukuru kwa Ruben which sunk (Author, 20/04/2017)

One of the most effective coping strategies adopted to deal with the situation has been to raise the floors of the houses some meters higher. This is aimed at helping the tenants avoid storm water enter into their premises whenever there is a flood event. However, as much as this intervention has proved over time to be very effective in the area only a few people are able to do it as it's inhibited by house tenure occupancy. From the survey results, 84.6% rented their houses and only 15.4% owned the houses they lived in.

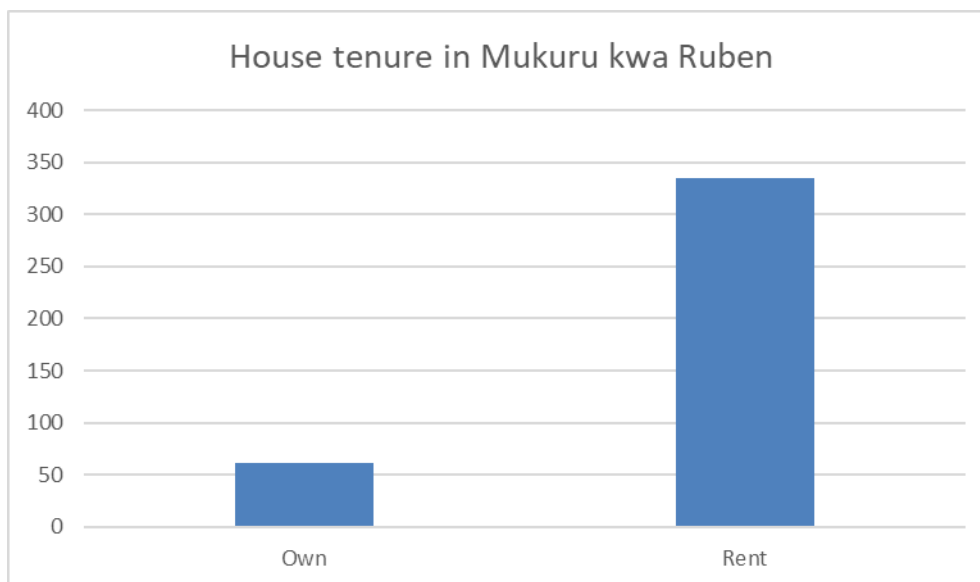


Figure 4-8: Housing tenure in Mukuru kwa Ruben

4.3.2: Digging up trenches



Figure 4-9: Mukuru kwa Ruben resident digging and clearing a trench near her house (Author, 18/04/2017)

Some of the residents in Mukuru kwa Ruben dig up trenches and clean up existing ditches to help create a pathway for the storm water to be drained into the river (Figure 4-9). The digging and cleaning of the trenches, require that the waste acquired from there and the soil to be dumped in a designated place, preferably a dumpsite. This is another intervention that has some level of success in the community as it's a personal initiative that can be replicated by community members and bring about some reprieve from the detrimental impacts floods bring along. An interesting observation that came out from the research was those respondents with some level of basic education had taken this up but those with no basic form of education didn't take up this intervention as a coping mechanism to floods and for those who had taken it up, they weren't doing it in the correct manner. Table 4-4 below shows the level of education of respondents in Mukuru kwa Ruben.

Table 4-4: Level of education of the respondents in Mukuru kwa Ruben

Characteristic	Distribution	Frequency	Per cent %
Highest Level of Education	Primary	186	46.97
	Secondary	126	31.82
	Tertiary	42	10.61
	No basic education	42	10.61
Total		396	100

However, since there is no functional waste management service in the community, the debris and waste cleared from the trenches are left just a few meters from where they were got. The trenches and drainages get to work for a while but soon get clogged up once all those wastes and debris find themselves back to where they were previously after being pushed their by winds and rains. As a result, flood events keep on recurring.

4.3.3: Putting sandbags along the path

Sand has a unique property of being porous. The storm water that comes into contact with the sandbag, is accorded the chance to seep into the sand and is denied the opportunity to occupy the space at the surface (Figure 4-10). This strategy helps people create walk pathways to get them to various destinations in the midst of floods. The coping mechanism also helps protect the residents from storm water which would normally infiltrate the houses through the door by ensuring the water doesn't get into the houses.



Figure 4-10: Sandbag placed along a path to ease movement in Mukuru kwa Ruben (Author, 18/04/2017)

4.3.4: Taking their belongings for safekeeping to neighbours in safer places

Whenever flood events occur, some members of the community take great advantage of the situation and break into abandoned houses to steal the belongings of those who have gone to take refuge at safer places. As a coping mechanism to both the floods and the thieves, those who take up this approach carry valuable items and give them to their friends who are in flood free areas for safe keeping until when the waters subside and they are able to come back and pick up life from where they left it.

4.3.5: Relocating to other areas

Table 4-5 shows the resilience of the community members in Mukuru kwa Ruben and those who had stayed there for more than 11 years demonstrated by their high resilience levels to floods. Those who had stayed there for less than 5 years appeared to be less resilient to floods events. However, those who had stayed there for more than 5 years appeared to have taken a coping mechanism of relocating to other areas that they felt were less exposed to flood events. The table below shows the relationship between developed resilience during floods versus the period residents stayed in Mukuru kwa Ruben.

Table 4-5: Resilience levels of Mukuru kwa Ruben based on the length of their stay in the area

Number of years stayed	Frequency	Residents who remained during and after flood events %
1-5 years	65	16.41
5-10 years	26	6.57
11-15 years	51	12.88
More than 15 years	178	44.95

4.3.6: Emergency responses

Emergency responses during floods in Mukuru kwa Reuben are imperative. The groups that come forth during the emergency periods play a major role of getting the affected persons to be able to start over after being adversely affected by the floods. Organizations such as Kenya Red Cross used to offer food and blankets initially but they have changed their system to offering the affected money that they can use to restart their lives. Currently, 7.8% of the respondents acknowledged having seen Kenya Red Cross Organization coming through during flooding period in their area. Majority of the respondents, 79.3% said they have never seen any emergency response from an organization when they are faced with floods, and they often depend upon themselves to save themselves. Transportation infrastructure and emergency responses have a high positive correlation. The low levels of emergency response as reported by the respondents could be attributed to poor road infrastructure in Mukuru kwa Ruben. Most of the affected villages can be accessed on foot or with motorbikes. This makes it hard for those means of transport to be used whenever it floods; making the community lose out from emergency response they could get from various organizations. Table 4-6 shows the presence of various organizations as perceived by the community, in response to flood emergencies.

Table 4-6: Rate of emergency response by various entities in Mukuru kwa Ruben

Organization/ Groups	Percentage
Religious Organizations	0.86%
National Youth Service	1.72%
Community Organizations	1.72%
Local Administration	2.59%
Kenya Police	2.59%
Nairobi County Council	3.61%
Red Cross	7.76%
None	79.31%

4.3.7: Inhibiting factors to coping strategies to flood risks currently employed by the community.

Despite the negative impacts of floods that are typically experienced in Mukuru kwa Reuben, only a paltry 18.1% of the respondents alluded to making deliberate efforts to take up a combination of the above-mentioned coping strategies to protect themselves as illustrated in figure 4-11.

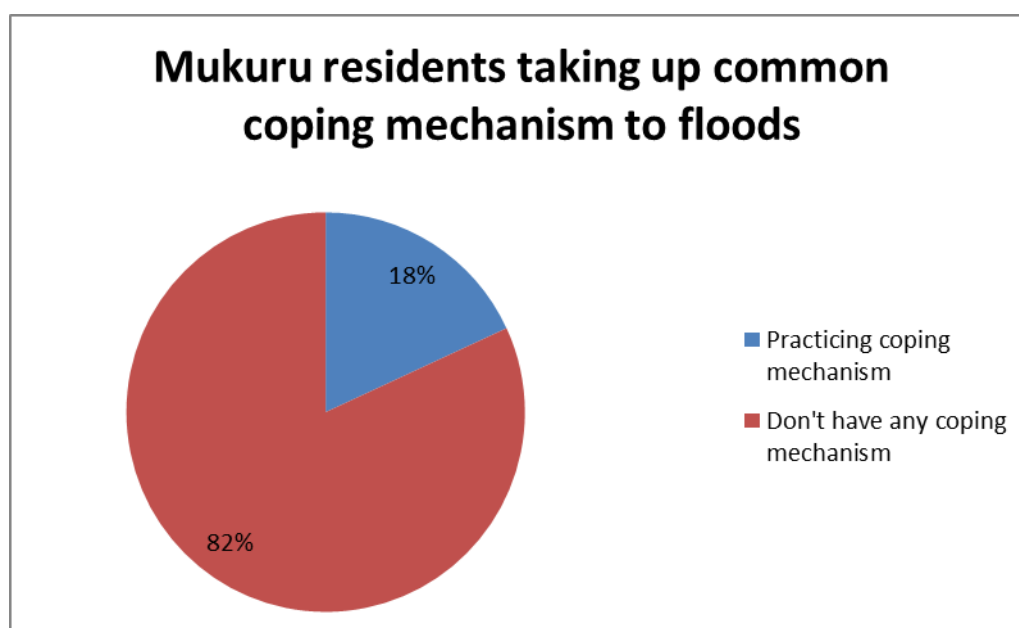


Figure 4-11: Percentage of inhabitants who employ any coping mechanisms to protect them from flood impacts

The result demonstrates two things. First, the high confidence that the inhabitants of Mukuru kwa Reuben have placed on hard adaptation measures such as infrastructures that can help aid with the flooding problem in their area. The hard adaptation measures are mostly expected to be effected by the National and County governments. The structural adaptation measures include: construction of houses built with stones and have proper drainage systems. Also, part of the structural adaptation measures desired by the community entails installation of culverts with wider width, an upgrade from what is available in the area at the moment Figure 4-12. The community believes that wide culverts can accommodate excess water that gets to pass through it towards the river and a dike to protect them from the occasional bursting of the Ngong River.



Figure 4-12: Culverts with thin width size in Mukuru kwa Ruben (Author, 18/04/2017)

Secondly, the result demonstrated a nonchalant approach amongst the inhabitants of Mukuru kwa Reuben. The awareness that they aren't the most affluent people in the society has made it extremely difficult for the inhabitants to take up low cost adaptation strategies that could protect them from the negative impacts of floods when they do strike them. Low cost adaptation strategies such as; raising the height levels of their houses, cleaning of trenches, avoiding dumping along ditches aimlessly, refrain from building along riparian land and on water paths are non-costly approaches that can be

taken up by communities to help them avert flood related impacts. A possible explanation given towards the poor attitude of the inhabitants is the low literacy rates and lack of exposure (Table 4-4). Sentiments that came out during the Key informant interviews is that there is always a camp of the illiterate and the literate and while suggestions such as low cost adaptation measures can be proposed during their meetings coming up with a consensus to adopt it more often than not proves to be a challenge. One of the key informants reported, "*Getting people to agree in Reuben isn't easy. There are two types of people; the learned and the unlearned. If any decision is to be implemented, the two parties must be presented but more often than not, a consensus is never arrived at. Eventually, you can find for example somebody can decide to clear the drainage system but when it gets to a particular area, the inhabitants there aren't always interested. They feel they should be paid to clean the drainage or the government should come and clear it for them. Whenever it floods, all the hard work done in the previous section of the drainage amounts to nothing and water find a way into their houses and destroy their belongings.*" (Key informant, 13.10.2018). The nature of house ownership also has made some people not to subscribe to engage in taking up some coping mechanisms such as raising the levels of the houses. Findings from the area indicated that only 15.40% of the respondents were house owners (Fig 4-8).

The 84.6% of those who rent have been disenfranchised the ability to engage in the particular coping mechanism of raising the level of the houses. A majority of the respondents who rent pointed out that their landlords aren't interested in raising the floor levels of the homes and when they do, they increase the rent. This may push some of their tenants away in an attempt to look for cheaper housing available in the area. Another notable observation was, to raise the levels of the houses; some of the contracted persons weren't doing it in the right manner. They avoided using pvc at the bottom to reduce on the high infiltration rate and opted to use soil and some stones and plastered the floor with cement then raised the roof and advertised the houses to unsuspecting tenants. The problem with this approach is that when the rains come, the storm water will continuously infiltrate the soil and after sometime weaken the floor slab and can now start getting into the house, and in some cases, the building may even start to go down further from the surface as shown by the diagrams below.



Figure 4-13: An image of a stranded child trying to cross to the other side of the estate (Author, 18/04/2017)

The most intriguing finding, however, was the slow uptake of relocating of inhabitants as a coping mechanism to escape from the negative impacts of floods in Mukuru kwa Ruben. Only 21.55% of the respondents admitted to relocate from their homes and go to safer places every time it floods. (Figure 4-14) This result was novel because of the devastating impacts that the inhabitants of Mukuru kwa Ruben are exposed to every time it floods and also because of the early warnings that they mostly receive from the local radio station, Ruben FM aired on the frequency 99.9. The radio station is a project of a Christian organization called Ruben center, which is managed by Christian brothers.

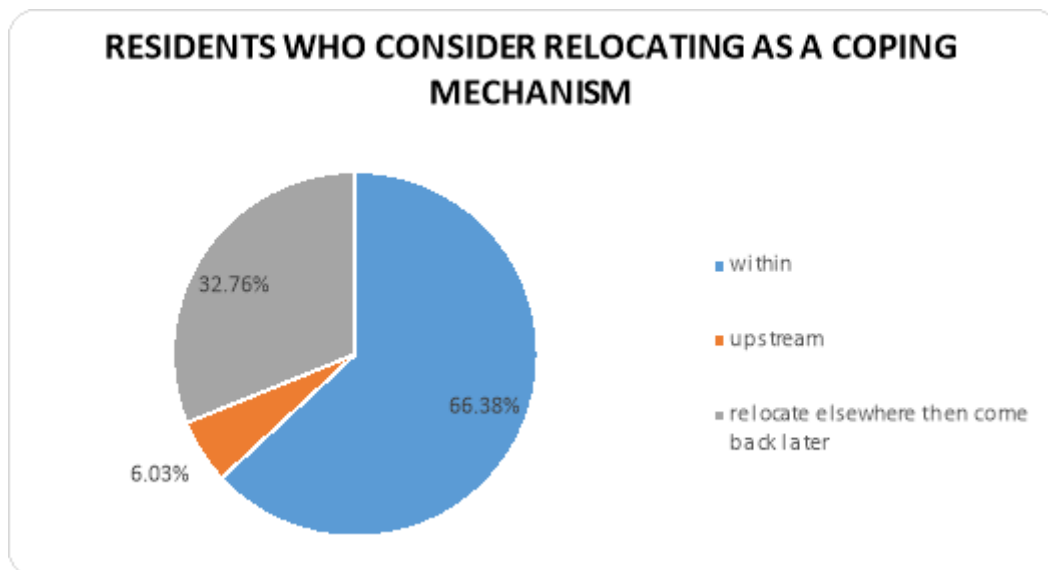


Figure 4-14: Relocation pattern of Mukuru kwa Ruben residents as a flood coping mechanism

Only 6.03% of the respondents who consider relocating during the flooding period move to upstream areas where they don't get to be affected negatively with the impacts of the floods. 66.38% of the respondents who relocate as a coping mechanism to flooding do so within the locality while 32.76% of the respondents admitted to relocate elsewhere beyond the area and would come back later when the floods have subsided. From the findings, it's clear that no matter where the inhabitants decide to relocate temporarily, they always find themselves back to the locality they were. Among other things, this can be attributed to the affordable cost of living that the area provides to them to the point that they cannot fathom residing in any other place other than Mukuru kwa Ruben. Several inhabitants disclosed that they only pay rent that costs them between KES 1200 to KES 3000, pays a flat rate of KES 300 for electricity. All the other amenities like water and food they find them at a very affordable rate hence the laxity of wanting to move to a relatively safe area that isn't prone to flood impacts.

4.3.8: Challenges and opportunities in the strategies used by Mkuru kwa Ruben settlement community as coping mechanisms to floods.

In this section, the results of the various strategies in place by the Mukuru kwa Ruben community, National and County government are analyzed to see the most appropriate ways Mukuru kwa Ruben can capitalize on to enhance their coping mechanism to floods.

4.3.8.1: Policies governing flooding disasters in urban areas.

Eight institutions handle flood management in the country. These institutions are responsible for implementing the policies for flood management in Nairobi County and more specifically in Mukuru kwa Reuben.

The institutions that have been mandated to address urban planning, physical environment and manage disasters have tried to do their role on a macro scale but have failed to a larger extent to execute their duties in urban informal settlements. From the 9 institutions mandated with the humongous role of planning and managing disasters only the office of the member of county assembly Mukuru kwa Ruben ward and the Kenya Red Cross Society have had their presence felt in Mukuru kwa Ruben.

The institutions are outlined in Table 4-7 below with a summary of their core mandate.

Table 4-7: Institutions mandated to address matters of urban planning, physical environment and disaster management

	Institution	Key Mandate
1.	The Nairobi City County- Land, Housing and Physical Planning Unit.	Responsible for policy formulation and leadership in various areas, key amongst them, City Planning.
2.	The Nairobi City County – Public works, Road and Transport Unit	Responsible for policy formulation and leadership in various areas concerning roads and transport but chief amongst them is storm water management systems in built-up areas.
3.	The Nairobi City County – Energy, Environment, Water and sanitation Unit	Responsible for formulation and leadership in many things Natural resource sector but key amongst them is solid waste management.
4.	The National Disaster Operation Centre (NDOC)	Office under the Ministry of Interior and Coordination of National Government. It is tasked with the management and coordination of disasters at the National level.
5.	The Kenya Metrological Services	Government institution tasked with offering metrological and weather services to the public and private sectors. This entails; weather forecasts, warnings and advisories on heavy rains or storms.
6.	The National Environment Management Authority (NEMA)	Leading Authority on environmental matters in the country. The agency is tasked with promoting the integration of environmental considerations into development policies, plans, projects, and programmes. The agency is also tasked with initiating and evolving procedures and safeguards for the prevention of accidents, which may cause environmental degradation and develop remedial measures where accidents occur, e.g. oil spills, floods, and landslides.
7.	Water Resources and Management Authority (WMA)	Operating at the national level, regional level (through 6 regional offices for the six major basins) and the sub-regional level via 26 sub-regional offices that serve the respective water resources sub-catchment areas. The Nairobi sub-regional office is supposed to work closely with Nairobi City County to tackle flood management in the city as the challenge is related to solid waste management in urban areas. WRMA also works through Water Resource Users Association's (WRUA's) and Integrated Flood Management Committees (IMC's) to address flood risk and manage river riparian zones.
8.	Office of the Member of County Assembly (MCA) Mukuru kwa Reuben Ward	Elected ward leader tasked with representing the views and proposals of the electorate to the County Assembly.
9.	The Kenya Red Cross Society (KRCS)	Humanitarian organization mandated with aiding the government on matters of disaster management as directed in the ACT of parliament Cap 256 in the laws of Kenya.

The study found six strategic plans and policies that have been developed in Kenya by various stakeholders and with a focus on Nairobi County on matters related to flood management. The policies and strategic plans are highlighted in Table 4-8 below:

Table 4-8: Policies and strategy documents addressing matters of urban planning and physical environment

	Policy / Strategic Plan	Main Objective
1	The National Environment Policy of 2013	Seeks to provide a framework for an integrated approach to planning and sustainable management of the natural resources and the environment in Kenya.
2.	Draft National Urban Development Policy of 2012	Provide a framework for sustainable urban development in Kenya.
3.	The Draft National Disaster Management Policy of 2010	Establish guiding principles for disaster management in Kenya by highlighting the institutional structures, responsibilities, roles, authorities, and processes to achieve a consistent, coherent and coordinated approach in the management of disasters.
4.	The National Housing Policy of 2004	Protect the environment of human settlements and of ecosystems from pollution, degradation, and destruction to attain sustainable development.
5.	The draft Nairobi Integrated Urban Development Master Plan (NIUPLAN)	To provide a guiding framework to manage urban development in Nairobi County for the period 2013 to 2030 and also realize the goals of Kenya's vision 2030 for Nairobi County.
6.	The Nairobi County Integrated Development Plan (NCIDP), 2014	Seeks to define the development priorities of Nairobi County, strategic policy thrusts and programmes/project intervention necessary for the county to achieve sustainable development both in the midterm and long term period.
7.	The flood mitigation strategy of 2009	Proposes flood mitigation strategic intervention areas and Action plans for the river basins in Kenya.

The policies and strategies developed to help in the management of floods implementation have been underwhelming. The implementers of this strategies and policies rarely set foot in urban informal settlements such as Mukuru kwa Ruben. As a result, urban informal settlements appear to operate on a set of separate policies and strategies as compared to other controlled development in the city.

The National Environment policy of 2013 acknowledges floods to be a natural disaster brought about by the adverse effects of climate change. The policy highlights the need for government to implement an integrated housing policy and a master plan that encapsulates environmental considerations. This is particularly important for inhabitants of Mukuru kwa Reuben and informal settlements in entirety for the development of better housing that can reduce the vulnerability brought about by floods. As illustrated in Figure 4-15, 80.17% of the inhabitants reside in structures made of iron sheets. This coupled with proximity to the Ngong River, the general topography of the area and lack of waste collection system, amongst other factors; make the community in Mukuru kwa Reuben extremely vulnerable to flood risks. However, since the policy was gazetted, the implementation of the integrated housing policy in Mukuru kwa Reuben has remained to be a distant reality. The major factor that has slowed integrated housing policy is the national infrastructure development strategy and action plan that were to guide the process are yet to be developed.

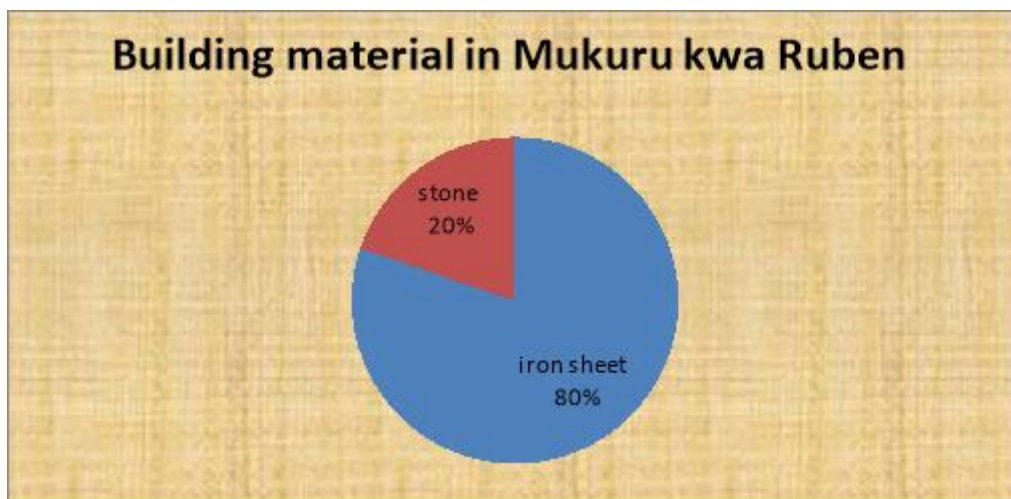


Figure 4-15: Common building material in Mukuru kwa Ruben

The policy explicitly describes desired floods management and practices. It commits to develop and implement awareness-raising strategies and capacity development for adaptation and mitigation against climate-related hazards such as floods. It also advocates the need to ensure that the government strengthens and enhances the early warning systems for climate and disaster risk reduction. Urban informal settlements such as Mukuru kwa Reuben, have not substantially benefited from the adaptation and mitigation measures that are supposed to be in place to reduce the impacts of flooding

in the area. Poverty and lack of sufficient flood education amongst the population seems to influence the top three causes of floods in the area. This explains the cynical attitude experienced by most of them when it comes to taking up nonstructural approaches towards flood adaptation in the study area.

The flood mitigation strategy of 2009 has various proposals for mitigating floods, especially in river basins in Kenya. It even acknowledges how Nairobi County is affected by floods annually but doesn't go ahead to outline practical steps that the County can use especially in informal urban settlements to mitigate floods in the area.

The draft National Disaster Management policy establishes guiding principles for disaster management in Kenya by highlighting the institutional structures, responsibilities, roles, authorities, and processes to achieve a consistent, coherent and coordinated approach in the management of disasters. It goes ahead and identifies floods as an environmentally triggered hazard but refrains from giving any coordinated and cohesive approach in dealing with the informal urban settlements such as Mukuru kwa Reuben found in Nairobi County. However, the policy is anchored on the now defunct ministry of special programs, which compromises the effective coordination of disaster management in Kenya. The policy fails to adequately address how disaster preparedness and coping mechanism can be taken up by the masses to help reduce on the increasing dependency syndrome on donor disaster related aid.

The draft National Urban development policy charges the National, County governments and Urban authorities to mitigate climate change effects by enhancing resilience through flood protection and infrastructure design. The only shortcoming is the lack of stipulated guidelines that the relevant institutions can use to go about this.

The Nairobi Integrated Urban Development Master plan (NIUPLAN) addresses issues that affect Mukuru kwa Reuben to a more considerable extent on matters related to flooding in the area. In particular it addresses the storm water drainage and waste management problem. Storm water drainage has been a preserve of the City Engineering Department which has been responsible for maintaining the storm water drainage systems constructed by the County government for the public. However, their work has been hampered by the loss of most of the technical data for existing storm

water drainage systems to a fire that rampaged City Hall in the year 2004. This has made it difficult for them to conduct routine maintenance, especially in the informal settlement areas because they can't locate where the physical drainage systems are. The other challenge affecting the City Engineers department has been the merging of storm water drainage in Nairobi County under Kenya Municipal Program and Nairobi Metropolitan Services Improvement Project (NaMSIP) by the Government of Kenya (GoK). The City Engineers Department was excluded from the project and therefore the information regarding its implementation is not available to the department. These serve to highlight the coordination fiasco in government agencies and slow adaptation to technology that could help backup technical data that can be retrieved when demanded.

As a country Kenya does not have any shortage of policies and strategies that can aid in averting disasters. However, the policies and strategies are hindered by some factors that make them difficult for the responsible organizations to effectively manage disasters. These include lack of adequate funding, human resources, equipment and even the dissolution of a focal ministerial docket that the disaster management policy had been pegged on. The above-mentioned shortcomings make it difficult for disasters especially those of flooding nature to be effectively dealt with.

4.7.1.2: Legal Framework

Eight Acts of Parliament exist are supposed to strengthen the policies and strategies to help in flooding management by providing legal backing. The available laws are described in Table 4-9.

Table 4-9: Acts of parliament of Kenya that addresses matters of urban planning and physical environment

	Acts of Parliament	Key Provisions
1.	The Kenya Constitution of 2010.	Gives every person in Kenya the right to a clean and healthy environment.
2.	The National Environment Management and Coordination Act {EMCA}, (CAP 387 of 1999) and the EMCA (Amendment) (No5 of 2015).	An act of Parliament that provides for a regulatory framework for Management and Coordination of the Environment.
3.	The climate change Act, (No 11 of 2016)	Provides for a regulatory framework for enhanced response to climate change; to provide for mechanisms and measures to achieve low carbon climate development, and for connected purposes.
4.	The Nairobi City County Disaster and Emergency Management Act of 2015.	To provide a legal framework for the management of disasters and emergencies in Nairobi County and connected purposes.
5.	Urban Areas and Cities Act (CAP 275 of 2011)	Provides for the classification, governance, and management of urban areas and cities.
6.	The Physical Planning Act, (CAP 286 of 1998)	Provide for the implementation of physical development plans and connected purposes.
7.	Water Act of 2002	To provide management, conservation, use and control of water resources and for the acquisition and regulation of the rights to use water’.
8.	Public Health Act 2017	Formalizes collaboration between National and County governments, obliges Kenya to address the health needs of vulnerable groups, and mandates the provision of emergency and specialized care.

The Constitution of Kenya 2010, under the Bills of Rights, gives every person in Kenya the right to a clean and healthy environment. Article 69 provides the state with powers of eliminating processes and activities that are likely to endanger the environment. Article 70 gives the public authority to take stock of environmental conditions and compel the state to take measures to prevent any act that has the potential of bringing harm to the environment; flooding effects in urban informal settlements included. The shortcoming to this is in the implementation which allows for non-compliant development to take place in Mukuru kwa Reuben. For example, key informants reported the raising of ground levels by private developers in the riparian land to allow for the construction of dwelling structures despite the vulnerability of the area to floods.

This is in the full glare of the Local authorities who know how illegal those activities are but still encourage it without dealing with them firmly as enshrined in the constitution.

Urban Areas and Cities Act of 2011 provides for the preparation of County Integrated Development Plans (CIDP) that identify various services and infrastructure that Counties should implement. Of relevance to this study from the Act is the development of Environmental Management Plans (EMP), disaster preparedness and response and physical and social infrastructure, that is to cushion Mukuru kwa Ruben from adverse flood impacts. The governance structure under this particular legislation requires representation by various resident associations in the City Board where the decisions for the plans are made. Mukuru kwa Ruben doesn't have a resident association in place. The mere fact that they don't have a resident association, denies them a chance to have a sit at the table where they could lobby for decisions that favor their community.

The Environmental Management and Coordination Act of 1999 (EMCA) provides for the preparation of National Environment Action Plan where one of its core functions is to identify and appraise trends in the development of urban and rural settlements, likely impacts that these may bring on the environment and strategies to abate the negative implications of those settlements in the country. The only shortcoming with this legislation and its revision as it appears in EMCA 2015 is the lack of provisions that relate to flood management in Cities and more specifically to urban informal settlements in cities. This makes it difficult for Environmental Impact Assessments (EIA), Environmental Audits (EA), State of the Environment (SOE) and Environment Outlook to be complied with to the latter.

The Nairobi County Disaster and Management Act of 2015 provide a legal framework for the management of disasters and emergencies in Nairobi County. The structure of the County Disaster Management Council as provided for in this Act is reasonably well represented with County Executive members of all the departments and ministries in the County, a Kenya Red Cross official, police commandant of the county and two public representatives. The public representatives are supposed to come from both sides of the gender divide so as to be representative of the society. Whereas the council has tried to be inclusive and even be sensitive on gender representation, it has failed to address how the public representatives are to be nominated. A more defined selection criterion

of the public representatives to come from disaster-prone areas in the County would be more useful. It would also eradicate the challenge of making a random appointment of public representatives based on nepotism or canvassing from well-networked individuals with very little knowledge of the magnitude of disasters that affect vulnerable communities in the city of Nairobi. Also, the Act directs that the council should come up with a plan to manage the hazards and make it available to the public. The shortcoming for this provision is it hasn't given a timeline for the plan to be created and shared with the public. This has been evident in the few years of the existence of the Act. Since its inception in 2015, no plan has been made public for the effective management of disasters.

4.3.8.2: Raising the height level of houses

As discussed in section 4.3.1, raising the height level of houses has been one of the coping strategies the community has been turning to during flood events. An opportunity presents itself for the County government of Nairobi to be keener on ensuring building codes are strictly adhered to even in informal settlements. The adhering to the building codes in Mukuru kwa Ruben has the potential to significantly reduce the rate of flooding in the community. The greatest challenge this coping mechanism faces is; the fact that house tenure in Mukuru kwa Ruben is mostly rental as illustrated in figure 4.2. This means that tenants can't modify the house they are in, that's the landlords' responsibility. Some of the interventions such as raising the height levels of houses in preparation for the floods may not be timely.

4.3.8.3: Digging up and cleaning of trenches

Figure 4-1 attributes poor waste management practices as one of the major causes of floods in Mukuru kwa Ruben. This garbage more often than not finds themselves in the trenches and cause blockage of the free flowing water, resulting to floods. However, this coping strategy can be strengthened by the County government assigning a designated dumpsite to serve Mukuru kwa Ruben. The availability of a dumpsite in the area will come with co-benefits such as revival of an efficient garbage and collection system and creation of jobs. The revival of the garbage collection system will ensure that garbage isn't disposed haphazardly around the community. This will lead to clean trenches that can smoothly take the storm water towards the river without affecting households. Those who will be actively participating in the waste management of Mukuru kwa

Ruben will also have a job that will be paying and as a result it increases their propensity to spend therefore boosting the local economy.

4.3.8.4: Putting sandbags along the path

Since the Ngong River cuts across Mukuru kwa Ruben, the easiest and cheapest place the sand can be extracted would be from its riverbanks. The challenge sandbags pose as a coping strategy to floods is exposing the community to flaunting rules on the sand harvesting guidelines of 2007, which prohibits any person from harvesting sand from riverbanks and transporting it without a license.

4.3.8.5: Taking their belongings for safekeeping to neighbours' in safe places

While taking some of their valuables for safekeeping to neighbors and friends in safer places, an opportunity arises for those living in flood prone villages to see safer places around the neighborhood. This exposure to safer places has the potential to make some of the residents change their mind on where to stay while in that community. The challenge to this particular coping strategy is; not all valuables can be saved from the floods. This is because; there is only enough space at the friends' and neighbors place that can accommodate household items from those who are being affected by floods.

4.3.8.6: Relocating to other areas

The challenge that is poised by this coping mechanism is for those who choose to relocate within Mukuru kwa Ruben, have to part with more money to rent better houses in the safer areas. For those who opt to leave Mukuru kwa Ruben for other areas, may also have to incur more in terms of transport to get to their work places (Especially those who work around Industrial area).

4.3.8.7: Emergency responses

Emergency response to floods in Mukuru kwa Reuben has not been very successful, and this can be attributed to insufficient investment in Flood Study Management in the area. Areas at risk and the magnitude of the flooding impact is a pool of knowledge that very little is known about it by the implementing agencies for disaster management in the county or if known they have been grossly ignored. As a result of the above, the existing plans for flood management at Mukuru kwa Reuben have turned out to be ineffective.

4.4: Enhancement of community's adaptive capacity to flood risk.

Adaptive capacity in the context of floods in urban informal settlements can be defined as the ability to adjust the behavior of the inhabitants to expand their coping range under the current climatic variability and also future climatic conditions (Adger et al., 2004).

Plans that have succeeded in enhancing the adaptive capacity of inhabitants elsewhere in places with similar flood risks such as in Mukuru kwa Reuben have put more emphasis on a progressive paradigm of flood risk management. According to Singkran (2017) and Tingsanchali (2012) progressive paradigm of flood risk management gives importance to the inclusion of the community in its programs and exerts some degree of emphasis on non-structural measures such as regulations, flood education, and land use planning to aid in the reduction of future flood risks.

A progressive paradigm flood risk management for Mukuru kwa Reuben will ensure there is a bottom-up system of implementation of flood management. The community will own the process because of their involvement in it. The good rapport between the community and the two tier levels of government, the National government and the County government will ensure non-structural measures such as regulations are followed to the latter. Flood education and enhanced early warning communication will be seamless as it will be easier to be acted upon by all the stakeholders and in return, future flood risks would be abated.

However, the most popular approach taken by the County of Nairobi and by extension the National government has been on a passive paradigm which seems to put more emphasis on top-down emergency responses approach to flooding events. The existing plans and practices for the management of floods in Mukuru kwa Reuben are ineffective majorly because they are top-down and have dedicated very little or wholly neglected the vital role of community participation.

4.4.1: Strategic Flood Risk Management Framework

The March 2018 floods in Mukuru kwa Reuben affected over 3500 inhabitants as indicated in the disaster file record at the Mukuru Kwa Reuben Chief's office and The Incident Command System of Reuben Ward. Severe damage in terms of property, lives and social disruption shed light on negligence in terms of flood management in informal

settlements. Considering this is a continuous threat that affects Mukuru kwa Ruben residents all year round, increased climate variability can only make it worse, if the necessary strategies and opportunities are not pursued for implementation.

Previous studies have shown the usefulness of taking up community stakeholders' participatory approach in trying to come up with lasting solutions to problems affecting various communities in the informal settlements. Bac Hung Hai Polder in Northern Vietnam managed to develop a framework that has protected them from the ravaging floods that they used to experience every other time (Hansson et al. 2013). Similarly, (Amendola et al., 2013) has illustrated how a consensus on the National Insurance System in Hungary was arrived at through stakeholder participation in a catastrophe model. It is therefore imperative that National government and the County of Nairobi work together to develop a progressive paradigm as soon as possible to be able to realize the benefits that inhabitants of informal settlements can accrue from this framework

After consultation with various stakeholders in Mukuru kwa Reuben on the best way to manage flood risks, the strategic flood risk management framework of the Australian Emergency Management Institute (*Australian Emergency Management Institute, 2011*) seemed viable to be adopted and customized to effectively deal Mukuru kwa Ruben situation. The framework has been successfully used to manage floods in New South Wales in Australia and also in Thailand.



Figure 4-16: Proposed flood risk management framework for Mukuru kwa Ruben

The proposed flood risk management framework for Mukuru kwa Ruben is anchored on a people centred approach, moving from the top-bottom approach that has characterized similar frameworks. Mukuru kwa Ruben already has coping strategies that the community uses during flood events. There is need for continuous review of current practices so as to be able to detect and address the deficiencies that come with them. This approach will ensure that the community starts planning ahead in anticipation of the floods, so as to reduce the possible impacts that they may be exposed to. A successful implementation of this approach will enhance sustainable governance arrangements in the community that is being supported by the floodplain management framework. The different pillars on the framework have been discussed in details below:

4.4.2: Community and stakeholders

The community and stakeholders will consist of Mukuru kwa Ruben residents and the relevant stakeholders such as religious institutions and Non-Governmental Organizations that offer key services to the community on a day to day basis. Their main

roles will be to give their views on appropriate adaptive strategies and flood mitigation measures to floods in Mukuru kwa Ruben. They will also play a vital role of reviewing effectiveness of flood risk management plans presented by Mukuru kwa Ruben flood management committee. These plans will be reviewed during village barazas that will bring together representatives from flood management committee, urban flood management committee and urban flood management entity, who will eventually implement the plans.

4.4.3 Mukuru kwa Ruben flood management committee

Mukuru kwa Ruben flood management committee will consist of members drawn from Nairobi City County Units; (e.g., Land housing and physical planning unit, Public works, roads and transport unit and Energy, environment, water and sanitation unit), Ministry of interior and coordination of National Government (e.g., The National Disaster Operation Centre and Kenya Police), Ministry of Health (Department of preventive and promotive health), residents from Mukuru kwa Ruben, environmentalists, Civil Society Organizations (CSOs) etc.

The major roles that the flood management committee would be expected to attain include: Highlighting policies with appropriate methods to reduce impacts brought about by flood events. They are also to make flood management plans after receiving public views from the community members, stakeholders and the technical committee. They are also to hold frequent consultative meetings with the community stakeholders and the technical committee for the purpose of continuous flood education and periodical monitoring of the flood risk management plans. Finally, they are to recommend mitigation measures to Urban Flood Management Entity for implementations.

4.4.4 Urban Flood management technical Committee

The flood management technical committee will be constituted by academicians from different departments in the University of Nairobi. The departments will be intensely involved include: Institute for Climate Change and Adaptation (ICCA); College of public health sciences; Department of meteorology and geology.

The major roles to be played by the urban flood management technical committee include: Prioritize flood prone areas in Mukuru kwa Ruben, be on the forefront of collecting data, conduct flood management studies and update the flood database.

4.4.5 Urban Flood management Committee

The Urban Flood Management Entity (UFME) is a body that has a pool of multiple disciplines aimed at generating a mix of appropriate flood management practices that will effectively help deal with flood risk in Mukuru kwa Ruben.

Since Nairobi City County (plans are underway to cede some of the functions of Nairobi City County to a new body called Nairobi Metropolitan Services NMS) has units responsible for managing flood policies and implementing the plans that are proposed to help effectively deal with flood events (Table 4-7), it's therefore suitably placed to act as the UFME for Mukuru kwa Ruben. As the UFME, the major roles that Nairobi City County would be expected to actively deliver on the following roles: develop sustainable governance agreements such as policies, laws and by-laws that are to aid in averting flood risks. It will also be tasked with implementing flood risk management plans in Mukuru kwa Ruben.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1: Conclusion

The reactionary approach to flood management in Mukuru kwa Ruben has continuously exposed the community to adverse impacts of flooding. The study established that the drivers of floods in Mukuru kwa Reuben were brought about by poor environmental management practices such as: encroaching flood plains, building on drainage paths and poor waste management practices. Infrastructural challenges arising from the rapid population growth and poor urban and physical planning in informal settlements were also noted to be responsible for causing floods in the area.

A people centered flood management response strategies that has won the support of relevant community stakeholders have the highest likelihood of enhancing the adaptive capacity of the vulnerable community in Mukuru kwa Reuben to flood risk. Various frameworks have been developed to try and effectively solve climate related disasters such as floods. However, the frameworks have always taken the top-down approach, which have partly contributed to the passive behavior of flood prone communities in developing countries whenever they are dealing with flood events. A disaster crunch model and local adaptive capacity frameworks have since been advanced by some practioners in an effort to alleviate community's adaptive capacity to floods. Though these are upgrades of previous frameworks, they can still be made better by pushing for a more people centered adaptive frameworks.

A people centered flood management response strategies that has won the support of relevant community stakeholders have the highest likelihood of enhancing the adaptive capacity of the vulnerable community in Mukuru kwa Reuben to flood risk. The study established that the drivers of floods in Mukuru kwa Reuben were brought about by poor environmental management practices such as: encroaching flood plains, building on drainage paths and poor waste management practices. Infrastructural challenges arising from the rapid population growth and poor urban and physical planning in informal settlements were also noted to be responsible for causing floods in the area.

The coping mechanisms currently undertaken by the community have some significant input in enhancing the community's adaptive capacity to flood risks however; they can be made better if the National and County governments move swiftly to cover the loopholes in the urban governance legislations which have not been implemented accordingly. The outcome of a rigorous community engagement in an attempt to enhance their adaptive capacity to floods in Mukuru kwa Reuben yielded a strategic flood management framework. Further research should be done to establish how existing urban informal settlements can be remodeled so that they can be sustainable settlements that are climate risk proof.

5.2: Recommendations

Based on the results from the study, the following measures are recommended to enhance adaptive capacity of flooding in Mukuru kwa Ruben informal settlement:

- Integral community stakeholders should conduct mass sensitization on effective low cost adaptive strategies to floods in Mukuru kwa Ruben. It's hoped that consistent community sensitization will greatly help them have a paradigm shift on how they respond to flood risk.
- Mukuru kwa Ruben should form a resident association, which can then have them have representatives who can sit at the Nairobi County disaster committee and accurately present the challenges of the community. It will be easier to lobby for the placement of municipal structures such as a waste collection point. The setting aside of a designated collection waste point will bring along cobenefits such as having organized youth and women groups who can be collecting and properly disposing waste in Mukuru kwa Ruben, hence effectively dealing with one of the major drivers of floods in the area.
- Road networks and expanded and clean drainages should be done in the area so as to help reduce the number of days' floods remain on the surface and also make it possible for inhabitants to be able to access health facilities during flood periods.
- Policy makers should engage the communities at the grassroots and develop policies and strategies that resonate with flood prone communities such as

Mukuru kwa Ruben and hopefully develop adaptive frameworks that can transform those communities to be resilient to flood risks.

- There is dire need to relook at the implementation strategies of the numerous policies and laws that are in place guiding management of floods in urban informal settlements. Involvement of the inhabitants at the round table together with experts has a great chance of enabling the inhabitants embrace the methodologies proposed and even help in sensitizing the neighbours back at their places.

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APPENDICES

Appendix A: Key informant Questionnaire

Masters of Climate Change and Adaptation

The University of Nairobi

Researcher: Muhatiah Wentland

Contact: muhatiahwentland@gmail.com / 0713748791

Research Title: Enhancing Adaptive Capacity to Flooding of Communities in Informal Settlements: A Community- Based Case Study of Mukuru Kwa Reuben, Nairobi County, Kenya

This information will only be used for scientific research.

-
1. Are you aware of the problem of flooding in your area? Yes; No; No idea
 2. If yes, how does your organization conduct flood management in Mukuru kwa Reuben?
.....
.....
 3. How does your organization work with informal settlement communities and other stakeholders in handling flood risks?(preparation, response and recovery)
.....
.....
 4. a) How are decisions for influencing flood management done by your organization/Institution?
.....
b) Who is involved? [targets actual decision-making processes]
.....
 5. What is your perception of how vulnerable Mukuru Kwa Reuben inhabitants are to floods?
 6. If vulnerable to flood risks, why?.....
.....
 7. If not vulnerable to flood risks, why?
.....
 8. What variables do you think mostly influence the level of flood vulnerability in Mukuru Kwa Reuben?
.....
 9. If you were to anticipate future changes to how flood management decision is done in Mukuru Kwa Reuben and particularly the role of informal settlement communities and stakeholders in influencing actions relevant at a local level, what changes might those be?

Appendix B: Household Questionnaire

Masters of Climate Change Adaptation

The University of Nairobi

Researcher: Muhatiah Wentland

Contact: muhatiahwentland@gmail.com / 0713748791

Research Title: Enhancing Adaptive Capacity to Flooding of Communities in Informal Settlements: A community Based Case study of Mukuru kwa Reuben, Kenya.

This information will only be used for scientific research.

1. Background Information

1.1 Personal Profile of Respondent

1. Age group:

1. 15-19
2. 20-24
3. 25-29
4. 30-34
5. Over 35 years

2. Highest Education level:

1. No education.
2. Primary
3. Secondary
4. Tertiary:

3. How long have you lived in the area

1. 1-5 years

2. 5-10 years

3. 11-15 years

4. More than 15 years

4. Sex of the respondent: Male Female

5. Marital Status: Married Single

6. Location:

7. Main Source of income:

1. Employed

2. Self Employed

3. Unemployed

8. How much are you able to spend within a day?

Less than Kes 300 More than KES 300

9. How often do you fall sick during flood events?

.....

10. Number of Family Members in this household:

.....

1.2 Building Information

Building Structure:

Function	Residential
Floor Material	1. Cemented 2. Mud floor 3. Earth floor
Wall Material	1. Nylon paper 2. Wood 3. Bricks/ Stone 4. Iron sheet

Roof Material	1. Iron sheet 2. Asbestos 3. Canvass
No of floors	1. One 2. Two 3. Three 4. 4 and over.

Building Age: 0-3 yrs 3-5 yrs 5-8 yrs 8 -11yrs Over 11 yrs

Ownership type: Rent Own

2. Elements at Risk

2.1 Building

Function	Residential	School	Shops	Hospitals	Place of worship	Other
Floor Material						
Wall Material						
Roof Material						
Pillar						
No of floors						

2.2 Building Contents

2.2.1: Wealth Index

Do you have the following items in your household?

Item	Yes	No
------	-----	----

TV set		
Radio		
Electricity		
Mobile Phone		
Fridge		
Solar Panel		
Table		
Chair		
Sofa		
Bed		
Cupboard		
clock		
Microwave		
Dvd Player		
Animal (specify the animal and number)		

3. Floods

3.1 Causes of floods

What is the cause of the flood based on your perception?

(1) Garbage	(2) Excessive Rainfall
(3) Land use change	(4) Uncontrolled city development
(5) Others	

3.2 Flood Occurrence

What is the highest of water levels you have experienced during the March floods in 2018?	1. Normal 2. Disturbing but still manageable 3. Unmanageable 4. Disastrous
How long was the flood duration in the last flood witnessed (March 2018)	Less than 2 days 3-5 days More than 5 days
Which year was the maximum height of water level ever occurred in this location?	

3.3 Damages and Losses (For landlords and home owners only)

What's the damage incurred during the last flood? Add info from the wealth index

Item	yes	no
Floor		
wall		
Windows		
Roof		
Electricity		

3.5 Flood Impacts

1. What are the common diseases that appear after the flood?
2. During floods, where do you relocate to?
 - (a) Within (b) upstream (c) relocate elsewhere then come back when it has subsided
3. (a) Have you considered moving away from this area to avoid the flooding impacts?

(b) Why do you say so?

4.0 Coping Mechanisms

What's the reason of living in this area?	
Cheap	
bought the Property	
Inherited Properties	
Better access to (place of works, school for children etc)	
Other:	

4.1 Have you applied any flood coping mechanism (protection from floods) in order to reduce the impacts of floods?

Yes No

If yes, what kind of flood coping mechanism (protection) have you done?

Before Floods	During Floods	After Floods

5.0 Framework development and strategy identification that will enhance the community's adaptive capacity to flood risk.

1. Whenever there are floods, which organizations are always at first to provide assistance to people in this location?
2. What strategies do they use to deal with flooding in this area?
3. What challenges have you noted in their strategies that are meant to increase the community's coping mechanisms against flooding disasters?
4. In your opinion what else can be done by the relevant stakeholders to increase your adaptive

capacity to flooding?

Appendix C: List of key informants interviewed at Mukuru kwa Ruben

	INSTITUTION	RELATIONSHIP TO COMMUNITY	GENDER
1	Ward Manager	Manages all funds related to Mukuru kwa Ruben ward development.	Male
2	Member of County Assembly (MCA)	Represents the ward in the Nairobi County Assembly.	Male
3	Local Administration	Area chief	Male
4.	Local Administration	Gatope chairman	Male
5	Local Administration	Feed the children chairman	Male
6	Local Administration	Rorie chairman	Male
7	Local Administration	Mombasa chairman	Male
8	Local Administration	Kisumu chairman	Male
9	Local Administration	Kosovo Chairman	Male
10	Nairobi County Department of Health	Public Health Officer Mukuru kwa Ruben ward	Female
11	Incident Command System: Department of Search and Rescue:	Safety Team Reuben ward	Male
12	Red Cross	Emergency Operations	Female

