ADAPTATION STRATEGIES TO ADVERSE EFFECTS OF CLIMATE VARIABILITY ON WATER AND SANITATION ACCESS IN MUKURU KWA NJENGA SLUM, NAIROBI COUNTY, KENYA

PHILIP BUNDI KARIUKI (BSc. Zoology and Botany)
REG No: N50/CTY/PT/24890/2011

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DECLARATION

Declaration by the Candidate:

This research project is my original work and has not been presented for examination in any other university.

MR. PHILIP BUNDI KARIUKI
REG No: N50/CTY/PT/24890/2011

Signature: _____ Date: _____

Declaration by the Supervisor:

This project has been submitted with my approval as University Supervisor.

Dr. Daniel G. Mang'uriu

Signature: _____ Date: _____

Department of Environmental Education, Kenyatta University

DEDICATION

I want to dedicate this research project to my family; Josphine, Roselyn and Eliana for their encouragement during finishing my masters project research. Great thanks to my brother Davies, my parents; James and Rose who have encouraged me and created a firm foundation for their children's education. Glory is to God.

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ABSTRACT

Climate variability is an environmental pressure to urban slum dwellers economic activities in most developing countries where households have been adapting to it for years. Slum dwellers are faced with inadequate access to water and proper sanitation. This problem is partly attributed to climate change. This research project aimed at exploring the adaptation and coping mechanisms of Mukuru Kwa Njenga slum community in Nairobi City, due to poor water supply and access to basic sanitation because of climate variability. The four objectives of the study were; to determine climate variability of Nairobi over the last 35yrs, to identify the community's adaptation and coping mechanism strategies to poor accessibility of portable water and basic sanitation due to climate variability; to determine the factors hampering the community access to adequate water supply and basic sanitation; and to assess how low accessibility to sufficient water supply and basic sanitation affect the achievement of sustainable development. Descriptive research design and sample size of 384 were formulated. Data analysis was done by use of statistical software known as Statistical Package for Social Sciences (SPSS). The findings reveal that majority of respondents at 94.2% agree unfavorable weather conditions contributes to sanitation issues now and possibly in the future. 59.5% of the residents in the study area experienced inadequate supply of water. Above 90% of residents store water by use of drums and jerry cans. It is also notable from the findings that the drainage systems in most parts of the study area are poor as indicated by 41% of the respondents. Implication of the findings suggests the populace should be guaranteed adequate supply of water and proper waste management by the county government and the citizenry working together to achieve a better living standard.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Climate variability has uniquely posed a great challenge for development. It is broadly perceived that the negative impact of climate change has exemplified both adverse situations and conditions for developing countries (McCarthy *et al*, 2011). Poor populations are recognized to be more prone and possess limited capacity to face the climatic changes (Swart *et al,* 2013). Some Countries have limited capacities in term of infrastructure and resources to cope with these changes. These factors are directly connected with those promoting sustainable development which aim to improve living conditions and access to resources (Smit and Pilifosova, 2011).

Accordingly, the international community, civil society, nation states, and the private sector are being called upon to develop mitigation and adaptation strategies to address the effects of climate change. Mitigation and development have historically defined the links between sustainable development and climate change. Nonetheless, change in climate adaptation is now often associated with sustainable development (AFDB *et al*, 2013; Munasinghe and Swart, 2012; Klein *et al,* 2014), meaning that sustainable development presents a natural entry point for the present study.

In the issue of climate change, susceptibility concern has gained increasing popularity in climate change studies in recent decades (Cutter, 2015; Canon, 2000). The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as 'the propensity of human and ecological systems to suffer harm and their ability to respond to stresses imposed because of climate change effects' (Adger *et al,* 2014). The vulnerability of a society is determined by the mode of development, allocation of resources and institutional setting (Adger and Kelly, 2000; Smit and Wandel 2006; O'Brien *et al*, 2013; Turner *et al.* 2013). The research on climate change susceptibility reveals that the poor and the most vulnerable are most affected. (Downing, 2013; Adger *et al*, 2011; Smit and Pilifosova, 2011; Ribot *et al.*, 2015).

Water is a basic commodity that climate change affects both the universe ecosystem and people's lives (Roncoli *et al,* 2011). Climate change is extremely affecting the hydrological cycle and therefore, water administration. This will thus affect human advancement and security (Christoplos *et al*, 2011). Environmental change impacts on both water assets accessibility as characterized by floods and drought that affect quantity of water. (Roncoli *et al,* 2011). These dangers will proceed with paying little heed to relief measures connected over the coming decades. Society needs to discover approaches to adjust to the progressions that are relied upon and to render its water framework and administrations stronger in adapting to new conditions and outrageous climate designs (Munasinghe and Swart, 2012).

Different fundamental adjustment measures that handle climate changeability and expand after existing area and water administration rehearses can possibly make strength to environmental change and to upgrade water security and hence specifically add to sustainable advancement (Mortimore and Adams, 2011). Adjustment to environmental change is critical. Water assumes a crucial part in it; however the political world still can't seem to perceive this idea. (Klein *et al*. 2014). As a result, adjustment measures in water administration are regularly underrepresented in national designs or in universal speculation portfolios. Along these lines, huge ventures and strategy shifts are required. Water is the soul of the planet, and the condition of this asset influences all characteristic, social and financial systems (Wisner *et al,* 2013, Ribot, 2015).

There is far reaching acknowledgment that the atmosphere of southern Africa will be more smoking and drier later on than it is today. By 2050, normal yearly temperature is relied upon to increment by 1.5-2.5° C in the south and by 2.5-3.0° C in the north contrasted with the 1961-1990 normal (Ragab and Prudhomme, 2002). Temperature rises will be more noteworthy in the mid-year than in winter, fueling weight on crops. Late model yields acquired by researchers from the US-based National Center for Atmospheric Research (NCAR) and the National Oceanic and Atmospheric Administration (NOAA) uncovered clear and sensational warming of the Indian Ocean into the future, which implies increasingly dry season for southern Africa (NCAR, 2005), the examination demonstrated that storms crosswise over southern Africa could be 10 to 20 percent drier than the 1950-1999 normal (Ragab and Prudhomme, 2002). Yearly local precipitation is relied upon to lessen by 10

percent, with more noteworthy decreases in the north than in the south (Ragab and Prudhomme, 2002).

Results from work from stations in Kenya and Tanzania, demonstrate that since 1905, the pattern of day by day most extreme temperature isn't essentially unique in relation to zero. In any case, day by day there is quickening temperature rise (Christy *et al.* 2009). The increase in average temperatures has resulted in huge differences in evaporation, hydrological cycles, lake and sea levels; including high number of adverse weather occurrence such as droughts and floods (Momanyi, 2006). The primary source of water is rainfall. Therefore, the predicted global climate change will certainly complicate the water supply and water quality situation in Kenya. These conditions increase temperatures due to global warming thus escalating evapotranspiration rates which contribute to raising water losses from time to time on the earth's surface.

The Kenyan water sector experienced reforms through the Water Act No. 8 of 2002. Beforehand benefit arrangement had been the obligation of a solitary National Water Conservation and Pipeline Corporation and in addition of a couple of neighborhood utilities set up since 1996. After the section of the demonstration benefit arrangement was bit by bit decentralized to 117 Water Service Providers (WSPs).. Countrywide assessments for 2008 by the JMP demonstrate that 31% (27% of urban and 32% of rustic) Kenyans approached private enhanced sanitation. In urban territories an extra 51% of the populace utilized shared restrooms. In rustic regions, open crap was assessed to be as yet rehearsed by 18% of the populace (Kovats and Akhtar, 2008).

Population increase in Mukuru Kwa Njenga slums is greatly contributed by rural urban migration. As a result, resources in these areas are becoming scarce thus leading to poor sanitation and water supplies (World Bank, 2009). According to WASREB (2012), water supply and sanitation in Kenya is portrayed by low levels of access, specifically in urban slums and in rustic zones, and poor administration quality as discontinuous water supply.

Sustainable development refers to a mode of human development in which resource use aims to meet human needs while ensuring the sustainability of natural systems and

the environment. These needs can be met not only in the present, but also for generations to come. The term 'sustainable development' was used by the Brundtland Commission (Brundtland report 1987), which coined what has become the most often-quoted definition of sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable development alludes to a method of human improvement in which asset utilize intends to address human issues while guaranteeing the supportability of common frameworks and nature, with the goal that these necessities can be met in the present, as well as for ages to come. The term 'reasonable advancement' was utilized by the Brundtland Commission, which instituted what has turned into the regularly cited meaning of feasible improvement: "advancement that addresses the issues of the present without trading off the capacity of future ages to address their own issues (United Nations, 2009).

1.2 Problem Statement and Justification

Mukuru kwa Njenga, like many other slums in Nairobi, is characterized by absence of basic services and infrastructure for instance, satisfactory access to water, garbage collection, sanitation, roads and footpaths, drainage, electricity and public lighting. Housing units are semi-permanent in nature and often reflective of the high population densities. Security of tenure is not guaranteed, and the threat of forced eviction remains a reality. Social amenities are insufficient with facilities such as schools and hospitals unable to cope with the population demand.

The physical topography of Mukuru makes it hard to get to in this way renders issues of water and sanitation more perplexing. The swampy soil does not allow the escape of waste water, which at that point stagnates, subsequently resulting to illnesses, for example, cholera, intestinal sickness and typhoid fever. According to WASREB 2012, it is said that "water is life and sanitation is nobility"; this dignity is absent throughout most of the expansive slum. The poor sanitation conditions found here are aggravated by lack of planning which characterizes most informal settlements. The residents live in a wanting condition occupying tiny semi- permanent structures built from materials such as

timber, card board, plastic and corrugated iron sheets. These structures house numbers far beyond their capacity. Water and sanitation issues in Mukuru Kwa Njenga slum are like those of other slums in Nairobi city like Kibera, Mathare and Korogocho. This study aims at exploring the adaptation and coping mechanisms of Mukuru Kwa Njenga slum community, due to poor water supply and wanting sanitation and its role in the achievement of sustainable development in respect of climate variability and change.

If climate change impacts are left un-attended to, they remain to worsen existing difficulties and make it more troublesome for urban areas and nations to accomplish feasible advancement and diminish destitution. To accomplish development goals in the world, the basic needs such as access to clean water require being resolved in totality.

1.3 Objectives of the Study

1.3.1. Broad Objective

This study aims at exploring the adaptation and coping mechanisms in respect to climate variability affecting water supply and access to basic sanitation among Mukuru Kwa Njenga slum dwellers.

1.3.2. Specific Objectives

i. To determine climate variability of Nairobi city (County) for the last 30-35 years, from 1980-2014.
ii. To assess the factors hampering the community to have access to improved water supply and basic sanitation.
iii. To identify the community's adaptation and coping mechanisms to water supply and access to bas c sanitation caused by climate variability.
iv. To assess how poor accessibility to adequate water supply and basic sanitation affects the achievement of sustainable development goals.

1.4 Research Questions

The study was guided by the following research questions:

i. Has Nairobi city (county) experienced climate variability over the last 30-35years? (1980-2014)?

ii. Which are the factors hindering the community within Mukuru kwa Njenga slum to have access to improved water supply and basic sanitation?

iii. Which are the community's adaptation and coping mechanisms in response to poor water supply and access to basic sanitation within Mukuru kwa Njenga slum, in the face of current climate variability and change?

iv. How does poor accessibility to improved water supply and basic sanitation affect the achievement of sustainable development goals?

1.5 Hypotheses of the Study

The hypotheses of the study are:

Ho_1 There is no relationship between changes in weather of Nairobi city (county) over the last 30-35 years (1980-2014) and climate variability.

Ho_2 There is no relationship between Mukuru Kwa Njenga community dwellers being able to access improved water supply and basic sanitation and the presence of factors hindering their accessibility.

Ho_3 There is no relationship between adaptation and coping strategies in response to poor water supply and basic sanitation access and climate variability by Mukuru Kwa Njenga slum dwellers.

Ho_4There is no relationship between accessibility to improved water supply and basic sanitation access and the achievement of sustainable development goals.

1.6 Significance of the Study

The results from the study has assisted in highlighting the adaptation and coping mechanisms of Mukuru kwa Njenga slum community, due to poor water supply and access to basic sanitation and its role in the achievement of sustainable development in the current context of climate variability and change. Based on the findings from this study, planners, policy makers and residents could address the problem and play a role in formulating effective policies that would help enhance adaptation strategies in terms of water and sanitation in the face of current climate variability and change.

The study will inform Kenyan Government and Nairobi County that indeed climate variability is real and is affecting people living in slums and other residential estates in

Nairobi as well as other municipalities in Kenya and beyond. The results will be a great asset to policy makers in formulating guidelines on sustainable water and sanitation access in the view of changing climatic regimes. The Nairobi County can be informed by the results to install more water connections, provide water points and build a proper sewerage system connecting sanitation facilities, to enhance adequate water supply and sanitation access to people living in Mukuru Kwa Njenga and other slums in general. It will also contribute towards stimulating and enhancing the current government project proposals of slum upgrading. This study contributes to the body of knowledge through the following: climate variability impacting on water supply and sanitation access and response inform of adaptation and coping mechanisms towards achievement of sustainable development goals. It is anticipated that the results of the study will help to formulate appropriate strategies such as installation of more water pipes to assist in adaptation and coping mechanisms of Mukuru Kwa Njenga slum community and other slums.

1.7 Scope of the Study

Subject Scope: The major subject scope was to study climate variability on water supply and sanitation access towards sustainable development in Mukuru Kwa Njenga slum, Nairobi County, Kenya.

Geographical Scope: The study was conducted in Mukuru Kwa Njenga slum, Nairobi County Kenya.

Time Scope: The time scope of the study was from March 2015 to July 2015.

Content Scope: In the study sustainable development is the dependent variable and was measured by the following independent variables: accessibility of portable water and basic sanitation, access to improved water supply and accessibility to improved water supply and basic sanitation.

1.8 Limitations of the Study

Several limitations were faced in this study which among others includes:

Attitude of Respondents: The accuracy of the results depended on the honesty of the respondents. The study relies on the level of honesty by respondents in answering the questionnaires. The researcher however mitigated these by giving the respondents to fill in the informed consent form swearing that what they would answer is the absolute truth and that honest responses were given while maintaining respondent confidentiality.

Resistance and access to information: Staff at management level, and leadership responsibilities ware included in the study. The challenges were in obtaining information from the top management. However, the researcher assured them of their anonymity and assurance given that the findings were to be used purely for academic purposes.

1.9 Conceptual framework

A conceptual framework is a logically developed, described and elaborated network of interrelationships among variables integral in the dynamics of a situation being investigated. It is therefore a logical way of expressing a particular attribute in a subject (Mugenda & Mugenda, 2013).

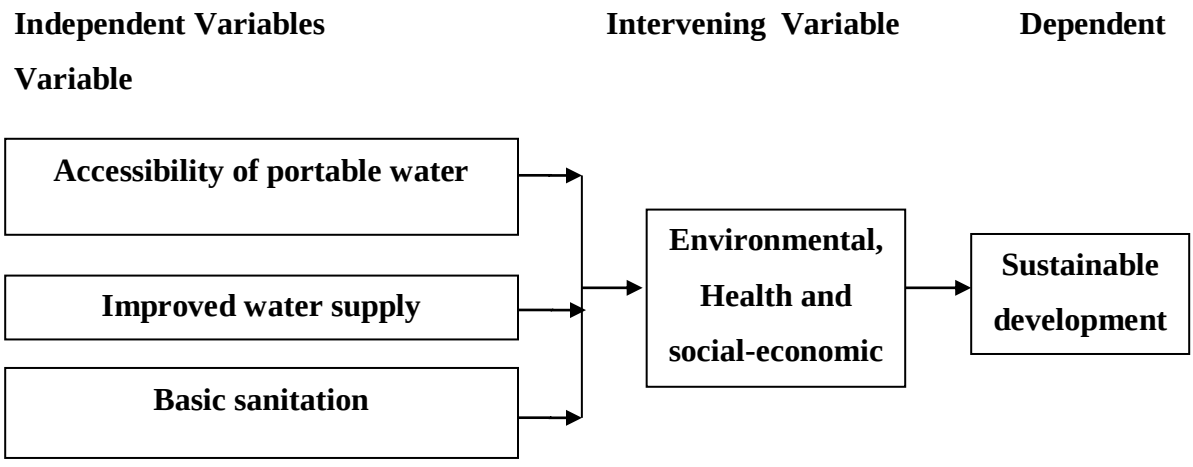

Figure 1.1 Conceptual framework; Adapted from: (Pelling, 2011)

1.10 Definition of terms

In this section the main definitions that are significant for the purpose of this project report is explained.

Urbanization

Urbanization is the physical growth of urban areas which result in rural urban migration and even suburban concentration into cities, particularly the very large ones.

Climate variability and change

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions, or in the distribution of weather around the average conditions (i.e., more or fewer extreme weather events).

Slums (Informal settlements)

A slum, as defined by the United Nations agency UN-Habitat (2015), is a run-down area of a city characterized by substandard housing, squalor, and lacking in tenure security. According to the UN-habitat (2015), the percentage of urban dwellers living in slums decreased from 47 percent to 37 percent in the developing world between 1990 and 2005.

Sustainable development

Sustainable development refers to a mode of human development in which resource use aims to meet human needs while ensuring the sustainability of natural systems and the environment, so that these needs can be met not only in the present, but also for generations to come.

Vulnerability

Vulnerability refers to the inability to withstand the effects of a hostile environment. A window of vulnerability (WoV) is a time frame within which defensive measures are reduced, compromised or lacking.

Adaptive capacity

Adaptive capacity is the capacity of a system to adapt if the environment where the system exists is changing. It is applied to ecological systems and human social systems.

Coping

This is expending conscious effort to solve personal and interpersonal problems, adaptive or constructive strategies, for example. The strategies reduce stress levels. These are measures put in place to adapt to various environmental changes.

Water access

Access to safe drinking water is the proportion of people using clean drinking water sources: household connection; public standpipe; borehole; protected dug well; protected spring; rainwater.

Basic sanitation

Basic sanitation is defined by UN-habitat (2015) as the reduced cost technology guaranteeing hygienic excreta and silage disposal and a clean and healthful living environment both at home and in the neighborhood of users. Access to basic sanitation incorporates safety and privacy in the use of these services. Coverage is the proportion of people using improved sanitation facilities: public sewer connection; septic system connection; pour-flush latrine; simple pit latrine; ventilated improved pit latrine.

CHAPTER TWO
LITERATURE REVIEW

2.1 Theoretical Review

A theoretical literature review will survey scholarly articles, books, and any other sources relevant to issue under investigation, Mukuru Kwa Njenga as the study area of research, and theory. Through theoretical literature review, a description, critical evaluation of the work and summary will be provided in relation to the research problem being investigated.

2.2 Action Theory

Basic action theory ordinarily describes action as behavior caused by an agent in a specific circumstance, MEA (2012). The agent's desires and beliefs (e.g. my wanting a glass of water and believing the clear liquid in the cup in front of me is water) lead to bodily behavior (e.g. reaching over for the glass). In the simple theory, the desire and belief jointly cause the action. Michael Bratman has raised problems for such a view and argued that we should take the concept of intention as basic and not analyzable into beliefs and desires. According to Bratman, M.E (1999), a primary concern of the philosophy of action is to analyze the nature of actions and distinguish them from similar phenomena. Other concerns include individuating actions, explaining the relationship between actions and their effects, explaining how an action is related to the beliefs and desires which cause and/or justify it, as well as examining the nature of agency. Due to an (effective) global environmental agreement on climate change becomes less likely in the short-term; adaptation to the inevitable consequences of global warming is now getting further emphasis. Although adaptation research is rising on the scientific agenda, this interdisciplinary field is still characterized by an evolving epistemological base.

2.3 Review of Past Studies on Adaptation due to Adverse Effects of Climate Variability on Sanitation and Water.

According to (CCSP, 2008) essential sanitation is important to the overall health of communities, as well as the environment. In this way, sanitation activities, regularly in conjunction with cleanliness ventures, are every now and again high need programs for

advancement associations. Water-related ailments are the most widely recognized reason for disease and demise among the poor in creating nations. Assessments demonstrate that more than two billion individuals live without access to sufficient sanitation (WHO, 2010 and Vision, 2030).

According to (ICLEI, 2011) Supporting environmental change adjustments for sanitation frameworks will build the versatility of development projects to enhance general wellbeing and ecological insurance. Numerous sanitation offices are situated at the most reduced rise conceivable and are in this manner helpless against environmental change-related ocean level ascent, storm surge, and flooding. More extreme tempest occasions can overpower offices, bring down stream levels and higher temperatures can influence water quality.

Adjustment alternatives can run from hard to delicate reactions. "Hard" alternatives allude to auxiliary changes (e.g., moving septic tanks and related pipelines to higher ground). "Delicate" alternatives elude to administration, operational, and arrangement changes (e.g., expanding upkeep of tanks and pipes, keeping up reinforcement frameworks) (CCSP, 2008). Some adjustment systems may require practically zero extra financing, if atmosphere factors are consolidated into forthright arranging and plan (USAID, 2014).

2.4 Accessibility to Improved Water Supply and Basic Sanitation to the Achievement of Sustainable Development goals.

According to (WHO/DFID, 2009) absence of sanitation can obstruct other advancement needs, for example, enhanced worldwide wellbeing, financial efficiency, and sustenance security. Water, Sanitation, and Hygiene (WASH) programs look to build access to the drinking water supply or sanitation administrations, enhance the nature of those administrations, or potentially advance cleanliness. Some water and sanitation programs offer chances to enable individuals to adjust to atmosphere inconstancy and change. Be that as it may, when atmosphere isn't viewed as, the targets of different projects may well be undermined (NRC, 2008).

Sanitation offices are profoundly delicate to storm surge, ocean level ascent, and flooding. Wastewater gathering, and treatment offices are frequently arranged at the most minimal point conceivable as their operation use gravitational draw, yet they can along these lines effortlessly be immersed by water level ascent. Septic frameworks and filter fields should be isolated from the water table for viable treatment yet rising groundwater levels amid flooding or rising ocean levels will constrain their viability (USAID, 2014).

As per (WHO/DFID, 2009) there is convincing proof that the atmosphere will pose numerous challenges in the future.

2.5 Climate Adaptation, Climate Variability and Sustainable Development

According to (WHO/DFID, 2009) rainfall patterns indicate increased irregularity and variability with neutral to slightly decreasing trends in annual rainfall over most areas in Kenya. However, a general increase in rainfall events during September to February has also been observed, suggesting a tendency of the 'Short Rains' (October-December) to extend into the normally hot and dry January and February over most areas. Though not overly significant, lower rainfall levels have been observed in annual rainfall, in the 24-hour intensity as well as in relation to the 'Long Rains' which usually contribute a significant percentage of the annual rainfall.

Forests are highly sensitive to climate change. According to (WHO/DFID, 2009), Kenya's forests cover is estimated to be 1.5%, which include both indigenous and plantation forests. The five water towers: Mt. Kenya; Mau Forests Complex; Cherangany Hills; Mt. Elgon; and the Aberdares, act as the main water catchment areas. Forest degradation and deforestation have caused significant destruction, reducing forest canopy cover, biodiversity composition, and increasing GHG emissions. Changing climatic conditions have also affected the regeneration rate, and biodiversity, especially for natural forests.

According to (WHO/DFID, 2009) Climate change has expanded vulnerabilities in Kenya. Poor agriculturists and groups or people with significant introduction to environmental change components are rendered defenseless, frequently confronting genuine product disappointments, pay misfortunes and business breakdown. Rain-bolstered farming, which represents 98% of the agrarian exercises in the nation, is the foundation of Kenya's

economy and is extremely defenseless against expanding temperatures, dry seasons and surges, which diminish horticultural profitability.

2.6 Critique of Existing Literature

According to (NRC, 2008) the impact of climate change on access to drinking-water supply and sanitation facilities will vary both by region and by facilities. To date, although such problems have been highlighted as serious and likely consequences of climate change by the Intergovernmental Panel on Climate Change (IPCC, 2014), there has been very little systematic assessment of the potential impacts.

According to (WHO/DFID, 2009) climate change has the potential to impact on both the supply and demand sides of Water, Sanitation, and Hygiene (WASH) delivery systems. Some potential impacts are likely to be direct and obvious, whereas others are likely to be indirect, insidious and more uncertain in nature and severity (CCSP, 2008).

2.7 Knowledge Gap

The adverse effects of climate change on access to clean sufficient drinking water supply and sanitation facilities have been researched in different regions and countries. Major researches on climate change have been focused on the agricultural sector. There has been minimal research investigating on impacts of climate change on informal settlement dwellers in relation to water and sanitation access, and their impact on sustainable development goals. Climate change which affects water and sanitation is crucial for poverty reduction and sustainable development, and it's a very crucial issue of the current 21st century (UNDP, 2007). According to Christian Aid, 2006, climate change poses the greatest threat to poverty reduction.

Climate change affects the poor most whom for the first time because of rural urban migration most live in the urban areas (Satterthwaite, 2011). Urbanization has resulted to the need of looking into risks and challenges being faced in these urban areas due to climate change (Huq and Satterthwaite, 2008.

The informal settlements in most urban centers of most developing countries like Kenya are at great risks associated with lack of access to safe water and sanitation services (WSP, 2011). Therefore, with the irreversible trends to climate change and rapid

urbanization (Guterres,2010), there is the urgent need for research on the adaptation strategies to water and sanitation due to impacts of climate change on to the urban poor.

Much research on adaptation strategies due to climate change impacts on water and sanitation is limited and research on the poor people which is extensive has been focused to the rural context (Allen et al, 2010) hence the need on my research to target the poor in the urban slum of Mukuru kwa Njenga becomes considerable since according to Roy, 2011, the number of rural poor will exceed the number of rural poor within this generation.

2.8 Conclusion

This study therefore focused on that gap and explored the current adaptation strategies being employed by Mukuru Kwa Njenga slum dwellers who form part of poor people in the urban context, looking into climate change impacting on water supply and sanitation access and factors hampering the community from obtaining them. The research also ascertained that from analysis of weather treads over a period of 35 years (1980-2014) climate variability has occurred in the study area. There is great increase of urban population and number of poor dwellers who live in the slums of these cities and towns (Satterthwaite, et al.2007). It is estimated that more than a billion people of urban dwellers live in the informal settlements which are characterized with poor housing, poor supply of piped water and poorly accessible. (Satterthwaite, et al.2007). According to Laukkonen 2008, those in the urban centers most affected by the direct and indirect impacts of climate change, a risk brought about by their low adaptive capacity together with the failures of the national government in provision of necessary infrastructure in the areas they live.

According to UNFCCC 2007, climate change is occurring at high speed with great impacts that calls for urgent development of their capacity to cope with climate change

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Study Area

Mukuru Kwa Njenga is a slum in the East of Nairobi, the capital of Kenya, latitude: -1° 18' 40" S, Longitude: 36° 52' 40" E. It belongs to Embakasi Constituency. Among other major slums in Nairobi are Korogocho, Kibera and Mathare.

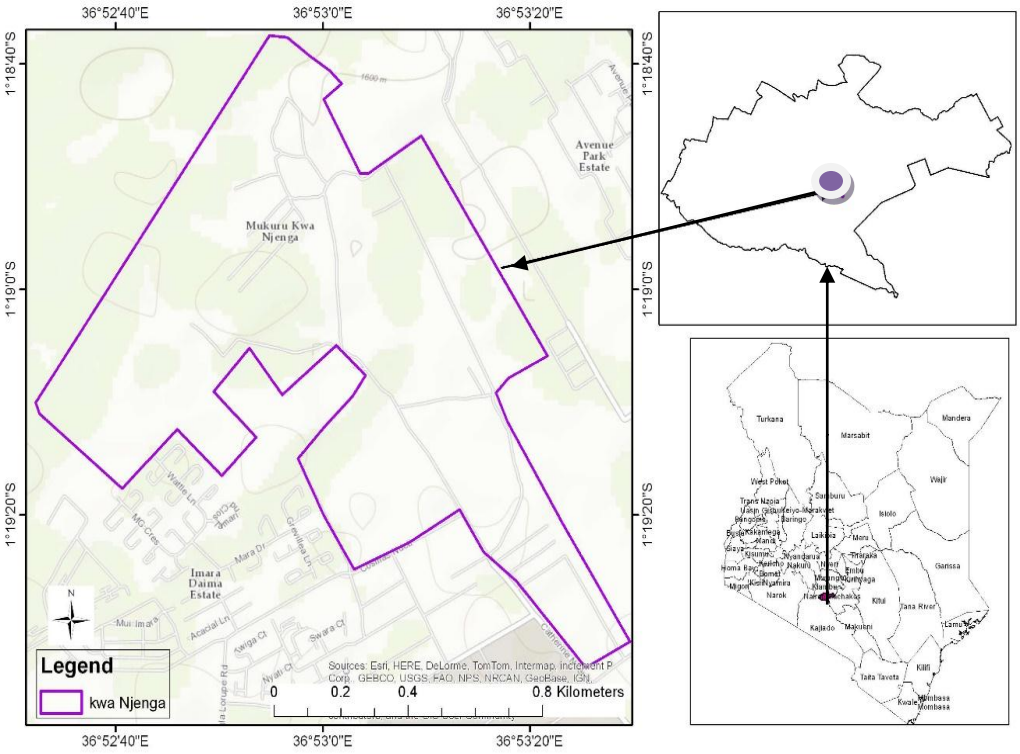

Figure 3.1 Map of the Study Area, Source: (Author)

According to KBNS, population census, 2009 the population of the slum exceeds 100,000 people. The residents live in squalid conditions occupying tiny semi- permanent structures built from flimsy material such as timber, card board, plastic and corrugated iron sheets. Figure 3.1 presents the location of the study area with respect to Nairobi city and Kenya as a country.

3.2 Research Design

This study adopted the descriptive survey research design employing both quantitative and qualitative approaches. Cooper and Schindler (2006) define survey research as the process of collecting representative sample data from a larger population and using the sample to infer attributes of the population. This research design was considered appropriate as it is feasible when the population is small and variable hence the researcher was able to cover all the elements of the population. Therefore, the survey was considered to be more efficient and economical.

3.3 Study Population and Sample Size

The target populations of this study were residents, chief and county officials working and living in Mukuru Kwa Njenga. According to Fisher *et al.* (1993), the following formula applies for population sizes above 10,000:

$$n = \frac{Z^2pq}{d^2}$$

Where n = the required sample size, when the target population is more than 10,000

Z = is standard normal deviate at the required confidence level (1.96) at 0.05

p = is the proportion of the target population estimated to have the characteristics being measured. The probability of 0.5 was used.

q = 1-p

d is the level of statistical significance

Therefore n = $\frac{1.96^2 x 0.5 x 0.5}{0.05^2} = 384$

As such, a total of 384 individuals were included in the study.

3.4 Sampling Technique

A sample is a subset of observations drawn from a population by a defined procedure. The sample represents a subset of meaningful size to make proper inferences. Samples are collected, and statistics are calculated from the samples so that one can make inferences or extrapolations from the sample to the population. Simple random sampling was used in this study. Questionnaires were distributed randomly among Mukuru Kwa Njenga residents. The samples size of this study was 384 respondents.

Since the population is highly homogeneous, a 10% proportion was used to select residents, while a census survey was used to sample chiefs and county officials as elaborated in the sampling frame (table 3.2) below. The technique gives more accurate results when most of the variation in the population is within group (Orodho and Kombo, 2002).

3.5 Research Tools

The study used survey tools of data collection, particularly semi-structured questionnaires with both closed and open ended questions. These were self-administered.

3.6 Data Collection Method

According to Creswell (2002) data collection is how information is obtained from the selected subject of an investigation. Primary data was collected using a questionnaire. The questionnaire contained both structured and unstructured questions. The open-ended questions were used to limit the respondents to given variables in which the researcher is interested, while unstructured questions were used to give the respondents room to express their views in a more pragmatic manner Kothari (1990).

3.7 Pilot Study

According to Mugenda, 2008 pilot test was necessary and ensured that the target respondents understood the questions well with accuracy of inferences which were based on research results. To test for reliability, a pilot test was conducted using questionnaires administered to the staff. This constituted 10% of the respondents. The reliability of the questionnaires was determined using test-retest method.

3.7.1 Reliability

The study conducted organization analysis to select a subset of variables from a larger set based on the original variables with the highest correlations with, the principal component factors. Reliability analysis was contacted using Cronbach's alpha to determine whether the data gathered on each variable was reliable.

3.8 Data Analysis and Presentation

This study was expected to use both quantitative and qualitative research. Once the questionnaires were received they were coded and edited for completeness and consistency. Quantitative data was analyzed by employing descriptive statistics and inferential analysis using statistical package for social science (SPSS) software. The data was then presented using frequency distribution tables, bar charts and pie charts for easier understanding. Inferential statistics involved correlation analysis. Qualitative Content analysis was also used to address the qualitative information obtained from key informants.

3.9 Ethical Consideration

Ethical Issues are norms governing human conduct which have a significant impact on human welfare. It involves making a judgment about right and wrong behavior, Kothari (1990). Before data collection, the researcher first got a letter from the School of Environmental Studies of Kenyatta University and commission of national council for research and innovation. The researcher also ensured that confidentiality of the information obtained should only be used for the study. Individuals had the option to refuse to participate. Appropriate credit is given to all parties contributing to the research.

CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents the results of the study based on the data collected from the field. The overall objective of this study was to explore the adaptation and coping mechanisms of Mukuru Kwa Njenga slum community, due to poor water supply and access to basic sanitation and its role in the achievement of sustainable development goals in the current context of climate variability and change. More specifically, the study sought to determine climate variability of Nairobi over the last 35 years; identify the community's adaptation and coping mechanism strategies to poor accessibility of portable water and basic sanitation in the current context of climate variability and change; assess the factors hindering the community to have access to improved water supply and basic sanitation; and to assess how poor accessibility to improved water supply and basic sanitation affect the achievement of sustainable development.

The results are presented in four sections starting with the background information of the respondents (4.2). The second section (4.3) presents results for the climate variability of Nairobi over the last 35yrs. The third section (4.4) presents results pertaining to the community's adaptation and coping mechanism strategies to poor accessibility of portable water and basic sanitation. The fourth (4.5) section concerns factors hindering the community to have access to improved water supply and basic sanitation while lastly the fifth section (4.6) reports on how poor accessibility to improved water supply and basic sanitation affect the achievement of sustainable development.

4.2 Bio data results

A total of 384 questionnaires were distributed but 83% (n= 319) responded while 17% (n=65) did not respond.

4.2.1 Response by Age

Age is an important demographic characteristic in the study with helps establish any pertinent trends in age distribution among the respondent. Age was also deemed a relative

indictor of respondents' length of experience with relevant aspects of the study problem hence reliability of responses. Figure 4.1 presents the findings.

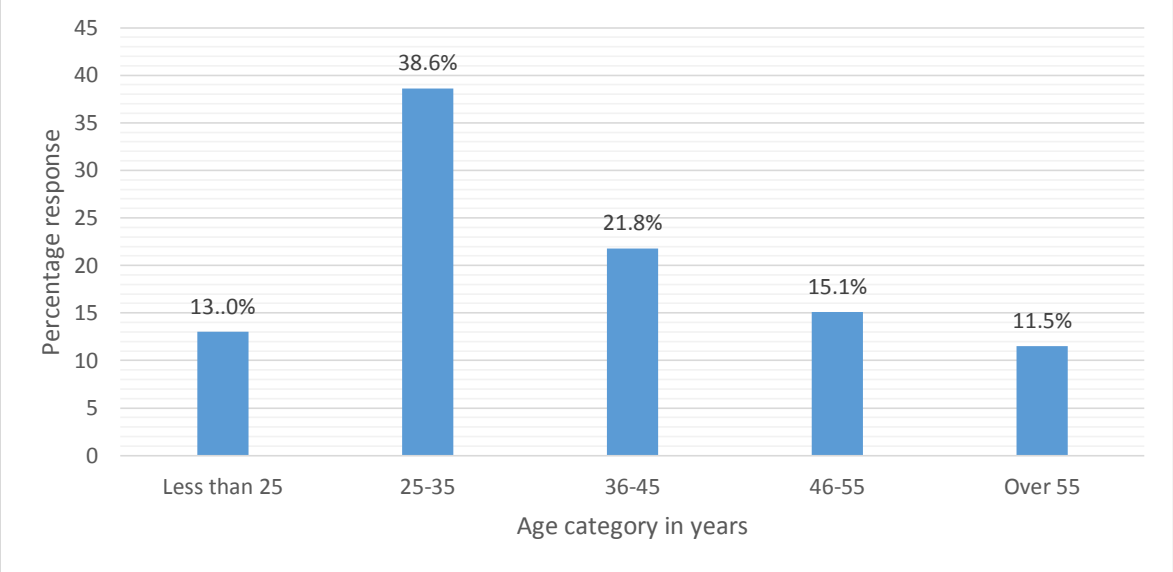

Figure 4.1 Age Distribution

Diverse age groups had a considerable representation in the study. The majority of respondents 38.6% (n= 123) were found to be within the ages of 25 - 35 years, followed by 21.8% (n= 70) in the 36-45 years category then the 46-55 years category representing 15.1% (n= 48) of the respondents. A skewed trend was noted across the age groups with the implication that the youth form the dominant age group in the study area. It follows then that diverse age groups would be affected by the impacts of climate variability on water and sanitation access in the study area.

4.2.2 Marital Status

To understand the household setup in the study area, the study deemed marital status an important demographic variable. This would give an overview of the household setting among pastoral communities with respect to marriage status. Figure 4.2 presents the findings.

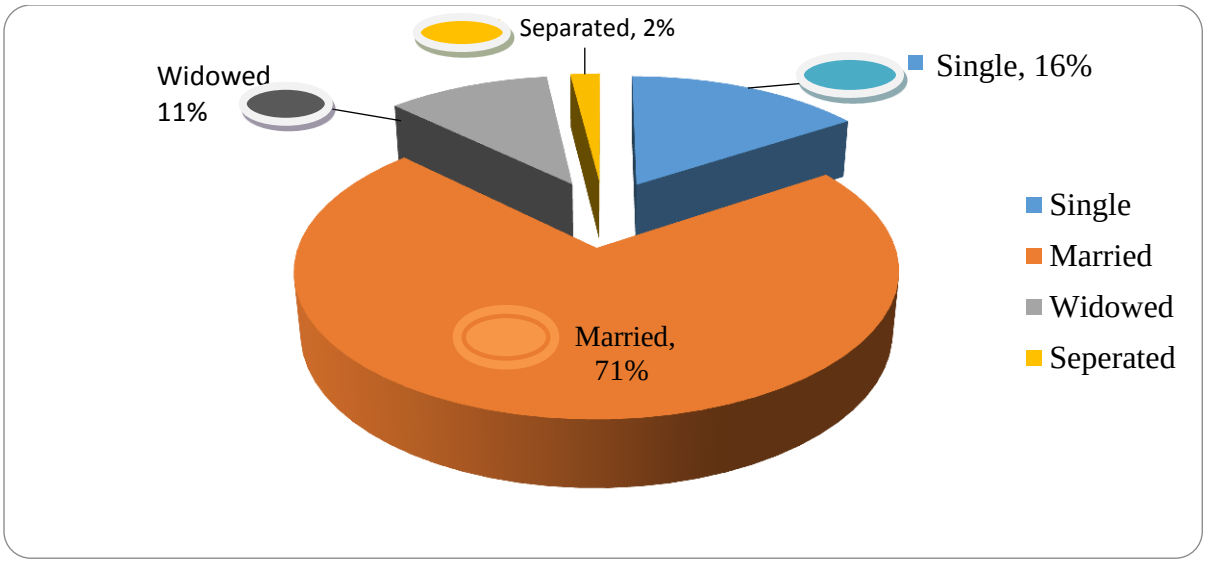

Figure 4.2 Marital Status

From the figure 4.2, it was established that a majority of respondents 71.0% (n=227) are married, followed by 16.0% (n= 51) who are single, then 11.0% (n=35), widowed. Only 2.0% (n=6) indicated being separated. It can be deduced from the findings that households exhibit relatively normal socio-demographic statistics with respect to the family setup, hence normally responsive to various environmental externalities with socio-economic welfare implications as in the present study area.

4.2.3 Household Size

The study further sought to find out respondents' household sizes, which would also help show any notable patterns among responses with respect to the respective household sizes in response to the external environmental externalities explored in the present study. Findings are as presented in figure 4.3.

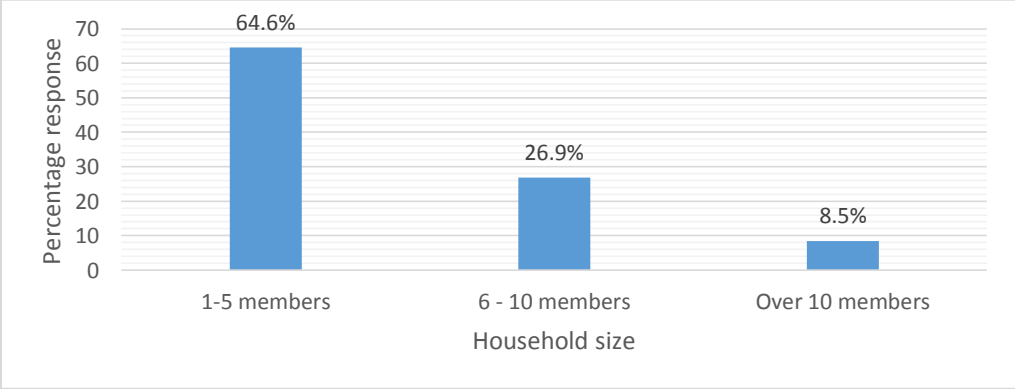

Figure 4.3 Household Sizes

As illustrated in figure 4.3, majority of households 64.6% (n=206) have relatively small family with between 1 and 5 members, followed by 26.9% (n=86) with between 6 and 10 members while 8.5% (n= 27) were relatively large with over 10 members. The relatively small family sizes recorded in the study area can be attributed to the limited resources that are characteristic of slum areas, including small houses to accommodate few household members as well as limited access to adequate water and sanitation.

4.2.4 Response by Length of Stay

With some level of experience in the study area necessary in establishing the study objectives, the study found it appropriate to establish the length of stay of the respondents, in the study area. This would ascertain that responses were already informed by diverse experience owing to respondents' respective lengths of stay. Figure 4.4 presents the findings.

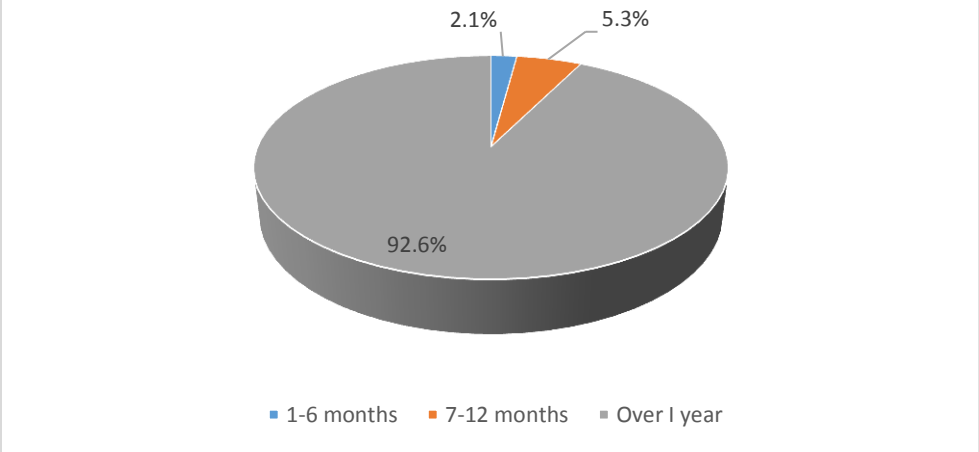

Figure 4.4 Responses by Length of Stay

As illustrated in figure 4.4, the study found that a majority of respondents, 92.6% (n=20) have lived in the study area for over 1 year. This was distantly followed by those who lived between 7 and 12 months, as indicated by 5.3% (n=17) of the respondents while only 2.1% (n=7) had lived in the study are for between 1 and 6 months. With a majority

of respondents having lived in the study area for at least 1 year, responses can be deemed as informed by adequate experience in the study area. The respective lengths of living experience translate into a wealth of experience on issues pertaining to access to water and sanitation in the study area and a majority of respondents were thus suited to participate in the study.

Interviews with key informants revealed that most county and environmental officials have worked at Mukuru Kwa Njenga slum for at least four years. This indicates that a majority of the officials are adequately experienced in environmental issues and challenges facing the Mukuru Kwa Njenga slums and were thus adequately fit to contribute to the study.

4.2.5 Response by Employment Level

The study also sought to determine respondents' employment status. This would serve to show households' socio-economic characteristics in the study area. Results are presented in figure 4.5.

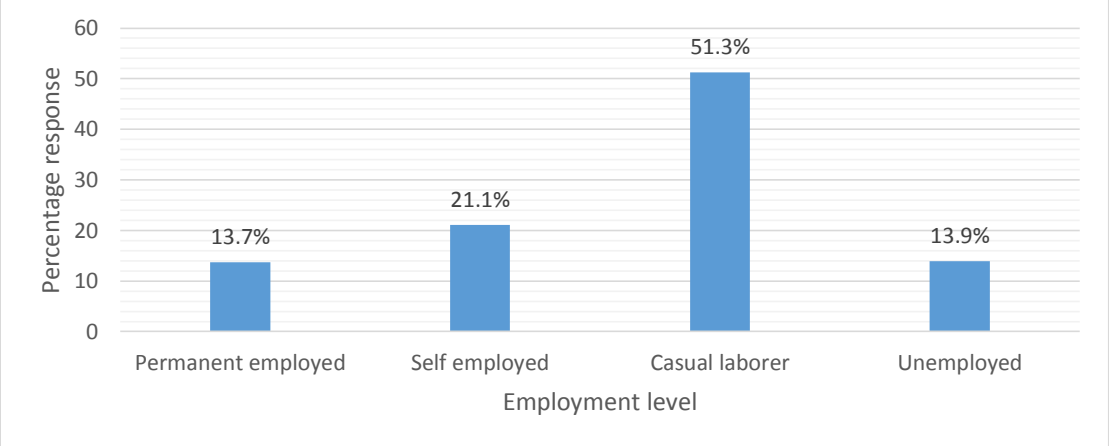

Figure 4.5 Responses by Employment Level

As presented in figure 4.5, majority of respondents, 51.3% (n=164), are employed as casual laborers, distantly followed by the self-employed at 21.1% (n=67) then 13.9% (n=45) who are unemployed while only 13.7% are permanently employed 13.7% (n=43). It can therefore be deduced that most respondents in the study area are employment on a casual labor basis. Such results are related to respondents' socio-economic status, of which to some extent, determines their access to adequate and clean water and sanitation.

4.2.6 Response by Education Levels

Respondents were also asked to indicate their highest levels of education. This would show the formal education literacy levels among respondents in the study area, as well as a general overview of education levels among the community members. Findings are as shown in figure 4.6.

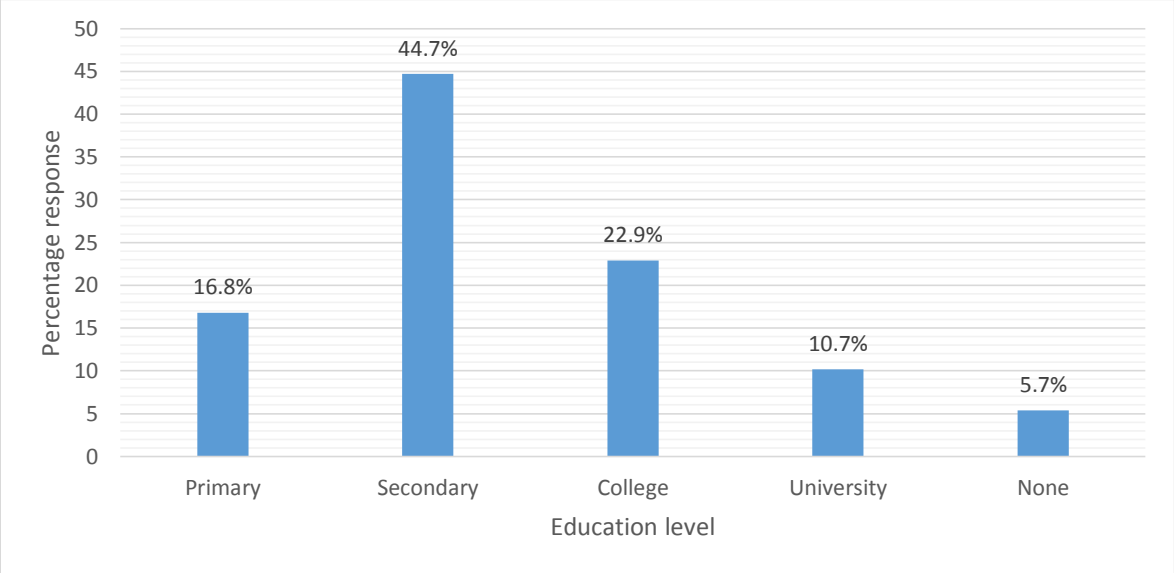

Figure 4.6 Education Levels

Figure 4.6 presents respondents' highest levels of education. From the findings, most respondents, 44.7% (n=143) indicated having attained a Secondary school level, followed by 22.9% (n=73) having attained a college level education while 16.8% (n=54) had attained primary education level. Only 10.2% (n=33) had a university education while a considerable 5.4% (n=17) are not formally educated. The finding is of the implication that at least a half of the respondents had at least attained secondary education level. Education levels in the study area can thus be deemed on average low among a majority of residents. The low education levels may have considerable implications on the adaptation practices by the residents, to the impact of climate variability.

4.2.7 Response by Income Level

Respondents were asked to indicate their total monthly income category. This would serve to further show the respective respondents' socio-economic status and subsequently the influence on adaptation strategies to climate variability. Figure 4.7 presents the finding.

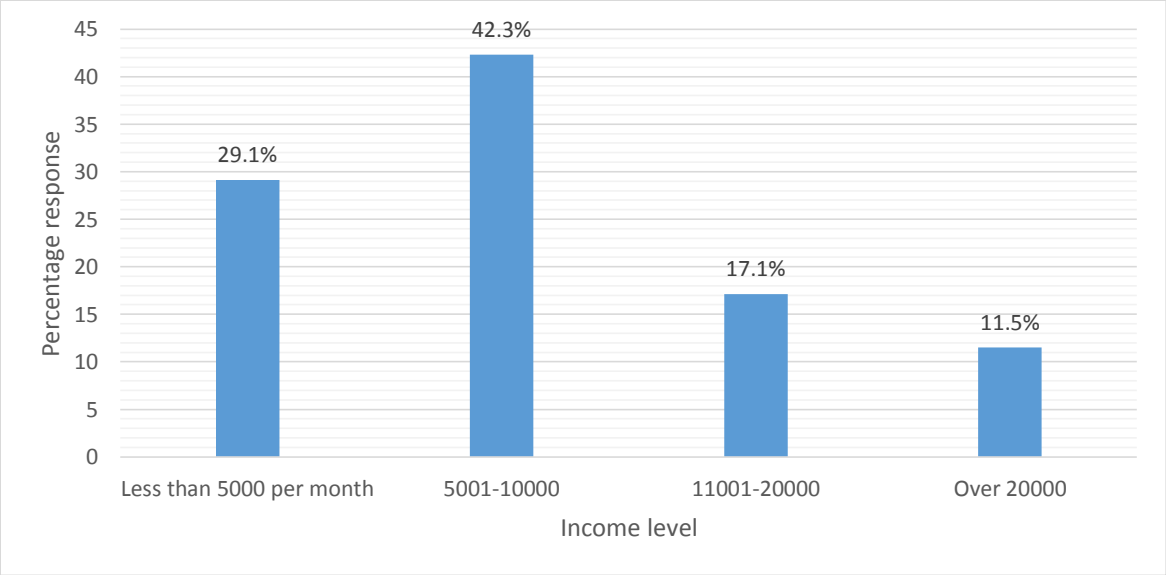

Figure 4.7: Response by Income Level

According to the results, most respondents, 42.3% (n=135), fell within the Kshs 5,001-10,000 monthly income category. This was followed by 29.1%(n=93) with less than Kshs5,000 per month then 17.1%(n=55) with earning between Kshs11,001 and Kshs20,001 while only 11.5%(n=37) earn over Kshs20,000 per month. It can therefore be deduced that only a sizable number of respondents in the study area have relatively sustainable incomes, considering the household sizes with a majority, cumulatively 71.4%, have below Kshs10, 000 in monthly income.

4.3 Climate Variability in Nairobi County

The study first sought to establish the climate variability in Nairobi County over the last 30 years. This meant to an indication of how indeed climate change has taken place across the period and subsequently determine its effects on water supply and sanitation in the study area. Due to data availability issues, the study used the minimum annual temperature data. Figure 4.8 illustrates the findings.

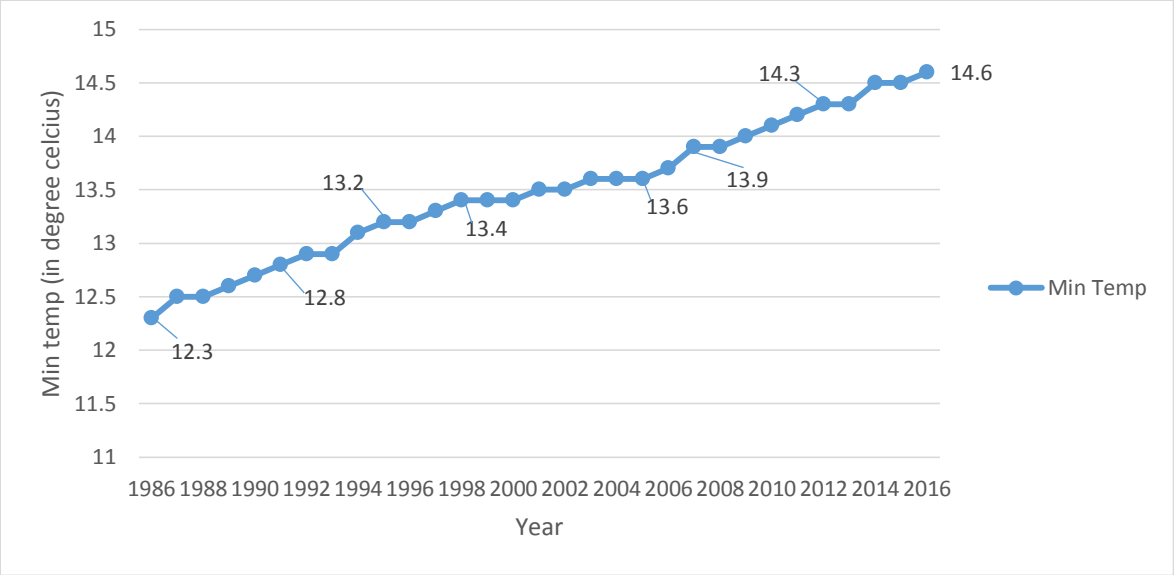

Figure 4.8 Minimum Annual Temperature in degree Celsius (Source: Kenya Meteorological Department)

As illustrated in figure 4.8, an increasing trend in minimum annual temperature in degree Celsius has been experienced across Nairobi County over the last 30 years. The lowest minimum temperature was recorded in the year 1986 at 12.3^{o} C to exponentially pick through 12.8 in 1991, then 13.2 in 1995, 13.4 in 1999, 13.6 in 2004, then 13.9 in 2008, 14.3 in 2012 picking at 14.6 in the year 2016. As such, it can be deduced that indeed climate variability and change as indicated by rising minimum temperature have been experienced in Nairobi County. This temperature data was obtained from Kenya metrological department whose purpose in the study was finding if indeed there is climate change as the weather patterns of the last 35 years from 1980 to 2014 indicates. The climate change has however affected water supply and sanitation in the study area hence making the residents to find ways to adapt.

The findings agree with Ragab and Prudhomme (2002) who argue that there is widespread acceptance that the climate of southern Africa will be hotter and drier in the future than it is today. By 2050, average annual temperature is predicted to have increased by 1.5-2.5° C in the south and by 2.5-3.0° C in the north compared to the 1961-1990 average. The finding is also in tandem with Christy *et al.* (2009) whose results from recent work from stations in Kenya and Tanzania indicate that since 1905, and even

recently, the trend of daily maximum temperature is not significantly different from zero. However, daily minimum temperature results suggest an accelerating temperature rise.

4.3.1 Average Temperature and Rainfall

Table 4.1 shows that in the past 35 years, the months of February and March records the highest maximum temperature compared to other months.

Table 4.1: Average temperature and rainfall

Years	Months (1980-2014)	Average Temperature (ºC)	Average Rainfall (mm)
1980 – 2014	January	25.2	63.1
1980 – 2014	February	26.4	52.0
1980 – 2014	March	26.4	95.3
1980 – 2014	April	24.4	214.5
1980 – 2014	May	23.2	167.2
1980 – 2014	June	22.2	36.2
1980 – 2014	July	21.5	19.4
1980 – 2014	August	22.0	24.1
1980 – 2014	September	24.4	28.2
1980 – 2014	Octobers	25.0	76.6
1980 – 2014	November	23.4	151.6
1980 – 2014	December	23.7	99.9

Source: (Kenya Meteorological Department)

Both February and March had 26.4ºC. The month of July was the coldest month with least average monthly temperature of 21.5ºC. The month of April had the highest amount of rainfall at an average of 214.5mm while the month of July had the least precipitation of 19.4 mm in the last thirty-five years.

4.3.2 The Trend of Temperature from 1980 to 2014

Figure 4.9 shows annual mean temperatures. Both 1987 and 2000 had the highest mean temperature (24.6°C) in the past 35 years in Nairobi. The year 1989 had the lowest mean (22.9°C). It was followed by the year 1985 with an annual mean of (22.5°C). Deduction from the trend of temperatures indicate that in the years when there was a very high temperature preceded by low temperatures.

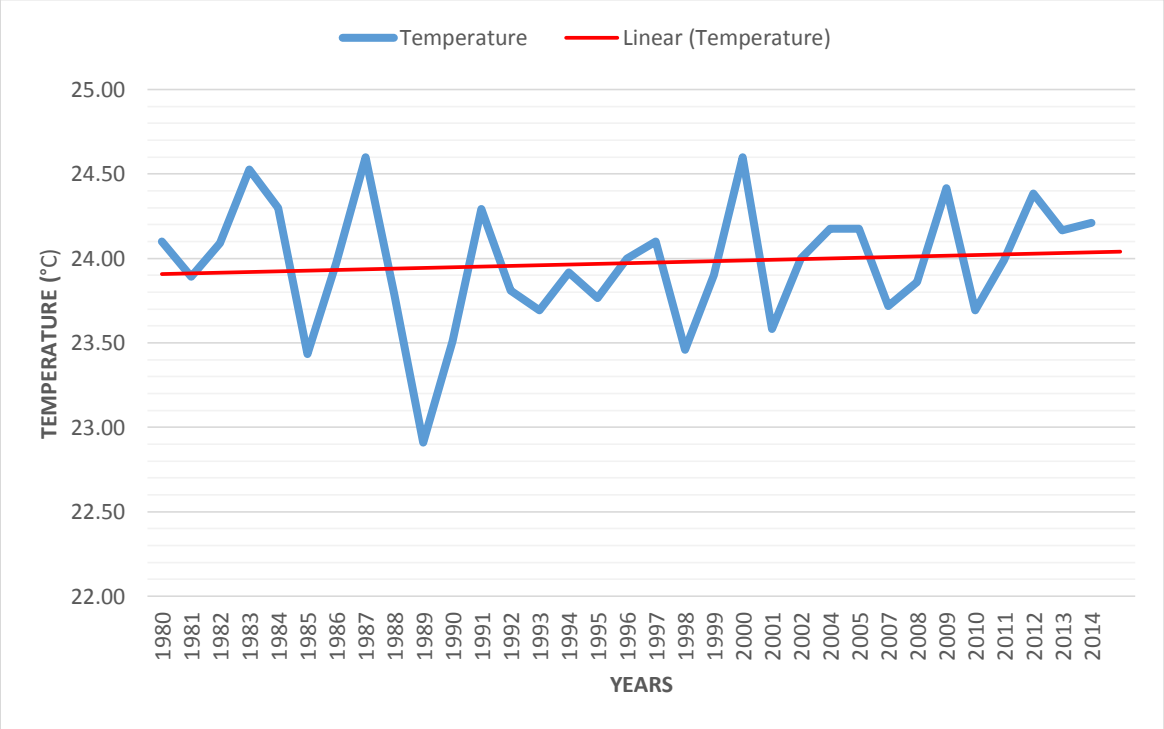

Figure 4.9: Trend for temperature since 1980to 2014 (Source: Kenya Meteorological Department)

4.3.3 Rainfall Trend from 1977 to 2014

Figure 4.10 indicates annual mean rainfall was 112.83. The year 1977 had the highest precipitation at 129.1mm followed by 2013 that had a mean of 123 mm. The year with the least mean amount of rainfall was 1984 that accumulated 40.2 mm.

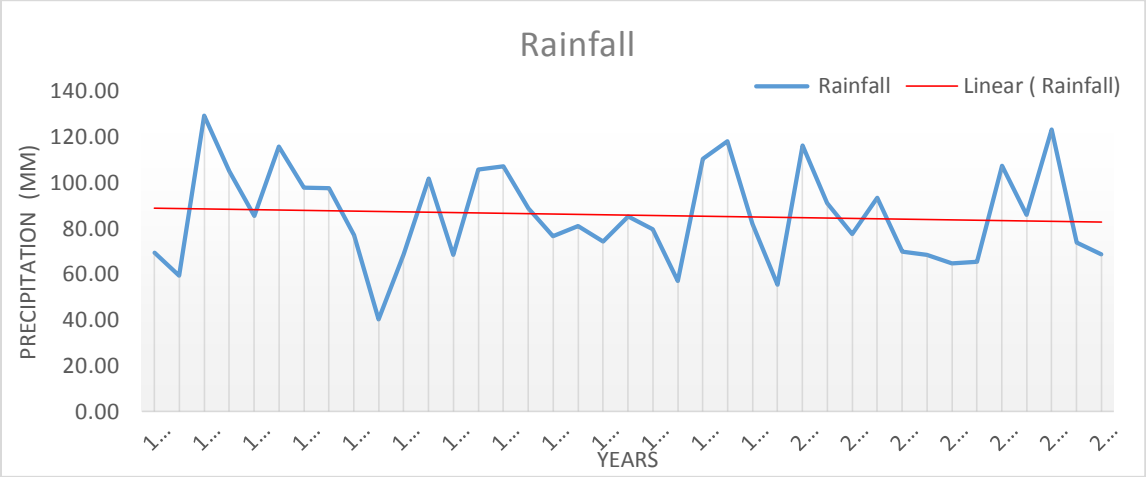

Figure 4.10: Annual rainfall trends (Source: Kenya Meteorological Department)

4.3.4 The Trend and Climate Variability between Precipitation and Temperature (1980 – 2014)

Figure 4.11 shows the trend between precipitation and temperature in in the past 35 years. From the trend, precipitation and temperature tend to take different shifts. In the initial years, precipitation was high as temperature was at moderate level. In the years when temperature was very high at (24.6°C) for both 1987 and 2000 had considerable low rainfall, that is 68.5 mm and 55.4 mm respectively.

The cyclic movement of temperature and rainfall depicts the climate variability over the 35 years. In most cases the low precipitation is associated with a temperature. Since 2001 to 2014 temperature was oscillating from 23.5°C to 24.5°C. The climate variability reflected by rainfall and temperature has affected the consistency of availability of water. This greatly affects sanitation levels in areas like Mukuru Kwa Njenga where low income household live.

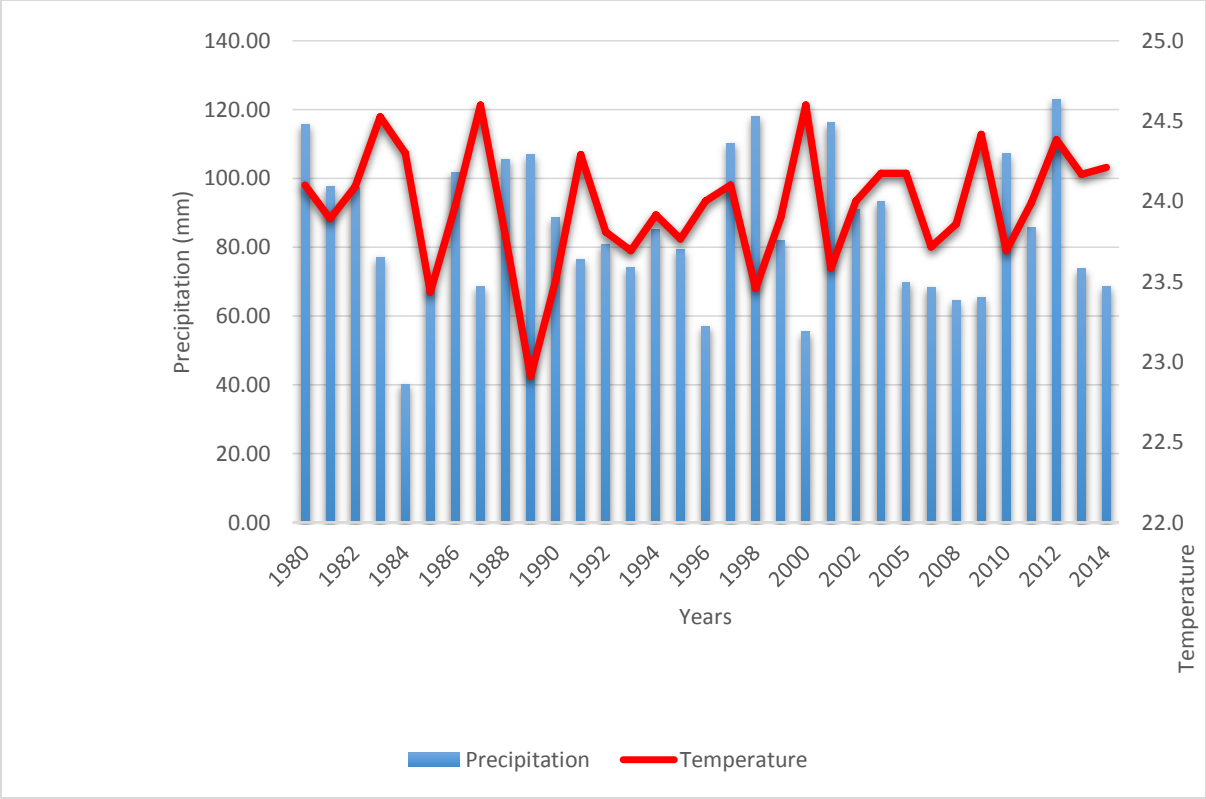

Figure 4.11: The trend between precipitation and temperature (Source: Kenya Meteorological Department)

4.4 Community's Adaptation and Coping Mechanism

The study sought to identify the community's adaptation and coping mechanism strategies to poor accessibility of portable water and basic sanitation in the current context of climate variability and change. This section is a presentation and discussion of pertinent questions asked in this regard.

Respondents were first asked to indicate their source of drinking water. This would serve as an indication of the safety of water used by respondents in their drinking and sanitation needs. Figure 4.12 illustrates the findings.

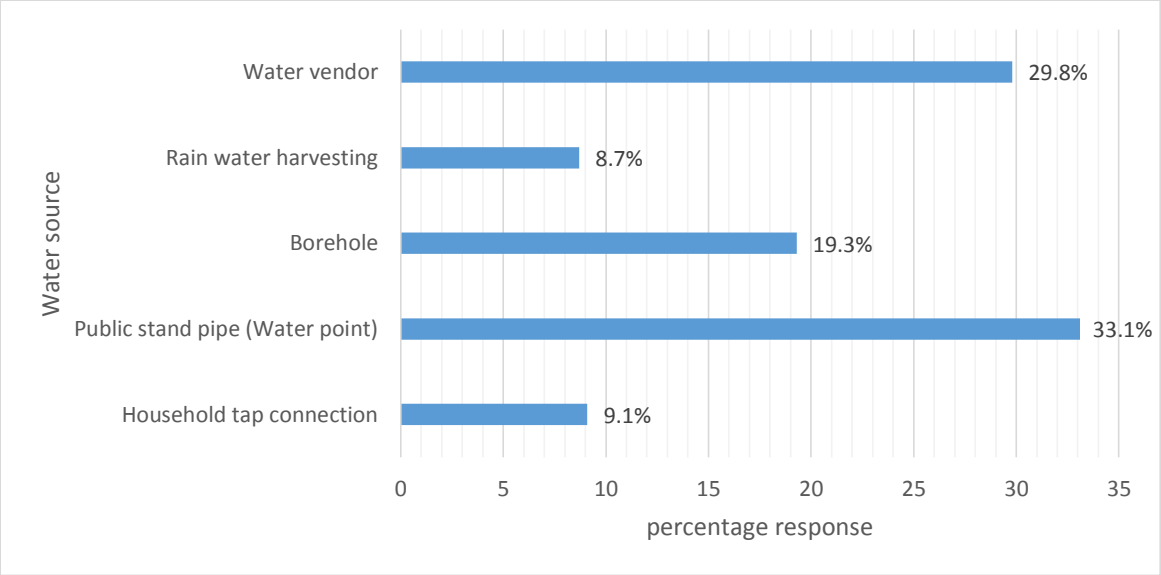

Figure 4.12 Water Sources

As illustrated in figure 4.12, a majority of respondents 33.1% (n=106) use public water points to fetch water, closely followed by 29.8% (n=95) of the respondents who affirmed utilizing water vendors while 19.3% (n=62) access borehole services. Only 9.1% (n=29) and 8.7% (n=28) of respondents use either household tap connection or rain water harvesting respectively. It can be deduced from this finding that adequate water is not readily available for most of the residents in the study area, as they must line up in order to access water either from a public water point or water venders. This translates into inadequate water to use for sanitation purposes, which has dire implications on the health of the affected residents.

The study was also interested in establishing whether respondents treat their drinking water; whether respondents have heard of the word "climate change"; whether respondents feel that there is variation of daily temperature and rainfall, whether they think anything can be done to tackle these changes; whether they ever experienced water shortage; Table 4.2 presents the finding.

Table 4.2 Community Awareness and experiences

Questions		Responses (%)	
		Yes	**No**
i.	Do you treat your drinking water?	28.8	71.2
ii.	Do you feel the pattern of weather is generally changing?	90.4	9.6
iii.	Have you heard of "climate change"?	100	0
iv.	Do you think anything can be done to tackle climate change?	67.3	32.7
v.	Have you ever experienced water shortage?	100	0

As detailed in table 4.2, all of respondents affirmed that they have ever experienced water shortage 100.0% (n=319); have heard of "climate change" 100.0%; they feel that the pattern of weather is generally changing 90.4% (n=288); and that something can be done to tackle climate change 67.3% (n=215). A majority however does not treat their drinking water 71.2% (n=277).

It can be noted from this finding that a majority of the residents both appreciate the reality of climate change and have personally been affected by the phenomenon in way, more particularly, experiencing water shortage as well as the changing weather patterns. The large number of households not treating water in any way before use can be seen as an impediment to a safe nutrition status and a significant cause of the reported health challenges.

The study sought to establish how respondents store their water. This would serve as an indication of both sanitary and water safety precautions as well as the water sustainability measures by residents with implications on their health. Figure 4.13 illustrates the finding.

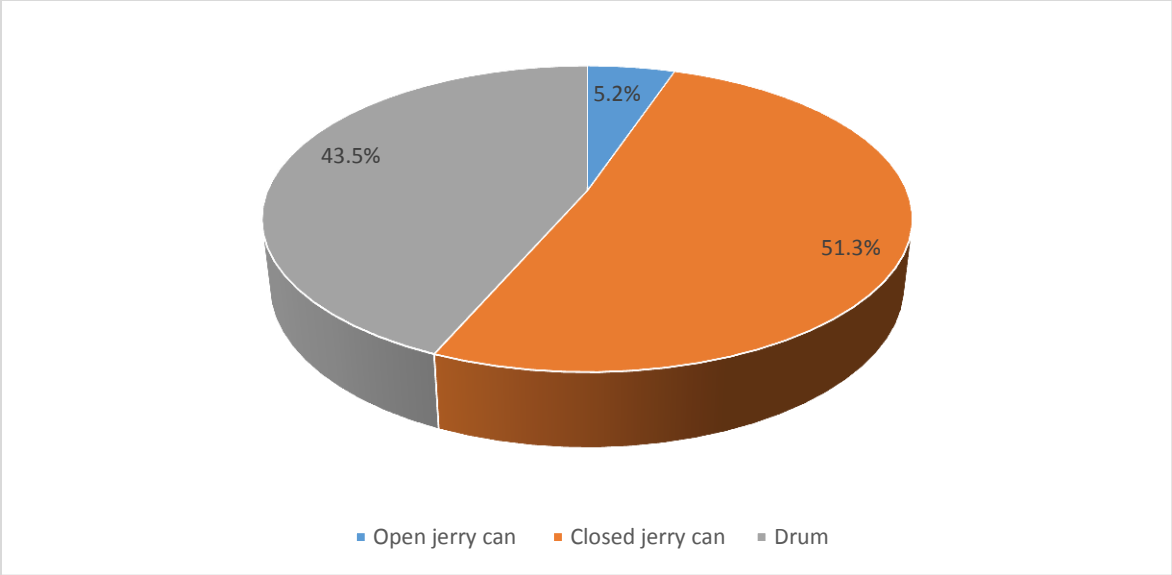

Figure 4.13 Water Storage

As illustrated, most respondents, 51.3% (n=164) store their water in closed jerry cans, followed by 43.5% (n=139) who store their water in drums while only 5.2% (n=17) use open jerry can as their water storage equipment. It can be deduced from this finding that a majority of residents in the study area observe sustainable water storage practices by use of drums and jerry cans and also take water safety and sanitary measures by closing their storages. If practiced consistently, this may significantly reduce water borne diseases and illnesses emanating from unsanitary water handling practices.

The study also sought to find out where respondents put their human waste, as whether pit latrines, flush toilets or paper bags (flying toilets). This would also be an indication of the level of sanitation in the study area, with regard to human waste, which also has implications on the residents' health. Figure 4.14 illustrates the finding.

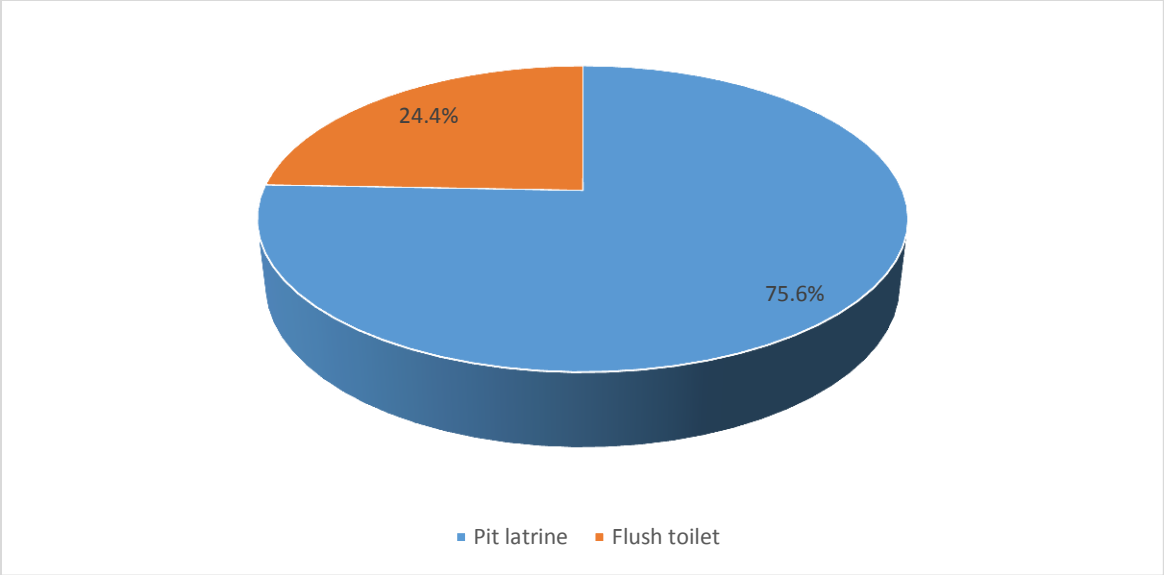

Figure 4.14 Human Waste Depositing

As illustrated in figure 4.14, most respondents 75.6% (n=241) deposit their human waste in pit latrines, while 24.4% (n=78) use flush toilets. As such, it can be noted that a majority of respondents use sanitary human waste deposit practices. Whereas these may be sanitary if properly used, improper use of the same may be unsanitary, considering the dense human population in the study area. When overly used, pit latrines tend to fill up fast which is hazardous to human health and flush toilets may be inadequate in absence of sufficient water.

Respondents were further asked to indicate materials they recycle, as whether water, plastic, cans and bottles. This would serve as an indicator of measures residents take in an effort to store more water for their domestic use. Results are as indicated in figure 4.15.

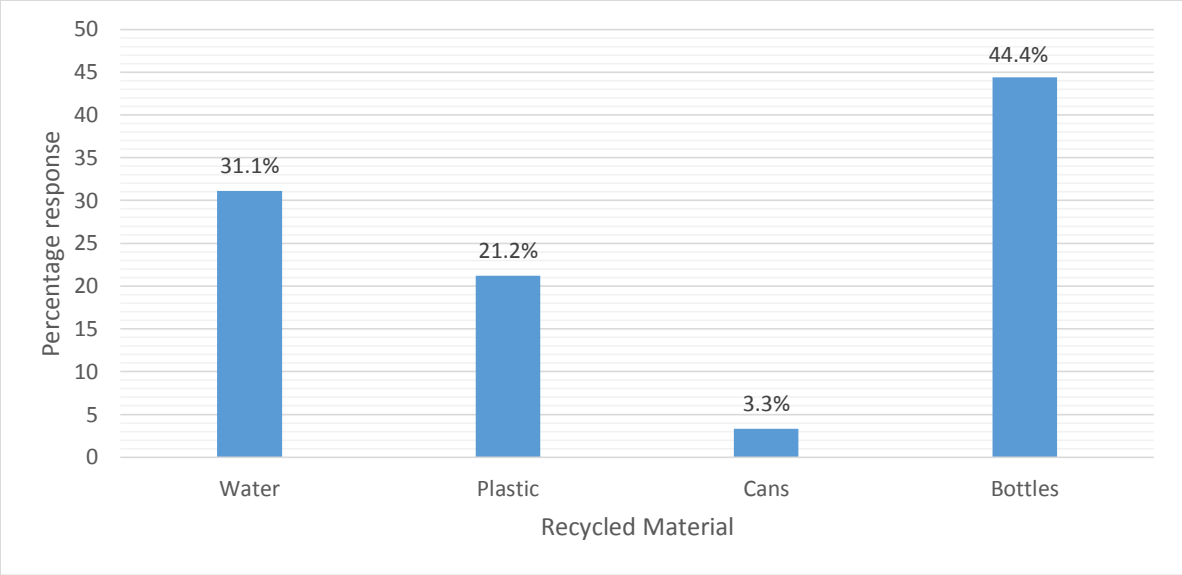

Figure 4.15: Recycled materials

Most respondents affirmed to recycling bottles, followed by 31.1% (n=99) who recycle water then 21.2% (n=68) recycling plastics while 3.3% (n=11) recycle cans. It can be noted that as a coping strategy, a majority of residents in the study area recycle bottles in order to use the same as water storage equipment. Secondly, most residents recycle water for their everyday domestic use to use the same in conserved manner. This can prove effective during water shortage episodes common in the study area.

The study sought to find out which among a range of environmental issues concerns respondents the most. This would indicate which environmental issues most residents prioritize the most and therefore need addressing fast. Figure 4.16 illustrates the finding.

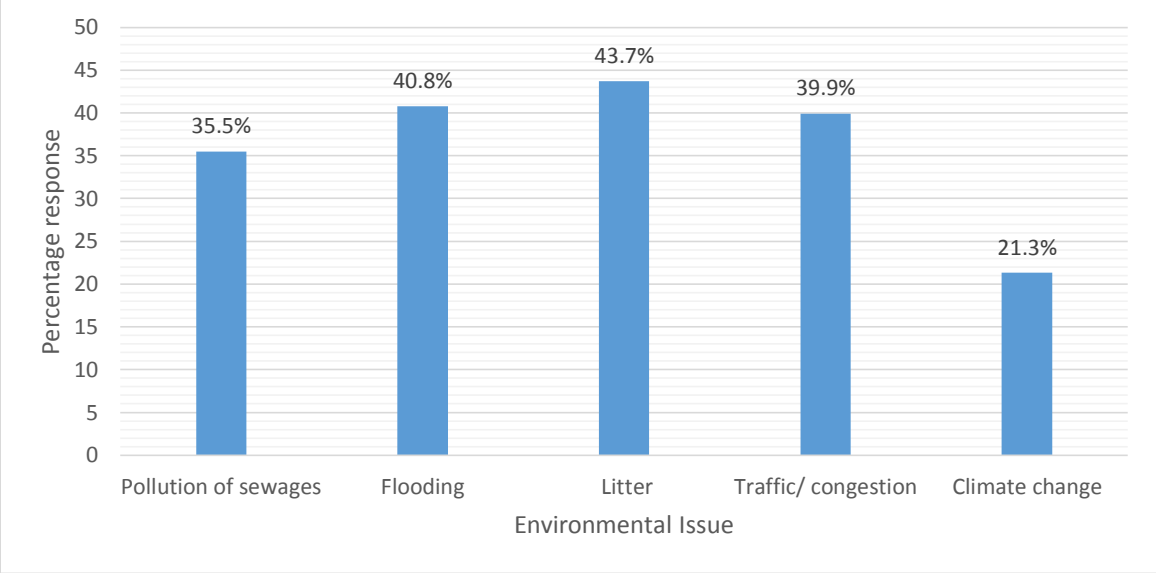

Figure 4.16: Environmental Issues

As illustrated, most respondents 43.7% (n=139) consider litter the most pressing issue, followed by flooding 40.8% (n=130) then traffic / congestion 39.9% (n=127) and pollution of sewages 35.5% (n=113) while 21.3% (n=68) consider climate change a pressing issue. It can be deduced from the findings that most residents in the study area are displeased with the scattered and unmanaged litter, which causes both food and water borne diseases in the study area. Flooding is also a significant cause for concern among residents owing to the poor drainage systems also with serious health and safety implications. A considerable number of residents further acknowledge climate change as an urgent cause of concern with an immediate need to address.

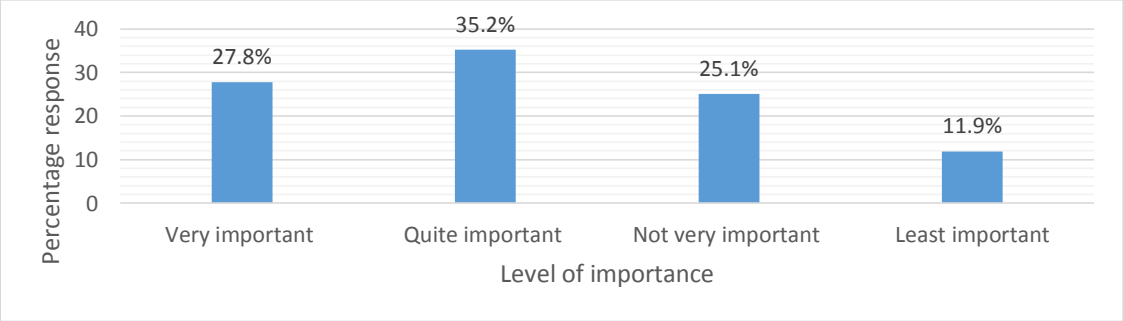

Figure 4.17 Importance of Climate Change /climate Variability

Respondents were further asked to indicate how important the issue of climate change/climate variability was to them personally. Figure 4.17 illustrates the finding.

Most residents consider climate change/climate variability as quite an important issue personally, while 27.8% (n=89) consider the same very important. Only 25.1% (n=80) of residents do not consider climate change/climate variability as a very important issue to them personally while 11.9 %(n=38) deem it least important. As such, most residents in the study area consider climate change a very important issue to them personally and their in their opinion, the same needs urgent attention. This can be attributed to the frequent water shortages in the study are and the changing weather patterns.

Respondents were asked to indicate the strategies their respective families employ in order to adapt to water shortage. Figure 4.18 illustrates the results.

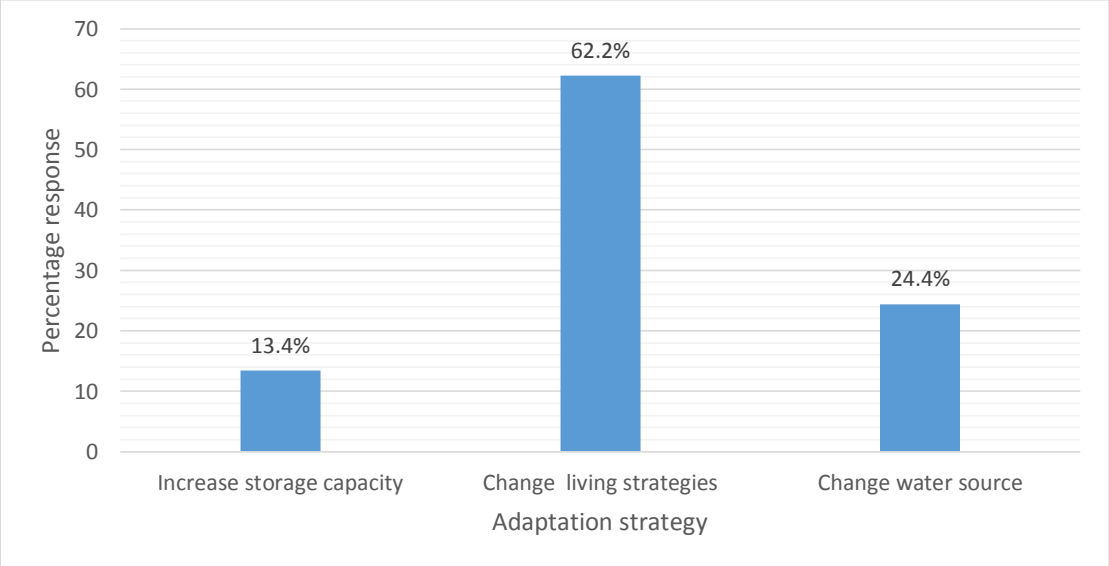

Figure 4.18 Water storage techniques applied in the study area

Most households were found to change living strategies as a technique to adapt to water shortage, while 24.4% (n=78) change their water source then 13.4% (n=43) increase their storage capacity. As such, it can be deduced that residents in the study area employ different techniques in order to adapt to water shortage which is one of the effects of climate change. The living strategies employed include use of minimal water during showering and washing cloths less frequently. Others diversify their water sources.

Key informants were further asked their understanding of what adaptive mechanism measures, the Mukuru Kwa Njenga residents have employed against water scarcity and inadequate sanitation access. Respondents confirmed that most residents use big drums and jerry cans to store water. This water was obtained from harvesting rain water when it rained and from water points when it's available. A respondent by the name Daniel Otieno observed that:

> *"I see most residents lining up drums and jerry cans to fetch water at public water points. This is a good adaptive strategy to make sure there is enough water during water scarce days."* This is one of the adaptive strategies to water scarcity.

In view of the current trends in climate variability, key informants were asked to recommend management strategies which in their opinion will enable the residents of Mukuru Kwa Njenga to remain protected from climate impacts. Respondents recommended that residents practice sustainable waste management by properly dumping waste in designated points to avoid blocking water drainages, which will help during heavy downpours. Respondents further suggested the sparing use of water in order to conserve for period of water shortages.

The findings agree with CCSP (2008) who argues that basic sanitation is crucial to the overall health of communities, as well as the environment. So, sanitation initiatives, often in conjunction with hygiene projects, are frequently high priority programs for development organizations. The findings are further supported by WHO (2010) and Vision (2030) which states that water-related diseases are the most common cause of illness and death among the poor in developing countries. Estimates indicate that more than two billion people live without access to adequate sanitation. In addition, the findings are in line with ICLEI (2011) who notes that supporting climate change adaptations for sanitation systems will increase the resilience of development programs to improve public health and environmental protection.

4.5 Factors Hindering the Community to have Access to Improved Water Supply and Basic Sanitation

The study sought to assess the factors hindering the community to have access to improved water supply and basic sanitation. This section is a presentation and discussion of pertinent questions related to the research question that was sought to be investigated.

Respondents were asked to describe the drainage in their area, as whether well drained, moderate, poor or very poor. This would serve to show how hazardous the drainage systems can be during heavy downpours. Figure 4.19 illustrates the results.

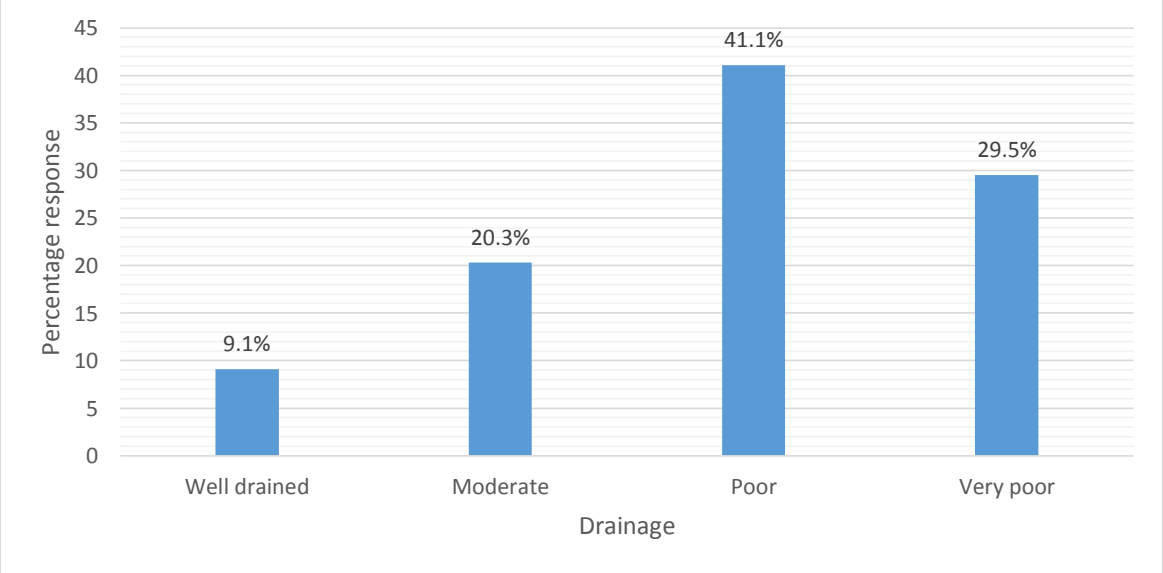

Figure 4.19: Drainage

Most respondents 41.1% (n=131) rated their drainage systems as poor, while 29.5% (n=94) rated the same as very poor. Only 9.1% (n=29) of the residents live in well drained areas. As such, it is notable from the finding that the drainage systems in most parts of the study area are poor and this has significant health repercussions especially during the rainy seasons as the consequent flush floods are likely to breed water borne diseases. The reported health issues from the sanitation conditions in the study area can be reported to such agents of water borne diseases.

Respondents were further asked to indicate how they cope with burst sewer lines. This was meant to gauge the capacity of residents to cope with such hazards to sanitation as sewage in case of burst sewer lines. The results are as presented in figure 4.20.

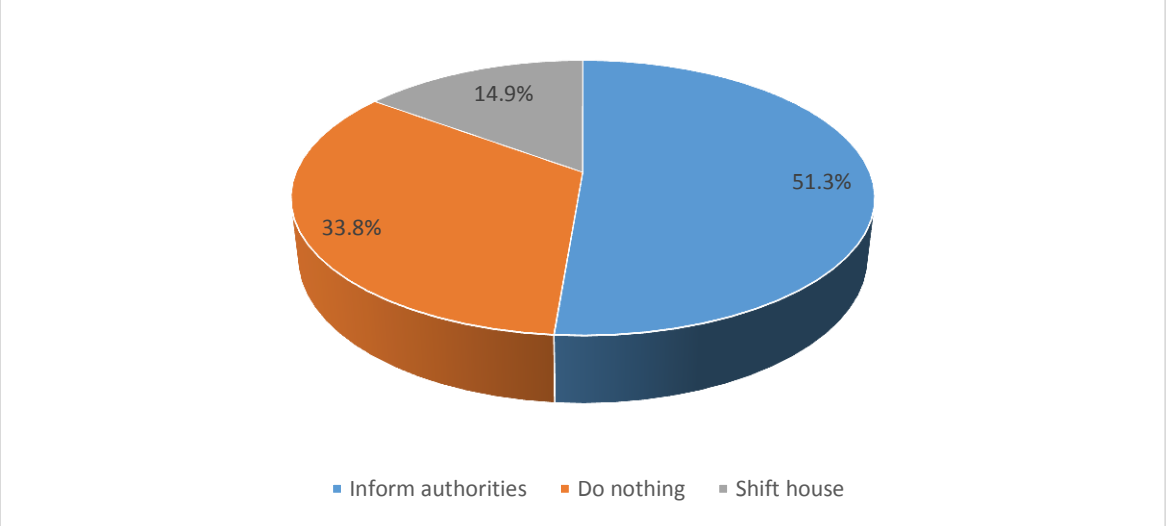

Figure 4.20 Response to Burst Sewer Line

Most respondents 51.3% (n=164) indicated that they do inform the authorities of burst sewer lines while 33.8% (n=108) indicated that they not have the capacity to do anything in such cases. Only 14.9% (n=47) shift their residences in such cases. From the finding, it can be deduced that most residents, other than informing the responsible authorities, do not have the capacity to address burst sewer lines, other than evacuating residents for the same reason. This exposes residents to serious food and water borne diseases due to the unsanitary environment created by burst sewer lines. Respondents were then asked to indicate what in their opinions changes the living conditions in their respective areas. Figure 4.21 illustrates the finding.

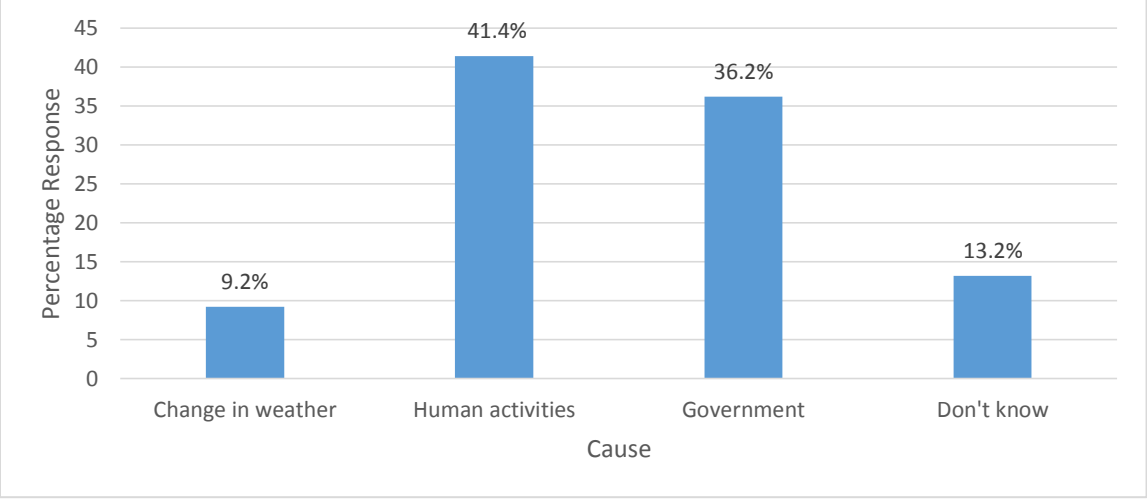

Figure 4.21 Causes to the Changes to the living conditions

Most respondents 41.4% (n=132) attribute the changes in their living conditions to human activities, followed by 36.3% (n=116) attributing the same to government while 9.2% (n=29) to changes in weather. From the foregoing most of the environmental issues experienced in the respondents' surroundings can be attributed to both human activities and the government. Such include littering, poor drainage, burst sewers and water shortages. It is thus possible to reverse the status quo by re-examining human activities and proper use of government resources.

Key informants were further asked to indicate the main factors that have contributed to the vulnerability of the Mukuru Kwa Njenga residents. To this end, it was established that overpopulation, vandalism of infrastructure and irresponsible waste handling are among the main factors that have contributed to vulnerability of the Mukuru Kwa Njenga residents.

According to a one key informant by the name Moses Omondi who is an environmentalist with a local NGO,

> *"The challenge with Mukuru Kwa Njenga slum is that the place is overcrowded and inaccessible, and this has led to the congestion of facilities such as dumpsites and water stagnation."*

This implies that there is need of regular education to the residents to prevent improper handling of waste since the area is inaccessible leading to flooding and a lot of waste in the area.

Asked on what activities/projects key informants undertake among the residents of Mukuru Kwa Njenga, it was revealed that a majority of respondents are concerned with environmental governance in the area including environmental inspection to identify any environmental issues affecting residents; and administrative functions including checking for health and safety of restaurants and other food outlets. A respondent by the name Humphrey working with the county government for instance offered:

"I am an Environmental Inspector, in Mukuru Kwa Njenga, like any other area within my jurisdiction, I am tasked with ensuring all environmental challenges that residents face are resolved in a timely and adequate manner."

This implies that the chief environmental inspector assigned to Mukuru Kwa Njenga is conversant with the challenges in the area and is always offering solutions to the residents living there.

Asked on what the organization intends to achieve through this (these) intervention(s) in Mukuru Kwa Njenga, it was unanimous among the key informants that the interventions were aimed at providing a healthy, safety and sustainable environment for residents for socio-economic prosperity and sustainable development.

The foregoing findings are supported by NRC (2008) who argue that climate change, as well as increases in climate variability, will increase the vulnerability of certain regions and communities to changes in hydrological responses. WHO/DFID (2009) adds that climate change has increased vulnerabilities in Kenya. Resource poor farmers and communities or individuals with substantial exposure to climate change elements are rendered vulnerable, often facing serious crop failures, income losses and livelihood collapses.

4.6 Sustainable Development Achievement through Accessible Water Supply and Basic Sanitation.

The study sought to assess how poor accessibility to improved water supply and basic sanitation affect the achievement of sustainable development. This section is a presentation and discussion of pertinent questions asked in this regard. The study was first interested in finding out how frequent residents experience water shortage, as whether daily, weekly or monthly. Figure 4.22 presents summary of results.

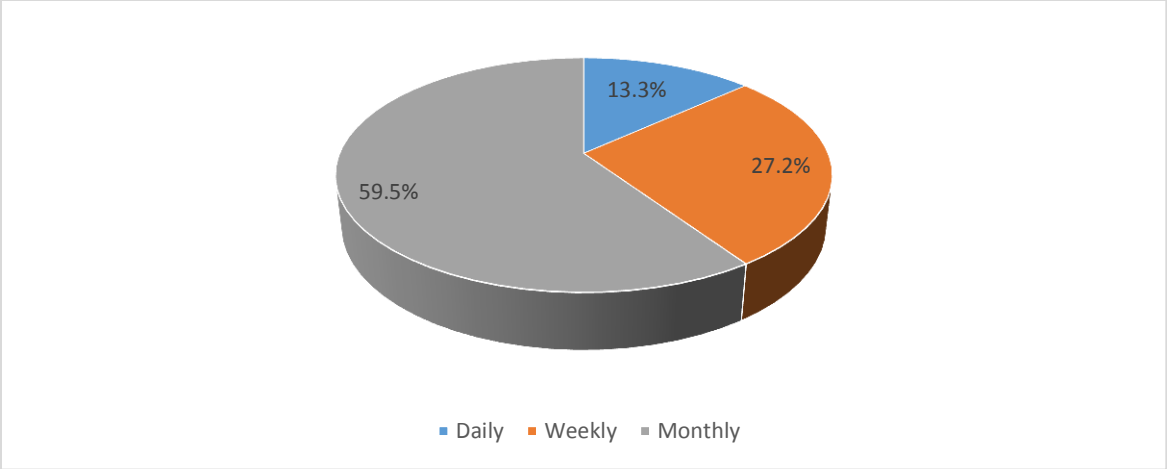

Figure 4.22 Frequency of Water Shortage

Most respondents 59.5% (n=190) experience water shortage on a monthly basis, followed by 27.2% (n=87) who experience the same weekly while 13.3% (n=42) have daily water shortage. As such, it should be noted that water shortage is a significant environmental issue in the study area with water shortage episodes being experienced to a large extent every month and a considerable number of cases, every week. This has dire implications on the sanitation needs of the residents.

The study sought to find out whether water pollution has extremely negative outcome on respondents' health; whether sanitation conditions have ever affected their health; whether apart from effects on people's health, respondents were experiencing any other effects of sanitation pollution; whether respondents perceive climate change as affecting or will directly affect them individually; and if their respective families have been affected by burst sewer.

Table 4.3 Effect of Climate Change on Water and Sanitation Issues on Sustainable Development Goals

Questions		Responses (%)	
		Yes	No
i.	In your view, has water pollution ever affected your health?	63.5	36.5
ii.	Has water pollution ever affected the health of any of your family members or friends?	78.8	21.2

iii.	Apart from effects on people's health, are you aware of any other effects of water pollution?	17.3	82.7
iv.	In your view, has sanitation condition ever affected your health?	71.2	28.8
v.	Apart from effects on people's health, are you aware of any other effects of sanitation pollution?	25	75
vi.	Do you think climate change is something that is affecting or is going to affect you, personally?	94.2	5.8
vii.	Has your family been affected by burst sewer?	78.8	21.2

From the above outline of responses (table 4.3), majority of respondents agree that climate change is affecting or will directly affect them in the future 94.2% (n=300); that their family been affected by burst sewer 78.8% (n=251); water pollution has impacted negatively on the health of either their family members or friends 78.8% (n=251); sanitation condition ever affected their health 71.2% (n=227); and that water pollution has ever affected their health 63.5% (n=203). A majority however, with exception to people's health, they do not know any other harmful result of water pollution 82.7% (n=264); also with exception to people's health, do not know any other negative outcome of sanitation pollution 75.0% (n=239).

It can be deduced from the foregoing that most of the residents have also suffered from the negative effects of human activities bearing on their sanitation and health. This is for instance burst sewers and water pollution which have ultimately affected a majority of the respondents' health as well as their family members'.

The study sought to find out the family monthly medical bills on water and sanitation related illnesses. This was meant to indicate the level of seriousness water and sanitation related illnesses emanating from such issues as water shortage, litter, burst sewers and poor drainage. Figure 4.23 presents the finding.

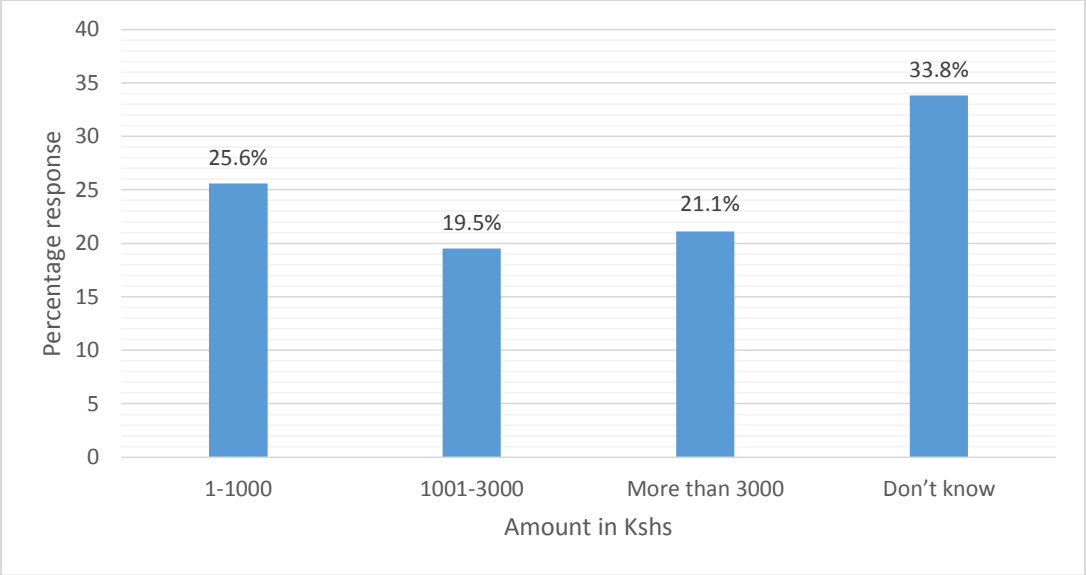

Figure 4.23 Monthly Medical Bills due to health issues attributable to water and sanitation.

Whereas most respondents were not sure of the monthly medical bills, 25.6% (n=82) of respondents put the figure at less than Kshs1000, followed by 21.1% (=67) at more than Kshs3000 while 19.5% (n=62) range the same between Kshs1001-3000. From this finding, it can be deduced that water and sanitation related illnesses emanating from such issues as water shortage, litter, burst sewers and poor drainage in the study area also have significant socio-economic consequences as significant funds are channeled towards medical bills.

Key informants were also asked whether climate variability is an important consideration in the planning and implementation of their programs. It was found in this regard that climate variability is indeed an important factor in respondents' lines of duty.

The study sought key informants' opinions on the main effects of water scarcity and sanitation access on the Mukuru Kwa Njenga livelihoods. It was found in this regard that the main effects of water scarcity and sanitation access on the Mukuru Kwa Njenga livelihoods include related illnesses such as frequent cases of Cholera, Typhoid and Diarrhea.

The findings are in line with WHO/DFID (2009) that poor hygiene and sanitation levels hamper crucial development agendas ranging from health and economic productivity.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of the research findings. The implications from the findings and areas for further research are also presented.

5.2 Summary of Key Findings

The study sought to identify the community's adaptation and coping mechanism strategies to poor accessibility of portable water and basic sanitation due climate change. A majority of respondents had water storage equipment's. Most respondents affirmed to recycling bottles, water and plastics.

The study further established that a majority of respondents agree that climate change is a phenomenon that is affecting or is going to directly affect them personally in the future.

The study sought to assess the factors hampering the community to have access to adequate water supply and essential sanitation levels. A majority of respondents rated their drainage systems as poor, while a low number of the residents live in well drained areas.

The study sought to assess low accessibility to adequate water supply and essential sanitation levels affect the achievement of sustainable development. A very number of respondent's experience water shortage on a monthly basis, a moderate number experienced water shortage weekly and a low number experience the problem on a daily basis.

5.3 Conclusion

From the findings, the following conclusions can be made; adequate water is not readily available for most of the residents in the study area, as they have to line up in order to access water either from a public standpoint or water venders. This translates into inadequate spare water to use for sanitation, which has dire implications on the health of the affected residents. It can also be deduced that a majority of residents in the study area observe sustainable water storage practices by use of drums and jerry cans and also take water safety and sanitary measures by closing their storages. If practiced consistently, this

may significantly reduce water borne diseases and illnesses emanating from unsanitary water handling practices.

The study further deduces that a majority of respondents use sanitary human waste deposit practices. Whereas these may be sanitary if properly used, improper use of the same may be unsanitary, considering the dense human population in the study area. When overly used, pit latrines tend to fill up fast which is hazardous to human health and flush toilets may be inadequate in absence of sufficient water. It is further noted that as a coping strategy, a majority of residents in the study area recycle bottles in order to use the same as water storage equipment. Secondly, most residents recycle water for their everyday domestic use in an effort to use the same in conserved manner. This can prove effective during water shortage episodes common in the study area. The living strategies employed include use of minimal water during showering and washing cloths less frequently. Others diversify their water sources.

It is also notable from the finding that the drainage systems in most parts of the study area are poor and this has significant health repercussions especially during the rainy seasons as the consequent flush floods are likely to breed water borne diseases. The reported health issues from the sanitation conditions in the study area can be reported to such agents of water borne diseases. Most of the environmental issues experienced in the respondents' surroundings can be attributed to both human activities and the government. Such include littering, poor drainage, burst sewers and water shortages. It is thus possible to reverse the status quo by re-examining human activities and proper use of government resources.

Water shortage is a significant environmental issue in the study area with water shortage episodes being experienced to a large extent every month and a considerable number of cases, every week. This has dire implications on the sanitation needs of the residents. It can be deduced from the foregoing that most of the residents have also suffered from the negative effects of human activities bearing on their sanitation and health. This is for instance burst sewers and water pollution which have ultimately affected a majority of the respondents' health as well as their family members'. It can also be deduced that water and sanitation related illnesses emanating from such issues as water shortage, litter,

burst sewers and poor drainage in the study area also have significant socio-economic consequences as significant funds are channeled towards medical bills.

5.4 Recommendations

In an era where climate change and the depletion of resources are fast becoming a reality in many parts of the world, we have to bear in mind the need for resource conservation as we spearhead different developmental activities. Informal settlements should not be condemned to filthy neighborhoods which lack sanitation facilities. The study recommends education on water usage and conservation methods by National Environmental Management Agency (NEMA) and other non-governmental organizations working in the area.

To handle hindrance to access to improved water and basic sanitation, the study recommends improved capacitation on Nairobi water and Sewerage Company to ensure adequate supply of water and drainage of the sewerage.

To cope with the effects of climate change in Mukuru kwa Njenga slums such as water shortage, the study recommends that both rainwater harvesting and water recycling mechanisms by the residents, Non-governmental organizations (NGO's) and the private sector. To ensure sustainability in provision of water and basic sanitation, the study recommends the drilling of boreholes by the county government and the non-governmental organizations.

5.5 Suggestions for Further Studies

The present study has explored the adaptation strategies to climate variability on water and sanitation access in Mukuru Kwa Njenga slum, Nairobi County, Kenya. The study recommends that future studies focus on:

1. More studies on mitigation being carried out in the area in response to climate change and variability should be researched.
2. Impacts of climate change and variability on water sources in the area should be researched.

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APPENDIX I: Questionnaire

Questionnaires for the residents of Mukuru Kwa Njenga slums

Dear Respondent

I am a master's student at Kenyatta University pursuing Master of Environmental Studies (climate change and sustainability). Currently, I'm carrying out a research on adaptation strategies to climate variability on water and sanitation access in Mukuru kwa Njenga slum, Nairobi County, Kenya. I kindly request you to fill in this questionnaire. The information collected will be used strictly for the purpose of this study and will be treated confidentially.

Thank you for agreeing to participate in the study.

Yours Faithfully

Philip Kariuki

A. Demographic question

1) State your age ……..
2) What is your marital status
   I. Single
   II. Divorced
   III. Married
   IV. Separated
3) What is your family size
   I. 1-5
   II. 6-10
   III. Over 10
4) How long have you been in the area
   a. Less than a month
   b. 1-6 months
   c. 7-12 months
   d. Over I year
5) What is your employment level
   a) Permanent employed
   b) Self employed
   c) Casual laborer
   d) Unemployed
6) What is your education level
   I. Primary
   II. Secondary
   III. College
   IV. University
   V. None
7) What is your income
   I. Less than 5000 per month
   II. 5000-10000
   III. 11000-20000
   IV. Over 20000

B. Climate change, Water and sanitation situation

8. What is your source of drinking water?

(A) Household tap connection (B) Public stand pipe (Water point) (C) Borehole

(D) Open field (E) Rain water harvesting (F) Water vendor

9 Is your drinking water treated?

[A] Yes [B] No

[C] I don't know

10. How do you store your water?

[A] Open jerry can [B] Closed jerry can [C] Drum [D] none

11. Do you treat your drinking water?

[A] Yes [B] No

12. Where do you put your human waste

a) pit latrine
b) flush toilet
c) paper bag (flying toilet)
d) none

13. how is the drainage in your area

a) well drained
b) moderate
c) poor
d) very poor

14. what is the condition when it rains

a) well drained
b) moderate
c) poor

15. What materials do you recycle?

a) water
b) Plastic
c) Paper
d) Cardboard
e) Cans
f) Bottles
g) Other ……

16. Please look at the following list of environmental issues, and circle the two issues that concern you the most. Please only circle two issues from the list:

a) Air pollution
b) Pollution of sewages
c) Flooding
d) Litter
e) Poor waste management
f) Traffic/ congestion
g) Climate change
h) Radioactive waste
i) Overpopulation
j) Urban farming

17. In your view, has water pollution ever affected your health?

a) Yes
b) No

18. Has water pollution ever affected the health of any of your family members or friends?

a) Yes
b) No

19. Apart from effects on people's health, are you aware of any other effects of water pollution?
    a) Yes
    b) No
    c) Don't know
20. In your view, has sanitation condition ever affected your health?
    II. Yes
    III. No
21. Apart from effects on people's health, are you aware of any other effects of sanitation pollution?
    d) Yes
    e) No
    f) Don't know
22. Do you feel the pattern of weather is generally changing?
    a) Yes
    b) No
    c) Don't know

23 Have you heard of "climate change"?
    a) Yes
    b) No
    c) Don't know

24. How important is the issue of climate change/climate variability to you personally?
    a) Very important
    b) Quite important
    c) Not very important
    d) Least important
25. Do you think climate change is something that is affecting or is going to affect you, personally?
    a) Yes
    b) No
    c) Don't know
26. Do you think anything can be done to tackle climate change?
    a) Yes
    b) No
    c) Don't know
27. What is the alternative source of water origin during scarcity?
    a) Tap/water point
    b) Borehole
    c) Open field
    d) Water harvesting
    e) Municipal council lorries
    f) Others……
28. Have you ever experienced water shortage?
    A. Yes
    B. No
    C. Don't know
29. How does your family adapt to water shortage?
    I. Increase storage capacity
    II. Change living strategies
    III. Change water source

IV. Don’t know
V. Use pit latrine to flush toilets

30. How frequent do you experience water shortage?
    I. Daily
    II. Weekly
    III. monthly
    IV. never
31. How do you cope with burst sewer lines?
    I. stay in the same house
    II. shift the house
    III. do nothing
32. Has your family been affected by burst sewer?
    I. Yes
    II. No
    III. don’t know
33. What do you think changes the living conditions in your area?
    I. change in weather
    II. human activities
    III. government
    IV. don’t know
    V. Others……
    …
34. Has the above condition been always like that? (Refer to Question 33)
    I. yes
    II. no
    III. don’t know
35. What your family monthly medical bills on water and sanitation related illnesses?
    I. 1-1000
    II. 1001-3000
    III. More than 3000
    IV. don’t know
36. Name organizations involved with water and sanitation projects in this area.

……
……

APPENDIX II: Key Informants Interview Guide (Interview Questions to Environmental Officer and county officials)

Name of respondent.....

Name of organization/Institution.....

Your title and position ……...

1. How long have you worked among the Mukuru Kwa Njenga resident?
2. What activities/projects does your organization undertake among the residents of Mukuru Kwa Njenga?
3. What does your organization intend to achieve through this (these) intervention(s) in Mukuru Kwa Njenga?
4. What in your opinion are the main factors that have contributed to the vulnerability of the Mukuru Kwa Njenga residents? (Explain)
5. Is climate variability an important consideration in the planning and implementation of your programs? Yes/No
6. If yes, how is it factored in your programs?
7. Which aspect of climate variability is profound in Mukuru Kwa Njenga?
   -Rainfall variability
   -Drought
8. What are the main effects of water scarcity and sanitation access on the Mukuru kwa Njenga livelihoods? (Explain)

   ……
9. What adaptive mechanism in your understanding have the Mukuru Kwa Njenga residents employed against climate variability in response to water scarcity and sanitation access?
10. Do you think these adaptive mechanisms are working in cushioning the residents of Mukuru Kwa Njenga from effects of climate variability in relation to water scarcity and sanitation access? Yes/No
11. If No, why?

    ……
12. If Yes. How?

    ……..

13. How are the residents' mechanisms linked with your interventions? (Explain)
14. With the current trends in climate variability, what management strategies do you think will enable the residents of Mukuru Kwa Njenga to remain viable?
15. Any other contribution you will like to make

Thank you for your time and valuable contributions.