VULNERABILITY OF URBAN INFORMAL SETTLEMENTS TO ENVIRONMENTAL HAZARDS:

A CASE STUDY OF KOROGOCHO IN NAIROBI

BY

GEOFFREY OMEDO

(C50/71852/2008)

A Research Project in Partial Fulfillment to the award of the Degree of Master of Arts in Environmental Planning and Management

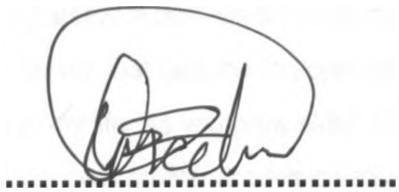
Department of Geography and Environment Studies

University of Nairobi, Kenya

October 2010

DECLARATION

THIS PROJECT IS MY ORIGINAL WORK AND HAS NOT BEEN PRESENTED FOR A DEGREE IN ANY OTHER UNIVERSITY

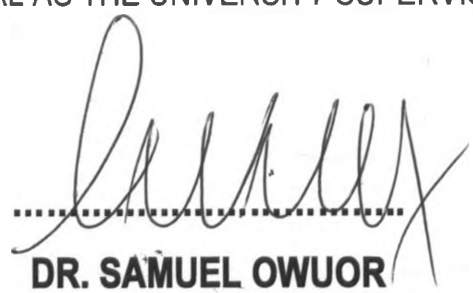


.....

GEOFFREY OMEDO

(M.A. EPM STUDENT)

THIS PROJECT HAS BEEN SUBMITTED FOR EXAMINATION WITH OUR APPROVAL AS THE UNIVERSITY SUPERVISORS



.....

DR. SAMUEL OWUOR

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

.....

DR. SHADRACK KITHIIA

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

DEDICATION

This work is dedicated to my daughter Hope Ayuma, who continually inspires me to strive even more, to stretch an inch higher; to persevere perhaps a minute more; to be an even better person. She is the single most important person that gets me to appreciate the life I have; the blessings I hold; and the usefulness of time in my life. As you grow older, Daddy wishes you one day get to read this thesis and purpose to attain even greater academic success than this.

ACKNOWLEDGEMENTS

The following people have played a significant role in supporting me throughout the course of my Masters education. I will forever acknowledge their individual efforts to support me, even when I doubted my abilities. They understood that I had to *juggle* my responsibilities at work, at home and in school and still provided me with the necessary support throughout my studies. I first wish to appreciate Dr. Samuel Owuor for believing in me and for going beyond his normal supervisory duties to train me and constantly inculcating in me the desire to succeed. My other supervisor, Dr. Shadrack Kithiia, was equally extremely supportive and guided me throughout the proposal development stages until the finalization of this research project. In addition, I wish to recognize and appreciate my academic and professional mentor, Dr. Grace Ongile (OGW), Chief Executive Officer of NEPAD Kenya Secretariat, for encouraging me to enroll for my masters and mentoring me at work. I also appreciate in similar vein, the friendship and support of Dr. Angela Reitmaier, formerly of UNDP Kenya, for believing in me and continually providing useful guidance and advice in my entire sojourn as a Masters student.

There are many more people who supported me and who provided the knowledge and material information used in this study. I appreciate Mr. Brian Otiende, Climate Change Programme Officer at Oxfam GB, for planting the seeds that culminated in this study. The Korogocho Community Resident Committee, the data entry project assistant and my entire team of research assistants are also acknowledged. Finally, I wish to most sincerely acknowledge my lovely wife, Sally, for always being there for me and encouraging me to work even harder. Your constant words of encouragement and devotion to our love is, I believe, the single most perennial motivation that continually pushes me to excel, socially, professionally and even academically. The list above is neither exhaustive nor even close to complete. Many others played a role and I genuinely acknowledge your support. I however, take upon myself all the weaknesses, inconsistencies, inaccuracies, and or any elements within this study that may fall short of the expectations of research in this particular subject.

PREAMBLE

".....The starting point for reducing disaster risk and for promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face, and of the ways in which hazards and vulnerabilities are changing in the short and long term, followed by action taken on the basis of that knowledge....."

UN 2005, Hyogo Framework for Action 2005-2015.

ABSTRACT

This study – an *assessment of vulnerability of urban informal settlements to environmental hazards* – was conducted in Korogocho as a response to the emerging world view that recognizes urban informal settlements as areas exposed to numerous environmental hazards and disasters. This is particularly evident in Kenya where the issue of proliferation of informal settlements and urban sprawl has been on the rise. For Korogocho, the Government is implementing a slum upgrading programme in recognition of the challenges of urban informal settlements therein. The main objective of this study was to assess the vulnerability of Korogocho to environmental related hazards. The study used both primary and secondary sources of data to achieve its objectives. Stratified random sampling was used to select respondents for a questionnaire-based household survey. Other methods of data collection included Focus Group Discussions, key informant interviews and observations. The study employed the use of community-based indicators system (*Bollin 2003*) for vulnerability assessment at a micro scale level. The indicators were weighted depending on the hazards, exposure and vulnerability, and coping capacity. The study results revealed that Korogocho is highly vulnerable to disease related hazards, floods, fires and droughts which culminate in famine and general insecurity. The lack of a cogent land-use plan for the area further complicates the problem. The study identified a number of challenges in disaster risk identification, management and reduction in Korogocho. These include the fact that urban disasters and risks have been neglected, lack of an early warning plan, weak institutional arrangements to support residents, lack of political goodwill and insufficient knowledge, experience and capacity by the residents. The study proposes the need for policy makers and stakeholders in Nairobi City to support the development of appropriate land-use systems for urban areas in addition to supporting research into cheaper but durable housing materials and technology. It recommends the development of a dynamic model that would serve to provide a responsive link between poverty and vulnerability in urban informal settlements. This would go a long way in enhancing the adaptive capacity of slum dwellers in Africa's rapidly expanding cities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF PHOTOGRAPHS

LIST OF EQUATIONS

LIST OF ABBREVIATIONS

ASAL	Arid and Semi Aril Lands
CBO	Community Based Organizations
CBS	Central Bureau of Statistics
COP	Conference of Parties
CRED	Centre for Research on the Epidemiology of Disasters
DPSIR	Driving Pressure State Impact Response Framework
DRR	Disaster Risk Reduction
EMCA	Environmental Management and Conservation Act 2008
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GIS	Global / Geographic Information Systems
IPCC	Inter-Governmental Panel on Climate Change
KCCRS	Kenya Climate Change Response Strategy
KENSUP	Kenya Slum Upgrading Programme
KIHBS	Kenya Integrated Household Budget Survey
KMD	Kenya Meteorological Department
KNBS	Kenya National Bureau of Statistics
MDG	Millennium Development Goals
OFDA	U.S. Foreign Disaster Assistance
SPSS	Statistical Package for Social Scientists
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WCDR	World Conference on Disaster Reduction
WHO	World Health Organization

CHAPTER ONE

THE INTRODUCTION

This chapter provides the introduction to the study problem. It presents the statement of the research problem; research questions; research objectives; research hypothesis; rationale and significance of the study; the conceptual framework; scope and limitations of the study; operational definitions and concepts; and organization of chapters.

1.1 Background to the Study Problem

The world we inhabit is assailed by both natural and unnatural hazards which sometimes develop into full-fledged disasters. These hazards and/or disasters have contributed to significant damage and fatalities, particularly afflicting the most vulnerable of human society. The majority of those affected in society are those who are least able to adapt and protect themselves from such occurrences *(UNEP Environment Outlook Report 2007).*

Indeed, those who are mostly affected are the ones with reduced resilience capacity due to poverty, social exclusion, marginalization and levels of exposure. Needless to say, the poorest in society are mostly affected due to the fact that the capitalistic nature of evolving societies tend to exclude the poor who have no alternative but to settle in areas that suffer from significant environmental injustices resulting from the geographical distribution of risks, hazards and disasters.

In recognition of this fact, the World Conference on Disaster reduction (WCDR) held in Kobe, Japan in January 2005 formulated the Hyogo Framework goal of creating societies more resilient to disasters, with a particular emphasis to urban areas. In this regard, the present study sought to contribute to the overall objective of the Hyogo Framework of Action. The study intends to provide some indication of how the global urbanizing trends can be able to effectively mainstream disaster risk and vulnerability management in order to enable decision makers to assess the potential impact of disasters and to promote the formulation of appropriate policy responses (*Birkmann 2006).*

1.2 Statement of the Research Problem

According to Cutter (2003), vulnerability to environmental hazards means the potential for loss of life and livelihoods due to environmental interruptions, which can be sudden or gradual. Since such losses vary geographically, over time, and among different social groups, vulnerability also varies over time and space. Some geographical regions are therefore at greater risk to get affected by natural hazards than others. The problem of environmental vulnerability is more pronounced in Africa, where a lack of proper planning, poor urban governance and reduced financing to local authorities further expose the ever expanding informal settlements to increased environmental hazards which can grow into full fledged disasters *(Awuor 2008)*. Indeed, this is a general trend in most developing countries. Hence, Kenya and Nairobi, in particular, is not an exception, but a norm for many African cities.

According to the *Annual Disaster Statistical Review 2008*, Africa accounted for 20% of global natural disaster occurrence. This was a slight decrease in reported natural disaster occurrence compared to the 2000-2007 annual average, mostly due to a decline in hydrological disasters. However, the number of victims increased compared to the same period (2000-2007). Climatological disasters were an important contributor to this increase, as Africa was hit by severe droughts, leading to over 14 million victims *(CRED 2008)*. It is not clear whether these disasters were reported more within urban areas or rural areas.

Information and data on Africa reveals a lack of reporting of hazards and natural disasters in general, and more particularly of economic losses that can be attributed to hazards and/or disasters. Information on such is scanty. Africa accounted for less than 0.5% of global reported economic damage costs from natural disasters in 2008, a share that is likely to be under-estimated *(CRED 2008)*. It is therefore important to ensure that sustained research on different elements of urban livelihoods is continually conducted in order to appropriately inform ongoing policy deliberations.

Over the last 20 years, there has been a notable growth of Nairobi as a regional socio-economic epicenter due to increased urban activities. The rural to urban migration phenomenon further exacerbated this astronomical expansion of the city with large populations of people shifting their base to Nairobi town and converting the peri-urban areas into informal settlement zones. The immigrants move in quest for employment, health, education and the general improvement of their living standards.

This has led to the radical increase in urban sprawl and slums which pose significant challenge to the environment and livelihood *(Amnesty International 2009*). Nairobi is reputed to be among the fastest growing cities in Africa with a fast expanding informal settlement base of more than 200 slums estimated to cover together a mere 5% of the city territory. Hence, the problem of hazards occurring within the informal slums is a real one for Nairobi. For instance, according to the 2009 Kenya Population Census, the total population of Nairobi was 3,138,369 people. The same census reports a total of 985.016 households, all occupying an area of 695.1 square kilometers *(KNBS 2010).*

With such an increase in the urban population, the problem of urban sprawl and proliferation of slums is a significant phenomenon. Korogocho is estimated to have a population of 100,000 people *(KNBS 2010).* Most of the informal settlements in Nairobi are congested, lack social amenities, are overcrowded and have poor infrastructural facilities, including being vulnerable to environmental hazards and disasters. This study intends to assess the vulnerability of urban informal settlements to environmental hazards and disasters, using Korogocho as a case study.

1.3 Research Questions

The research questions that guided this study are:

1. What is the typology of environmental hazards in Korogocho?
2. What is the vulnerability of Korogocho to environmental hazards?
3. What is the potential impact of environmental hazards in Korogocho?
4. What response strategies do residents in Korogocho have to environmental hazards?

1.4 Research Objectives

The main objective of this study was to assess the vulnerability of Korogocho to environmental related hazards. To achieve this broad objective, the following specific objectives were formulated:

1. To conduct a rapid environmental hazard assessment in Korogocho.
2. To determine the typology (*year of occurrence, potential impacts, response*) of environmental hazards in Korogocho.
3. To evaluate the vulnerability of Korogocho to environmental hazards.

1.5 Working Hypothesis

This study was guided by the following working hypothesis; Korogocho is not affected by environmental related hazards and disasters.

1.6 Rationale and Significance of the Study

Societies are becoming more urban with more people preferring to stay within urban areas *(Oxfam 2009)*. For Nairobi, this is evident since the population statistics indicate that the city has witnessed a growth in population from independence to date (KNBS 1999). According to the 2009 population census, Nairobi has a population of approximately 3.2 million people – majority of them living in informal settlements. The study area, Korogocho, straddles two rivers, Gitathuru and Nairobi, hence posing a number of riverine related ecosystem environmental challenges to the residents. In addition, the presence of the Dandora dumpsite on the western fringes of the settlement provides predisposing factors for environmental hazards and disasters. It is useful to obtain recent statistics and data on the hazards and vulnerabilities, which occur within such informal settlements. It is also important to understand the inherent vulnerabilities in informal settlements.

The results of this study can help the City Council of Nairobi and the Ministry of Nairobi Metropolitan Development to develop appropriate disaster management strategies for informal settlements in the city. Indeed, on the many occasions when fires have erupted in Nairobi's slums, lack of access for the fire fighting department staff exposed the slum residents to even greater suffering. This calls for deliberate concerted planning efforts by the relevant agencies to ensure

that slum residents are covered in cases of hazards or disasters. This can only be possible if comprehensive studies and researches are conducted to inform the planning processes.

The Hyogo Framework for Action notes the importance of conducting vulnerability assessments to ensure that adaptive characteristics are properly mainstreamed in the development processes. In addition, the Kenya Climate Change Response Strategy recognizes the importance of vulnerability assessments to guide the broad adaptation to climate change programmes that Kenya is currently setting out to implement (*KCCRS 2010)*. This study therefore seeks to complement other studies that have been conducted in urban areas. Indeed, the UN Habitat contends that urban areas are globally becoming key centers of climate change adaptation and even mitigation *(Safer Cities Initiative*). The choice of the study area for this study is guided by the geographical characteristics of Korogocho, including the fact that the settlement is straddled by two permanent rivers (River Gitathuru and Nairobi River).

1.7 Scope and Limitations of the Study

While the frameworks explained above provide the basic context within which the study is framed, it is not the intention of this study to perform a full vulnerability assessment. As *Turner (2003)* recommended, this would entail measuring a range of dynamics, including multiple interacting perturbations and stressors, how the systems restructure after the responses taken, as well as nested and scalar dynamics of hazards. At a household level, one would also take into account household adaptation practices, which would be difficult to compute for households in Korogocho. Not undermining the importance of all these factors, the focus of this study is on the broad environmental related hazards and disaster in Korogocho and the levels of exposure of the residents to them. This then helps in analysis of the vulnerabilities therein and identification of the coping strategies.

The ongoing slum upgrading programme in Korogocho, spearheaded by the Ministry of Local Government is an example of the government's responses to vulnerability of urban informal settlements to environmental related hazards. In addition, it is important to point out that this study

is anchored within a broader study on "*Climate Change Vulnerability, Risk, Impact and Adaptation in Nairobi's Informal Settlements*". The broader study, conducted in Mukuru Kwa Njenga and Korogocho, generated benchmark data and information on the resilience of Nairobi to the impact of climate change.

1.8 Operational Definitions and Concepts

Hazard A dangerous condition or event that threatens or has the potential for causing injury to life or damage to property or the environment.

Disaster A serious disruption of the functioning of a society, causing widespread human, material, or environmental losses which exceed the ability of the affected society to cope using its own resources.

Risk The probability that a particular system or population will be affected by hazards

Vulnerability Potential for loss due to a sudden or gradual environmental interruption

1.9 Organization of Chapters

This report is organized into five chapters. *Chapter 1* provides an introduction to the understanding of the study problem. *Chapter 2* presents the literature review. *Chapter 3* gives an overview of some aspects of the study area as well as discussing the methodology. *Chapter 4* presents data analysis, discussions and interpretation, while *Chapter 5* is a summary of research findings, conclusions and recommendations.

CHAPTER TWO
LITERATURE REVIEW

This chapter presents the literature review on urbanization and growth of urban informal settlements; environmental hazards and disasters; assessing vulnerability; vulnerability assessment studies; and review of policy framework. As a conclusion, the chapter identifies some gaps from the literature review that the present study intends to fill.

2.1 Urbanization and Growth of Urban Informal Settlements

There is no doubt that the world is urbanizing at a high rate (*UN-HABITAT 2008; World Population Report 2007; Satterthwaite 2004; WEF 2002).* For example, the World Population Report (1950) noted that less than 30% of the world's population lived in cities in 1950. However, this proportion increased to 47% in year 2000 (2.8 billion people) and is projected to increase to 60% by the year 2025. Urbanization is occurring even more rapidly in sub-Saharan Africa *(Owuor 2010;* A*wuor 2008; UN-HABITAT, 2006; Satterthwaite 2004).* In the near future, half of the total population in Africa will be living in urban centers (*UN-HABITAT 2008).* Current estimates indicate that Africa's population has just passed the 1 billion mark (*World Population Data Sheet 2009).* The increase in the urban population can be attributed to natural increase in population (excess of births over deaths) and migration to urban areas *(Nabutola 2005).* The ever increasing urban population in Africa serves to exacerbate the impact of what would ordinarily have been harmless hazards due to increased vulnerability and exposure to risks (*UNDP 2004*).

One of the consequences of the high urban growth in sub-Saharan Africa has been the mushrooming of informal settlements. The new immigrants to urban centers naturally move into areas that are neglected and abandoned, river banks, steep slopes, marsh lands, wastelands and other adjacent dry sparse lands (*UN-HABITAT 2008*). Indeed, these areas develop into death traps for the environment and the livelihood of these communities, hence providing a perfect opportunity for environmental hazards which have the potential to grow into fully fledged disasters.

It is estimated that more than half of the urban population in Kenya live in the country's informal settlements (*OXFAM 2009*). In Nairobi, it is estimated that an even higher percentage (over 60%) of the population live in slums (UN HABITAT 2006). On the basis of a specially constructed expenditure-based model, a World Bank Study of 2006 (*World Bank 2006*) estimated that with a poverty line of KShs 3,174 per adult equivalent per month (excluding rent), nearly three-quarters (73%) of slum households in Kenya are poor. Hence the issues of urban sprawl coupled with abject poverty provide a fertile ground for severe fatalities and damage to property in instances of environmental hazards and/or disaster occurrence.

The United Nations Environment Programme *(UNEP, 2007b)* estimates that 72% of all Africa's urban population lives under '*slum conditions*' as opposed to 56% in South Asia. The definition of slum conditions can draw from physical, legal, demographic or functional perspectives. Indeed, informal settlements or '*slums*' are defined by the UN-HABITAT as a household that lacks one or more of the following: durable housing, sufficient living area, access to improved water, access to sanitation and or secure tenure. Oxfam defines a slum as a "*contiguous settlement where the inhabitants are characterized as having inadequate housing and basic services*". Unfortunately, slums are often not recognized and effectively addressed by public authorities as an integral part of the city, leading to continued neglect and social exclusion. It is the sore sight on the face of the beauty in the urban centers.

2.2 Environmental Hazards and Disasters

For many years, mankind has been attempting to manipulate the natural environment – sometimes in a destructive manner – to respond to his immediate economic needs. This is done without taking into account the risks brought about by this destruction. Perhaps, this has been aggravated by accelerated changes in demographic and economic trends which have disturbed the balance between ecosystems, particularly in the urban areas. By and large, this has led to environmental degradation which has resulted in increased hazards that can be able to eventually culminate into disasters. Such disasters can trigger the occurance of other secondary disasters which can deepen the suffering of societies.

Of course, the impact of demographic, social and economic factors on nature should not be overlooked either. According to WHO, by the end of the 20th century, the impact of natural disasters to the world economy reached 50 billion dollars annualy *(WHO Report 2006)*.

A hazard can be defined as a dangerous condition or event that threatens or has the potential for causing injury to life or damage to property or the environment *(CRED 2006)*. There are two broad categories of hazards based on the origin: (1) natural hazards (hazards with meteorological, geological or even biological origin) and (2) unnatural hazards (hazards with human-caused or technological origin) *(see Table 1)*. In the dynamic evolution of society, hazards are part and parcel of developments and it is important for communities to build internal resilience mechanisms and to appropriately mitigate against these hazards.

Table 1: OFDA/CRED International Hazard/disaster Database

<table>
<tr><th colspan="4">HAZARDS AND DISASTERS</th></tr>
<tr><th>Biological</th><th>Geophysical</th><th>Hydrological</th><th>Meteorological</th></tr>
<tr><td rowspan="2">Epidemic
• Viral infectious diseases
• Bacterial infectious diseases
• Parasitic infectious disease
• Fungal infectious diseases
• Insect infestations
• Animal stampede</td><td rowspan="3">Earthquakes/Tremors
Volcano eruptions
Mass Movement (dry)
• Rock fall
• Landslide
• Avalanche
• Subsidence</td><td rowspan="3">Floods
• General flood
• Flash flood
• Storm surge/coastal flood
• Mass movement</td><td>Storms
• Tropical storm
• Extra – tropical cyclone
• Local storm</td></tr>
<tr><td>Climatological
Extreme temperature
(Heat wave, cold wave, extreme, winter conditions)
• Drought
• Wildfire
• Forest fire
• Land fire</td></tr>
<tr><td>Socio-Cultural
• Crime and general insecurity
• Food stress
• Riots and political tension</td><td></td></tr>
</table>

(Source: Adapted from EM-DAT 2008)

Hazards can in actual fact be harmless, especially if they occur within areas that are not heavily populated. Hence the risk potential of hazards is a factor of a number of other variables including geographical location, socio-economic characteristics, population and physical environmental characteristics, among others.

For instance, an earthquake occurring in a sparsely populated desert is unlikely to compare to an earthquake within a densely populated urban area. With this in mind, it becomes important to assess the likely impacts that hazards, both natural and unnatural, can have on urban areas, with a particular emphasis on the informal settlements within urban centers where the poorest of the society live. Such an assessment needs to be conducted proactively in order to support the processes of developing a reliable early warning system. A city would for instance benefit immensely if a clear evacuation plan, emergency exit routes, food and healthcare support networks exist long before a disaster strikes. In such instances, the unpredictability of occurrence can sometimes lead to unnecessary deaths due to lack of proper tents, clean water, blankets and medical care. This study recognizes the importance of mainstreaming advance preparedness into local planning processes.

It is also important to note that any hazard has the potential of evolving into a full-fledged disaster with grave ramifications. A disaster is a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering (*CRED Annual Disaster Statistical Review 2008).*

Climate change has been reported to increase the likelihood of extreme weather events such as droughts, floods and heat waves, as well as more gradual changes in temperature and precipitation. In the urban areas, climate change is likely to have a greater impact on the urban poor. Urban poverty levels; food, water and energy insecurity; poor sanitation; human health epidemics; infrastructural damage; and poor access to basic services is likely to increase *(Boko et al 2007; Kundzewicz et al 2007)* with time.

2.3 Assessing Vulnerability

The increase in risk in informal settlements in most developing countries can be attributed to overcrowding, faulty land-use planning and haphhazard construction, inadequate infrastructural facilities and services, and gross environmental degradation *(Ozden 2006)*. In assessing vulnerability, there are a number of key considerations that are normally considered *(Cutter 2003)*, including the identification of conditions that make people or places vulnerable to extreme natural events *(Burton, Kates and White 1993; Anderson, 2000)*, the assumption that vulnerability is a social condition *(Blaikie et al., 1994; Hewitt 1997)*, and the integration of potential exposure and societal resilience with a specific focus on particular regions *(Cutter 2000)*. The IPCC (2001) has identified six main categories in development of vulnerability indicators for assessment purposes (see *Table 2*).

Table 2: IPCC Indicators for Assessment of Vulnerability

Sensitivity or adaptive capacity category	Proxy variables
Settlement/Infrastructure sensitivity	Population at flood risk from SLR Population without access to clean water and sanitation
Food security	Cereals production area Animal protein consumption per capita
Ecosystem sensitivity	% land managed Fertilizer used
Human health sensitivity	Completed fertility Life expectancy
Water resource sensitivity	Renewable supply and inflow Water use
Economic capacity	GDP (market)/capita Gini Index

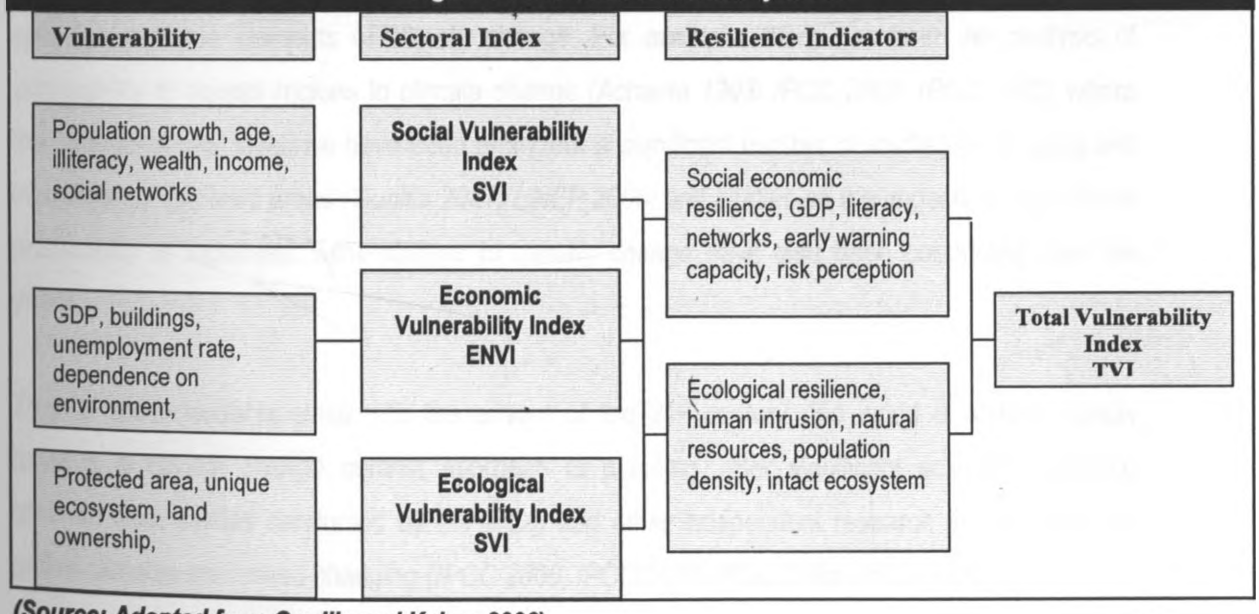
(Source: IPCC 2001 Annual Report)

The IPCC (2001) developed six major indicators that can be used to assess vulnerability and they include settlement/infrastructural sensitivity; food security; ecosystem sensitivity; human health sensitivity; water resource sensitivity; and economic capacity. The collection of data within the six main categories can therefore lead to a successful computation of vulnerability assessment within a given locality. However, the challenge would be obtaining the requisite data, particularly for African countries.

The present study focuses on the exposure (settlement/infrastructure sensitivity, food security), vulnerability (ecosystem and water resource sensitivity) and coping capacity (economic). This is in realization of the fact that ability to assess vulnerability is increasingly being seen as a key step towards effective risk reduction and the promotion of a culture of disaster resilience (*Birkmann 2006*). Indeed, some scholars contend that, "... *in the light of increasing frequency of disasters and continuing environmental degradation, measuring vulnerability is a crucial task if science is to help support the transition to a more sustainable world...* " (*Kasperson et al. 2005*)

It is however known that assessing vulnerability is a complex process due (in part) to the lack of consistency in the definitions of vulnerability *(Cutter 199; Adger 2006)*. In addition, the presence of myriad important variables that can be used to assess the issues of vulnerability serves to further complicate the process of assessing vulnerability. Indeed, the closest anyone has come to contextualizing all the variables that can be used in conducting a comprehensive assessment has been through the Total Vulnerability Index (TVI) as developed and used by *Gunila and Kaiser (2006)* (*Figure 1*). The TVI presents the indicators that can be used to assess vulnerability at local, national and regional levels.

Figure 1 : The Total Vulnerability Index



(Source: Adapted from Gunilla and Kaiser 2006)

Most vulnerability studies conducted have only applied a section of the vulnerability indicators in the TVI index. For instance, a number of studies have applied variables related to exposure such as proximity to the source of threat, incident frequency or probability, magnitude, duration or spatial impact *(Watts and Bohle 1993; Blaikie et al. 1994)*. Others (*Cannon et al. 2003:5*) have argued that vulnerability is only partially determined by the type of hazard; but mainly driven by precarious livelihoods, the degree of self protection or social protection, qualifications and institutional settings, among such other factors.

In other studies *(Awuor 2008; Nabutola 2005)* the use of social impacts and response strategies are often used to measure the vulnerability of society (livelihoods and infrastructure) to hazards and disasters. Interesting analysis of special needs populations (children, elderly, infirm), are also coupled with analysis of poverty/wealth indicators, and gender, among such other categorizations which can be used to establish the vulnerability and resilience within communities to adapt to hazards and disasters.

2.4 Empirical Vulnerability Assessments Studies

There is significant evidence of a number of empirical studies that have been conducted globally on vulnerability related subjects. However, the majority of such vulnerability studies are mostly specific to certain elements of climate change. For example, there has been an analysis of vulnerability of coastal regions to climate change *(Achanta 1993; IPCC 2001; IPCC 2007)* where the impacts of seal level rise have been analyzed. A significant number of studies on flooding and inundation of low level areas *(Gunilla 2007; UNEP 2006)* and studies on the impacts to agricultural productivity to increased vulnerabilities to climate change have also been conducted over the years.

This is understandable since with the advent of the 21st century, the world is shifting rapidly towards a climate change centrist approach to planning, after significant scientific evidence gleaned from studies conducted by the IPCC and other independent research showed that the global climates are indeed changing *(IPCC 2000; IPCC 2002; IPCC 2006; IPCC 2009)*.

Hence the issue of climate change and its impacts to urban areas has become the core focus of significant research globally and nationally on vulnerability assessments.

This has been driven by the realization that the general movement of societies towards urbanized economies and urbanized livelihoods would present urban centers as the new appropriate frontiers of advancing sustainable human development *(Owuor 2010; Wisner and Pelling 2009).* The maxim goes, if societies are becoming more urban, and if the urban centers are well managed, then this would eventually result in improved livelihoods across all societies. *Owuor (2010)* found that the most vulnerable groups to the harmful impacts of climate change in *Korogocho* and *Mukuru kwa Njenga* are those sections of the population living in areas most exposed to such impacts, hence least able to avoid the direct or indirect impacts. Indeed, he further noted that those most likely to be affected by such impacts are those with the least adaptive capacity to cope with the ever increasing droughts, floods and such climate change related effects.

2.5 Review of Kenya's Policy Framework

The role of policy is of utmost importance in the analysis and understanding of vulnerability of urban informal settlements to environmental hazards. In this regard, an overview of related policy framework is essential to understand the response strategies at local level, national and even the global level. The following key policies were reviewed: the Kenya National Climate Change Response Strategy (2010), the draft Housing Policy (2008), the draft Disaster Response Strategy (2009), the Nairobi Metro Vision 2030, and Kenya's Constitution (2010).

The Kenya National Climate Change Response Strategy (2010)

The launch of the Kenya National Climate Change Response Strategy just before the COP 16 Copenhagen Summit in December 2009 was indeed a significant step towards ensuring that the country had a practical policy to guide climate change interventions (KNCCRS 2010). This strategy notes the importance of both mitigation and adaptation and recognizes the importance of disaster risk reduction by dedicating the entire Chapter 6 of the strategy to *"Vulnerability assessment, impact monitoring and capacity building"*.

The strategy emphasizes that although Kenya is reported to be vulnerable from the harmful impacts of climate change; little information is present on the exact nature of vulnerabilities. The strategy therefore reiterates the importance of funding research in vulnerability assessments at both national and micro scale levels to ensure that more information on this subject is available to guide the response strategies to be effected by stakeholders.

The draft Housing Policy (2009)

The issue of deplorable housing standards in Korogocho is a major concern, and a key component of this is the quality of houses. The quality of housing in informal settlements contributes directly to enhancing the vulnerability of the residents to hazards and disasters. The policy recognizes the importance of enabling the poor to access housing and basic services and infrastructure. It also aims at encouraging integrated and participatory approaches to slum upgrading, including income-generating activities that effectively combat poverty, in addition to promoting and funding of research on the development of low cost building materials and construction techniques. The policy further elaborates the desire by the government to move towards best practices of housing using cheap technology, but durable and more secure. Some pilot projects have since been rolled out including Korogocho Slum Upgrading Program, Kibera Slum Upgrading Programme and the Mavoko Slum Upgrading Program.

The draft Disaster Management Strategy (2009)

In this strategy, the government recognizes the importance of reducing vulnerabilities. This is a step towards institutionalizing mechanisms for addressing disasters. The policy details Kenya's disaster profile as dominated by droughts, fire, floods, terrorism, technological accidents, diseases and epidemics that disrupt people's livelihoods, destroy the infrastructure, divert planned use of resources, interrupt economic activities and retard development. An in-depth analysis of the institutional structure for the disaster response strategy for Kenya clearly indicates that urban areas were given a perfunctory emphasis. The policy only notes that investment in disaster management would have to recognize the scale of vulnerability as fundamental in understanding and dealing with disasters.

It introduces the urban dimension by noting that, "*people living in informal settlements and the ASALs are particularly vulnerable. This vulnerability corresponds to the incidence of poverty in the country*" (*Draft National Disaster Management Policy 2009*).

Quite significant to the study, the policy is bold in emphasizing the need for preparedness on the part of the government, communities and other stakeholders in disaster risk reduction activities. This is a positive step, and the Korogocho Community Resident Management Committee would therefore provide useful information to the government on how to actualize disaster risk reduction interventions within an urban setting. Such partnerships would go a long way in mainstreaming disaster risk reduction in the development process so as to strengthen the resilience of vulnerable groups to cope with potential disasters.

The Nairobi Metro Vision 2030

The Nairobi Metro Vision 2030 is an ambitious policy proposal in the form of a Ministerial Strategic Plan for the Ministry of Nairobi Metropolitan Area. It is both bold and proactive in its analysis of the problems affecting effective realization of the Metro Vision 2030. Some of the problems are presented as: uncompetitive metropolitan economy , due to rapid urbanization, inadequate infrastructure and utilities, poor transport mobility and connectivity-power in terms of water, and solid waste. The vision further recognizes that the poor quality of life (i.e. medical, housing and education) affect the process of realizing the vision. Importantly, the strategy notes the lack of appropriate interventions to respond effectively to housing and fire disasters in the city. The policy hopes to enhance the quality of life in the city through "*...housing and elimination of slums, environmental management strategy...*" (*Nairobi Metropolitan Vision 2030*).

The New Constitution (2010)

Kenya now has a new constitutional dispensation which recognizes the importance of effective utilization of land and Kenya's natural resources for the benefit of the people. The constitution also has an expanded bill of rights that secures the fundamental rights and freedoms of the citizenry to a wide array of natural justice. This includes safeguarding the livelihood of the landless squatters in

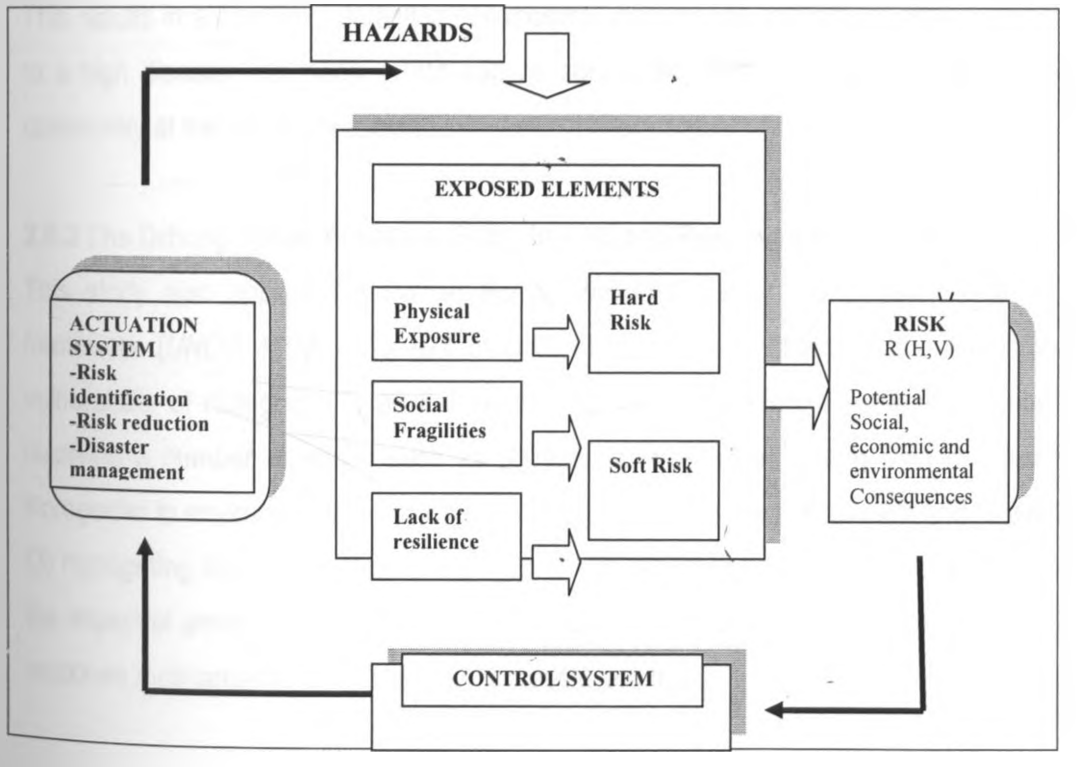
both rural and urban areas. The further devolution of power to the county level is another significant policy intervention within the constitution that will go a long way in reaching out to the residents of urban informal settlements and to respond to the emerging problems of urban vulnerability (*The New Constitution 2010).*

2.6 The Conceptual Framework

The assessment of the vulnerability of Korogocho to environmental related hazards, utilizes the notion advanced by a number of vulnerability researchers that contends that detailed vulnerability assessments are most effectively conducted at the micro or local level with an occasional application to broader regional area *(Birkmann 2006).* Hence methodological decisions often mean applying localized case study approaches for more broadly based patterns and distributions. The study employs two conceptual frameworks, complementing each other, to model the vulnerability of Korogocho to environmental hazards.

2.6.1 Model for Holistic Approach to Disaster Risk Assessment and Management

Figure 2: Holistic Approach to Disaster Risk Assessment (Adapted from Cardona,2000)



In this conceptualization, risk (an objective measure of the likelihood of a hazard event) interacts with mitigation (measures to lessen risks or reduce their impact) to produce the hazard potential. The hazard potential is either moderated or enhanced by a geographic filter (site and situation of the place, proximity) as well as the social fabric of the place (*see Figure 2*). The social fabric includes community experience with hazards, and community ability to respond to, cope with, recover from, and adapt to hazards, which in turn are influenced by economic, demographic, and housing characteristics. The social and biophysical vulnerabilities interact to produce the overall place vulnerability. Hence the framework characterizes vulnerability factors in three broad categories:

1. Physical exposure and susceptibility designated as hard risk and viewed as being hazard dependent.
2. Fragility of the socio-economic system, which is viewed as soft risk and being non-hazard dependent.
3. Lack of resilience to cope and recover, viewed as soft risk and being non-hazard dependent (*Cardona and Barbat, 2005: 53*).

This results in a complex interaction of exposure, vulnerability and lack of coping capacity leading to a high disaster risk index, which can be able to be used in vulnerability assessments for a community at the micro scale level.

2.6.2 The Driving Force, Pressure, State, Impact and Response Framework

This study also applies the Driving Force, Pressure, State, Impact and Response (DPSIR) framework (*UNDP 1992*) as a tool of generating environmental statistics and information on vulnerability of Korogocho to environmental hazards. The DPSIR framework is a useful tool for clarifying a number of issues such as (1) teasing out the key driving forces of vulnerability of Korogocho to environmental hazards; (2) identifying the pressures that exist and to which sectors; (3) highlighting the present state of Korogocho with regard to environmental hazards; (4) analyzing the impact of environmental hazards to the livelihood Korogocho residents; and (5) identifying the response mechanisms if any, and how successful are they.

2.7 An Overview of the Literature Review

It is clear that sustained work is ongoing in ensuring that disaster reduction and recovery will continue to be at the fore front of global intervention measures. In fact, the setting aside of 13th October as a special United Nations day to mark international disaster reduction clearly shows these global efforts on DRR. This study hopes to sustain these global efforts and to contribute to safer cities for sustainable human development in the long run. The study seeks to focus in an area that needs recent research in Africa; the area of rapidly expanding informal settlements that neither border an ocean, a sea or large water mass nor an area that is within geophysically active locality with many active volcanoes, earthquakes, landslides.

Lastly, the above policy framework review reveals that the Government of Kenya has set in place a number of important policy and legislative frameworks to deal with disaster risk reduction at the national level. Sadly though, most of the critical policies are at drafting stage and it would be important that these policies are finalized and enforced at both the national level and at grass root level.

CHAPTER THREE

RESEARCH METHODOLOGY AND STUDY AREA

This chapter discusses the research methodology and thereafter presents the relevant characteristics of the study area. As such the chapter is divided into two sections. The first section concerns the methodological aspects of the study while the second section presents the study area.

3.1 Research Methodology

3.1.1 Sources and Methods of Data Collection

To achieve its objectives, this study made use of both primary and secondary data. Primary data was collected through:

1. A random survey of households in Korogocho using a standardized structured questionnaire (*see Appendix*).
2. Random informal interviews with the residents during a tour of the settlements.
3. Direct field observation.
4. A focus group discussion with the Korogocho Community Management Committee members, comprising of various stakeholders in the settlement.

On the other hand, the collection of secondary data involved reviewing and utilizing the existing relevant literature and policy documents on vulnerability and hazards. The emphasis was placed on analyzing existing disaster risks, causes and resulting local needs; local capacities for risk reduction and their financial implications for resident's livelihoods; international context of vulnerability assessment as a means of mainstreaming disaster risk management into development processes.

The focus group discussion complemented the general household survey. The members of the Korogocho Resident Community Management Committee were engaged in a half day discussion on various aspects of the settlement's vulnerability to environmental related hazards and disasters.

Members of the focus group discussion were chosen from each of the five villages and were a mix of men, women and the youth in the settlement.

3.1.2 Sampling Design

Stratified random sampling was employed in this study to determine the respondents for the random survey of households. Korogocho was stratified into its nine villages. Five villages were then randomly selected for the survey. These were Korogocho A, Grogan A, Grogan B, Vietnam and Highridge. 15 households were then randomly selected from each of the five settlements. As such, 60 households was the sample size. The goal of stratified random sampling is to achieve desired representation from various subgroups of the population *(Mugenda and Mugenda 1999)*.

3.1.3 Data Processing

The questionnaire-based data was first of all subjected to cleaning, i.e. verifying whether all the questions were answered correctly. The data was then coded before being entered in the computer as an SPSS (software) data base. Whereas, the pre-coded (closed-ended) questions were easier to deal with, the open-ended questions were either coded into broader categories of responses or analyzed qualitatively. The data was thereafter subjected to descriptive statistical analysis and cross tabulations.

3.2 Data Analysis: Use of the Community Based Indicator System Method

As identified in the Chapter Two on Literature Review, there are a number of methods employed in empirical studies analyzing the vulnerability to environmental hazards. This study applied the Community Based System method as developed by Bollin (2003) in a similar study in Indonesia. This is because the community based indicator system for vulnerability assessment was generated, to particularly respond to micro scale vulnerability assessments and to generate a disaster index at a community level like Korogocho. The framework systemizes the key elements of risk management into the factors of hazard, exposure, vulnerability and coping capacity measures (*Bollin 2003*).

The resulting indicator system comprises of a total of 47 individual indicators arranged according to Hazards (H), Exposure (E), Vulnerability (V) and Coping Capacity (C) (*see Table 13 Appendix 6.2*). In the end, the comprehensive table as developed and used by Bollin (2003) for all the vulnerability factors, broken down into the main factors is generated for each recorded hazard as the broad template upon which the weighting process will be conducted. The weighting process involves the assigning of cut off points to each individual indicator as observed or recorded in the questionnaires and or the focus group discussions.

Equation 1: Computing the Vulnerability Index of an Area

$$\text{Vulnerability} = \frac{\text{Hazard} * \text{Risk}}{\text{Coping Strategies}} \quad \text{----------} \quad \text{(i)}$$

(Adapted from UNDP 1992)

Indicator and Factor Scores (scaling and weighting)

Step 1: Different measurements of individual indicators in Korogocho from questionnaires, focus group discussion, interviews and observation

Step 2: Scaling by assigning values 1, 2, or 3 depending on category (i.e. low, medium or high; 0 is given when indicator does not apply)

Step 3: Hazard specific weight generated and applied for each hazard (weighting has to be adjusted for country specific conditions

Step 4: Separate composite indices (scores) calculated for the four broad factors of risk

Step 5: Findings integrated into hazard index, exposure index, vulnerability index and coping capacity index (the scores vary between 0 and 100, i.e. 33.3 per thematic area)

Step 6: The final risk index is computed through linear relationship, where contribution of each factor theme is weighted equally

Hence:

Equation 2: Computing the Vulnerability Risk Index for Korogocho

$$R = (wHH + wEE + wVV) - wCC \quad \text{---------- (ii)}$$

(Adapted from Bollin 2003)

Where:

R = overall risk index; **H** = the score for Hazard; **E** = the score for Exposure; **V** = the score for Vulnerability; **C** = the score for Capacity; **W** = the Constant Coefficient of 0.33 (uniform weight for all factors)

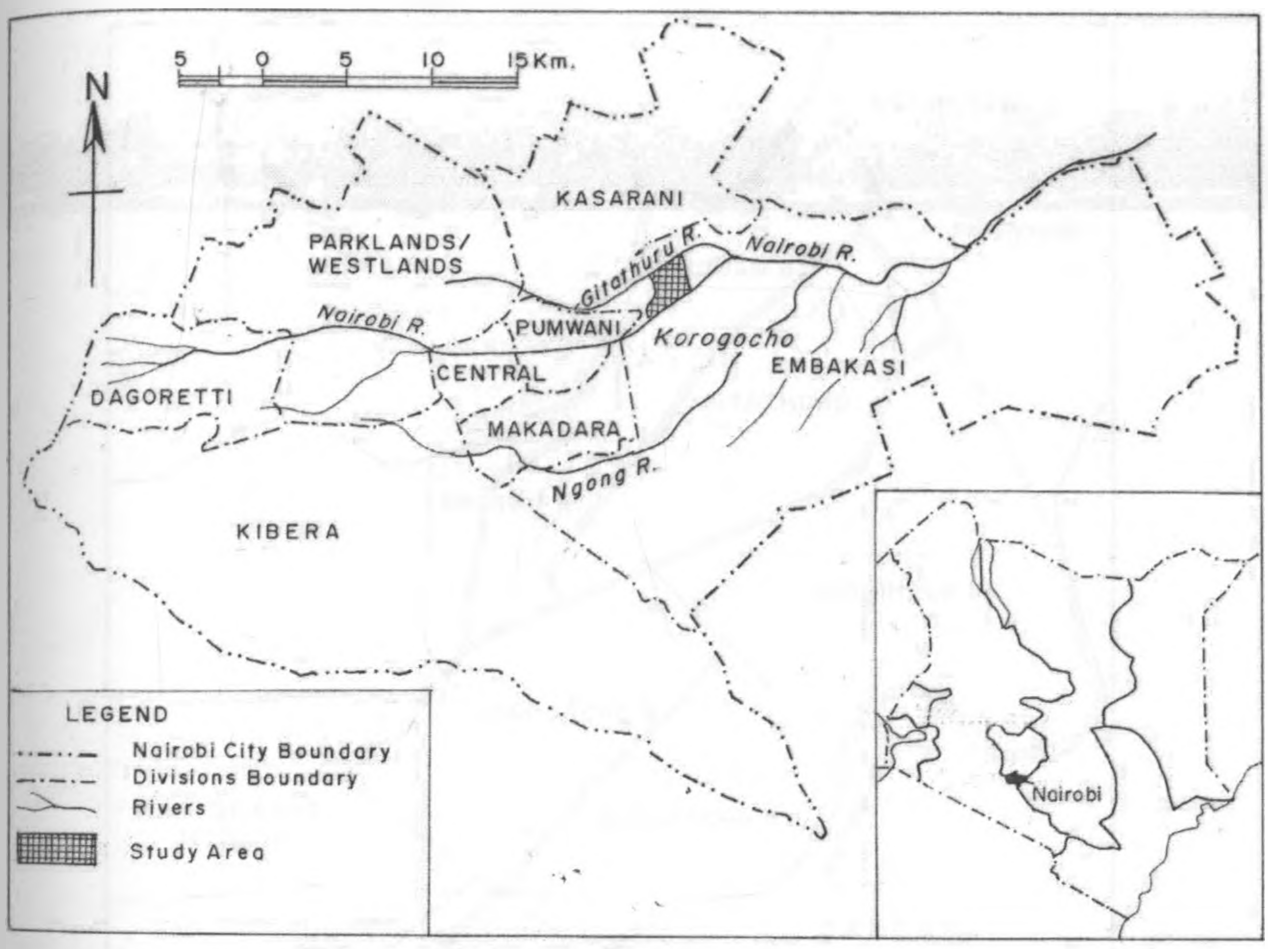
3.3 The study Area

3.3.1 Location and Demographic Characteristics

This study was conducted in Korogocho which is located in the Nairobi North District, Kasarani Division, approximately 11 kilometers from the central business district (*Map 1).* The population of Nairobi North District is about 1 million people (KNBS 2010). Korogocho is the fourth largest informal settlement in Nairobi, after Kibera, Mathare Valley, and Mukuru Kwa Njenga.

It covers an area of about 49.2 hectares (*Korogocho Slum Upgrading Programme 2009*) and consists of nine settlements, namely Grogan A, Grogan B, Kisumu Ndogo, Nyayo, Highridge, Korogocho A, Korogocho B, Gitathuru and Ngomongo (*Map 2).* The settlement is bordered by two rivers: River Gitathuru to the north and Nairobi River to the south as can be clearly observed in Map 2. The two rivers are a permanent feature in the area of study.

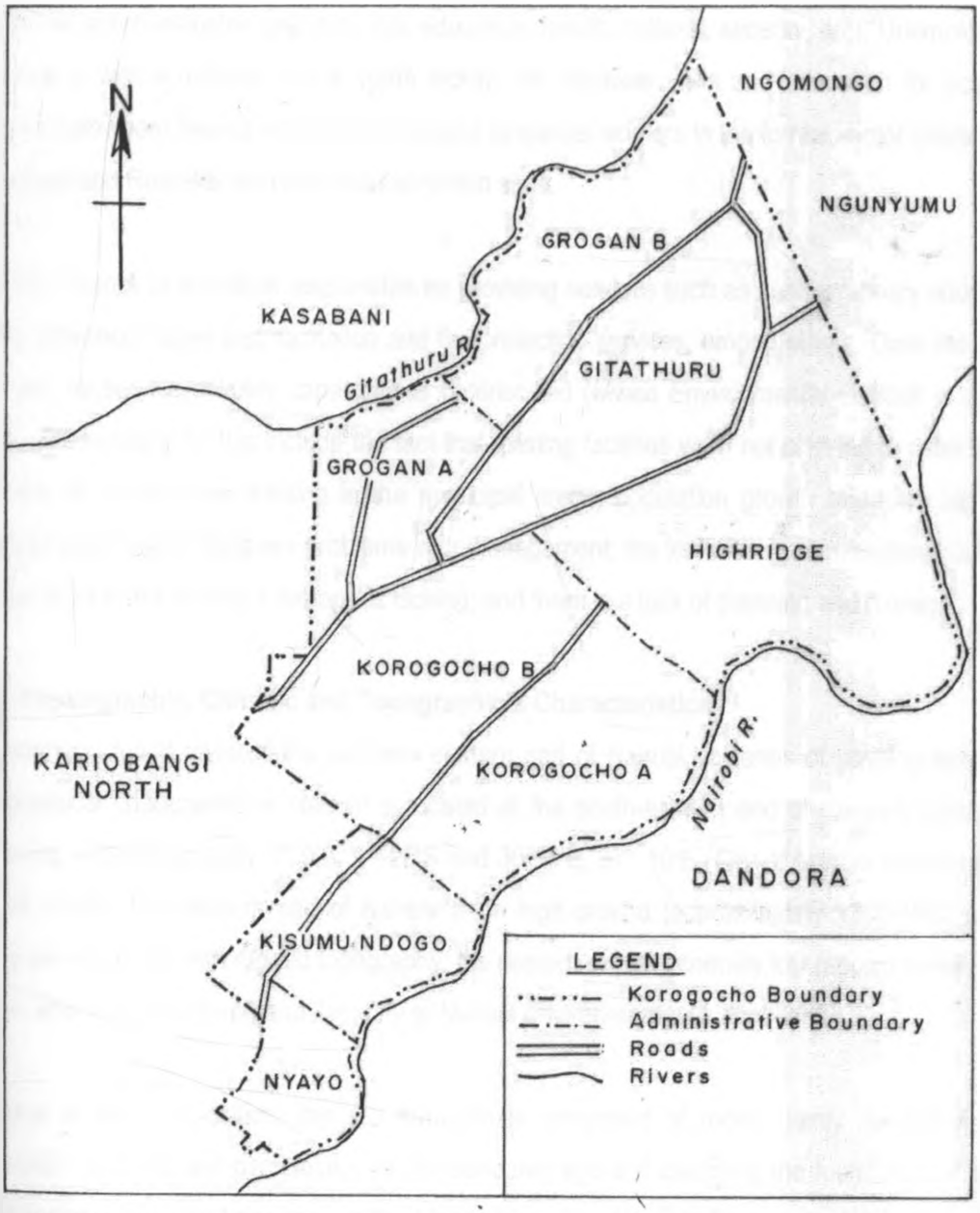
Map 1: Map of Nairobi Showing the Location of the Study Area



Map I: Map of Nairobi showing the location of the study area
Source: Korogocho Slum Upgrading Project Office

It is important to note that to the north western boundary, Korogocho borders the largest dumping site in Nairobi – the Dandora dumping site – which poses significant environmental health and security risks for the residents and the surrounding settlements. However, some residents believe that the dumping site is a blessing, since quite a number of families eke out a living rummaging through the dumpsite for recycling materials, food stuffs and animal feeds.

Map 2: Map of Korogocho Showing the Villages



Map 2: Map of Korogocho Informal Settlement showing the Administrative Units.

Source: Korogocho Slum Upgrading Project Office.

3.3.2 Socio-economic Characteristics

Korogocho, like many other slums in Africa is characterized by a weak socio economic profile across the entire indicator spectrum (i.e. education, health, cultural, security, etc). Unemployment is rampant, with a majority of the youth lacking the requisite skills and education for acquiring formal employment. Hence many are employed as casual workers in the formal sector industries in Babadogo and Ruaraka area and in construction sites.

The City Council of Nairobi is responsible for providing services such as health, primary education, refuse collection, water and sanitation and fire protection services, among others. Over the years, however, its service delivery capacity has deteriorated (*Urban Environmental Outlook of Nairobi 2006*). The reasons for this include the fact that existing facilities were not planned to cater for the numbers of people now residing in the municipal areas; population growth rates are high; the resource base is low; there are problems with management; the technical and institutional capacity needed to increase service coverage is lacking; and there is a lack of planning and foresight.

3.3.3 Physiographic, Climatic and Topographical Characteristics

Korogocho is found towards the northern eastern part of Nairobi. In terms of physiographic and topographical characteristics, Nairobi is located at the south-eastern end of Kenya's agricultural heartland, at approximately 1° 9'S, 1° 28'S and 36° 4'E, 37° 10'E (*City of Nairobi Environmental outlook 2006*). The western part of Nairobi is on high ground (approximately 1700-1800 metres above the sea level) with rugged topography, the eastern side is generally low (approximately 1600 metres above the sea level) and flat *(City of Nairobi Environmental Outlook 2006)*.

In terms of soil composition, the soil structure is composed of rocks mainly comprising of a succession of lavas and pyroclastics of the cainozoic age and overlying the foundation of folded precambrian schist's and gneisses of the Mozambique belt (*Nairobi Environmental Outlook 2006*). With regard to the climate of the study area, it is important to note that at an altitude of about 5,500 feet (1700 meters), Nairobi has a temperate tropical climate with definite wet and dry seasons, and the absence of any large seasonal change in temperatures. It has two main rainy seasons. The

highest rainfall is received between March and April and the short rainy season is between November and December. The mean annual rainfall ranges between 850-1050mm (*Kenya Meteorological Department 2010*).

The mean daily temperature ranges between 12 and 26°C. It is usually dry and cold between July and August, but hot and dry in January and February (CBS 2003). The mean monthly relative humidity varies between 36 and 55 per cent. The mean daily sunshine hours varies between 3.4 and 9.5 hours (CBS 2003a). Hence Korogocho is covered within this climatic regime, and the long and short rain seasons would expose the residents to flash floods and general flooding associated with these seasons.

CHAPTER FOUR

RESEARCH RESULTS AND DISCUSSIONS

The specific objectives of this study were to conduct a rapid environmental hazard assessment in Korogocho; determine the typology of environmental hazards in Korogocho; evaluate the vulnerability of Korogocho to environmental hazards; assess the potential impact of environmental hazards in Korogocho; and to determine the response strategies to environmental hazards in Korogocho. Based on these objectives, this chapter presents conceptual framework, the research results, analysis, discussion and in depth interpretation.

4.1 Typology of Hazards in Korogocho, their Impacts and Coping strategies

This study identified 5 broad categories of hazards that have occurred in Korogocho. They are: biological, geophysical, hydrological, meteorological and socio-climatological hazards as shown in *Table 3.* Some of these environmental hazards sometimes result in deaths, fatalities and extensive damage to property within the villages in this area.

Table 3: A Rapid Analysis of Hazard and Disaster Occurrence in Korogocho

TYPOLOGY OF HAZARDS IN KOROGOCHO SLUM			
Biological	**Geophysical**	**Hydrological**	**Meteorological**
Epidemics - Cholera, malaria, tuberculosis, dysentery, fungal infections, HIV/AIDs, common colds, flu, malnourishment *Insect Infestation* - Pest infestations - Rat infestations	*Earthquake* - Earth tremors are a common feature but no fatalities were reported *Mass movement (dry)* - Landslides especially during construction and in river banks	*Floods* - El Nino floods - Common flash floods - General flooding due to poor draining systems, construction of houses in flood plains and underground water seepage - Flooding due to River Gitathuru and Nairobi River bursting their banks	*Storms* - Strong storms that washed away houses - Localized storms during the main rainy season
Socio-climatological			
Extreme temperature (i.e. cold and hot) *Droughts* *Fires*			

(Source: Fieldwork)

4.1.1 Floods (Hydrological and Meteorological Hazard)

The most significant hydrological and meteorological hazard that affects Korogocho is floods. Floods have been occurring in the settlement in an almost predictable cyclical pattern. For instance, most of the respondents still recall the veracity of 1998 El Nino floods that swept away most of the houses that were constructed along River Gitathuru and Nairobi River. According to most of the respondents, flooding occurs every year during the rainy season (*Table 4*). In some cases, rains from Ngong Hills cause flooding downstream in Korogocho and the bursting of the river banks of the rivers. The floods mostly affect the residents who live next to the two rivers. The two affected villages are Grogan and Gitathuru. Those with mud floors also suffer as the houses become inhabitable. The residents are sometimes forced to move to other houses, but sometimes due to poverty, they continue to live in these houses. *Table 4* presents the year that respondents reported the occurrence of a flood, the observed impacts and some of the coping strategies adopted by the community.

Table 4: Flood Occurrence, Impacts and Coping Strategies in Korogocho

Year	Impact	Coping strategies
1989 1995 1996 1997 1998 2003 2006 2009 2010	• People were displaced • Adults and children drowned • Houses were washed away, especially those near the river • Houses collapsed, especially those made of mud • Houses were filled with water • There was outbreak of waterborne diseases • Property and bridges were destroyed • Small livestock were swept away	• Temporarily moved to safer places or higher grounds • Dug channels to facilitate free flow of water • Use "soil" bags or tyres to divert water • The most affected received tents, food, clothes and medicine from Red Cross, the government and church (except in 2003 and 2009)

(Source: Fieldwork)

The general impacts of floods reported during the study include people being displaced, drowning of adults and children, houses being washed away, collapsing of houses and houses being filled with mud. This also leads to the outbreak of waterborne diseases and the destruction of property and infrastructure such as bridges. During the focus group discussion, it was observed that that as much as floods are generally destructive, *"they sometimes bring good things like sofa sets from*

Gikomba which we pick and use". However, fatalities have been reported when "*a number of people have drowned or been washed away while trying to retrieve these things from the river.*" According to one old man in Korogocho, the worst floods to ever hit the area were during the El Nino rains in 1997/1998. This fact was supported during the targeted one on one interview with some key respondents which elaborated further that the El Nino floods affected the whole settlement. Quite a significant number of people died while others were displaced. Houses were washed away, with bridges, roads, and sewer facilities being rendered unusable. Recurrent flooding in some sections of Grogan A, Vietnam and Gitathuru has led to the houses here being rendered unusable (*see Photo 1*).

Photo 1: Floods in Korogocho

Photo: This area has been rendered uninhabitable due to constant inundations with flood water. Notice the neglected house structures. ***(Source: Fieldwork)***

The focus group discussion further reported cases of people, especially students and those who are drunk, drowning as they attempt to cross the flooded rivers during rainy season. The residents recalled that in February 2010 about six people drowned as they tried to cross the flooded river and that several houses close to the river were also swept away. The heavy rains in December 2009 also caused floods in the area and structures close to the river were either destroyed or swept

away. The destroyed houses were observed in Highridge and Grogan B. At the time of this study, the houses were still unoccupied. Normally, the flooding situation can last for 2 to 3 days. Grogan A and Highridge villages have schools which are located near the river, further enhancing the exposure of the students to flood related vulnerability. During floods, the school programme is not only disrupted but the pupils are also exposed to water-borne diseases and other related health hazards when they resume.

With regard to coping strategies, some residents have tried to develop some coping strategies to deal with problem of floods (see *Photo 2& 3).* In some instances, the use of natural stones and rocks to act as artificial dykes, the process of digging trenches around the house to drain away the excess waters in addition to that of raising the base of the houses. Still, these are only short term measures that would only be effective during normal rainfall regimes. In instances of heavy and continuous rainfall, these measures would not be able to save the residents from becoming homeless. Normally, the residents temporarily move to safer places or higher grounds, dig channels to facilitate free flow of water and use soil bags or tyres to divert the water. In some instances, the most affected receive tents, food and medicine from Red Cross, government and other well wishers.

Photo 2: Coping with Floods in Korogocho

Photo: This house has in Gitathuru been further supported by a stronger base of rocks and sand to act as a barrier to flood waters. ***(Source: Fieldwork)***

Photo 3: Coping with Floods in Korogocho

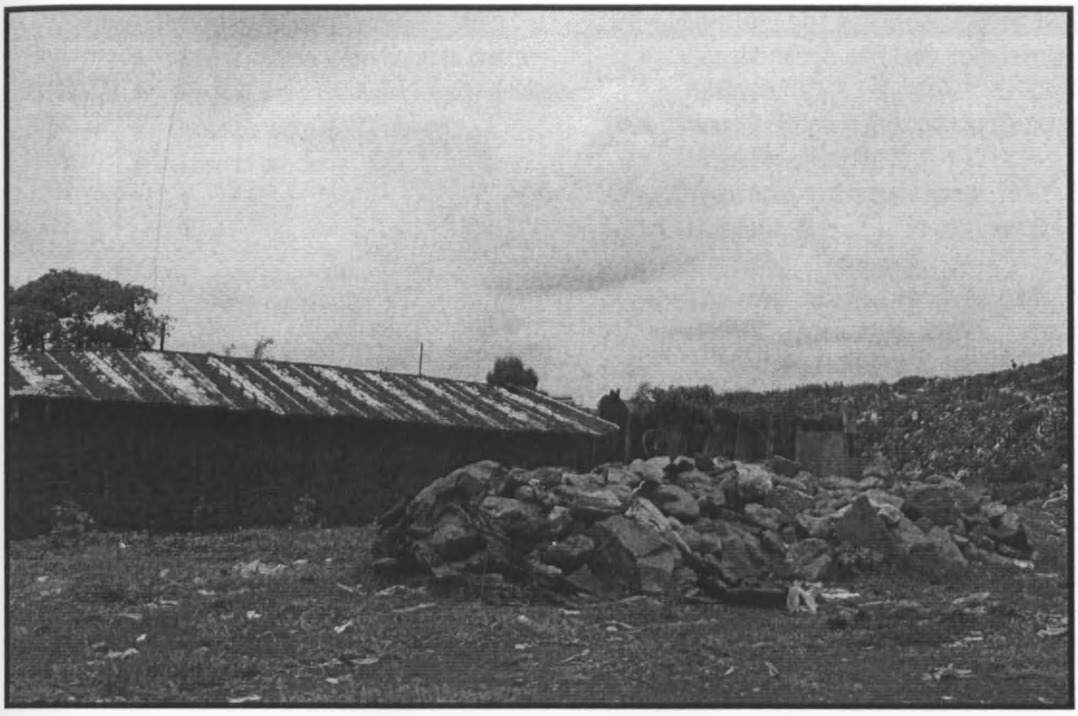


Photo: This house has in Grogan B has been constructed in a flood plain for Nairobi River. An artificial dyke is used to break the flood waters during the rainy seasons. ***(Source: Fieldwork)***

4.1.2 Fire (Socio-climatological Hazard)

As illustrated by *Table 5*, fire outbreaks are a big problem in Korogocho. According to some of the respondents, the worst fire outbreak in the settlement occurred in 1980 in Grogan A and Grogan B, where over 100 houses were completely burnt down and a large number of people injured and displaced. Since then, a number of fires normally erupt, especially during the dry spells, which further leader to destruction of houses and property. During the 2007 post election violence, quite a number of houses in Grogan B were set ablaze as a result of the post electoral animosity that flared up within Korogocho. Mostly, fires are triggered by stoves, charcoal burning, tin lamps, faulty electrical connections and even deliberate jealousies triggered by animosity or malice. Fires are dreaded, especially if they occur at night and during dry spells since water to put out the fires is a major problem.

Table 5: Fire Occurrence, Impacts and Coping Strategies in Korogocho

Year	Impact	Coping strategies
1980 1993 1994 1999 2000 2007 2008 2009 2010	• Some people were burnt to death • People were left homeless and helpless • Houses were burnt down • Loss of property	• Sought refuge and help from friends and relatives • Sought refuge in the community centre • Moved to other areas • Went back to the rural home • Mobilized ourselves to stop the fire from spreading • The most affected received tents, food, clothes, household items, medicine, building materials and money from the church, NGOs, government, well wishers, Red Cross, Islamic community, area MP and Councillor (except in 1999 and 2010). • The fire brigade helped to put out the fire

(Source: Fieldwork)

As indicated in *Table 5*, fire hazards normally lead to some people being burned to death, residents being left homeless, houses being razed down and general loss of property. Fire outbreaks are attributed to the overcrowded conditions, the type of materials the houses are built of (see *Photo 4*), and lack of access roads for fire fighters, lack of water, to fight the fire, and sometimes domestic quarrels and ethnic animosity. It was also reported that during such incidences, some people take advantage to steal from the victims and those who have volunteered to help – the worst being at night. In addition, the help they get is normally "not enough". Korogocho remains highly vulnerable to fire related hazards. The lack of a clear fire fighting plan for the settlement, coupled by a poor road infrastructure for easy access in addition to intermittent water supply all serve to show that fires can turn into significant disasters in Korogocho.

The issue of lack of access to water was reported as a major impediment to putting out the fires if and when they occur. The residents do not seem to have access to firefighting equipment like fire extinguishers. The knowledge of residents on management of fire outbreaks was scanty, indicating a general lack of preparedness on their part. Lack of lighting within most villages in Korogocho also serves to complicate rescue efforts, especially in instances of these fires breaking out at night. *Photo 4* clearly shows some of the most common housing materials used in this area.

The common coping strategies employed in dealing with the fire hazards include, seeking refuge and help from friends and relatives, seeking refuge in the community centre, moving to other areas (rural homes) and efforts at community mobilization to stop the fire from spreading. The questionnaires indicated that the most affected received tents, food, clothes, household items, medicine, building materials and money from the church, NGOs, government, well wishers, Red Cross, Islamic community, area MP and Councillor (except in 1999 and 2010). In few instances, the Nairobi City Council fire brigade helped to put out the fire.

Photo 4: Type of Housing Materials in Korogocho

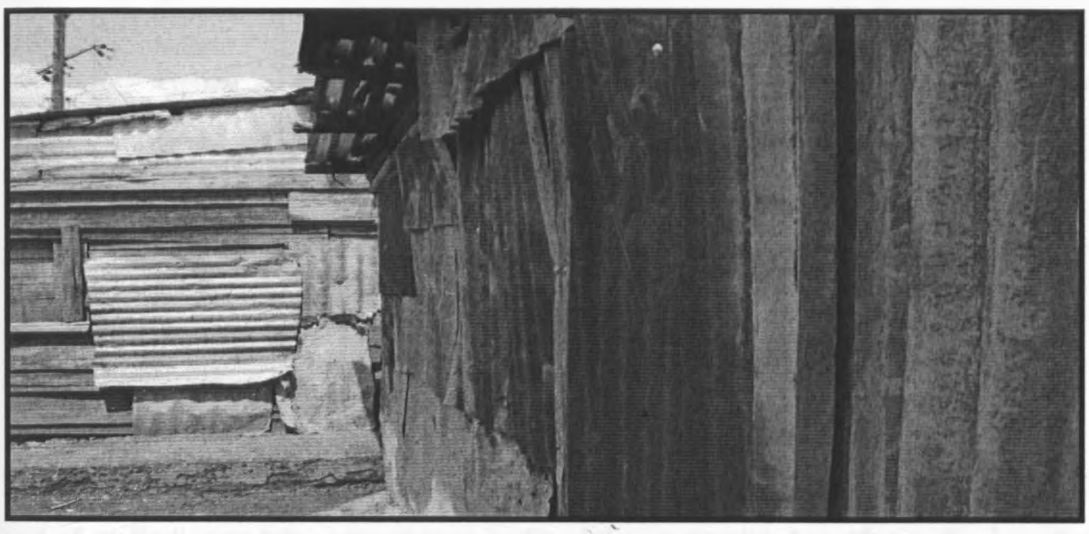


Photo: A house constructed using corrugated iron sheets. In the background, a house constructed using iron sheets and wood. ***(Source: Fieldwork)***

4.1.3 Health Epidemics (Biological Hazard)

The outbreak of health hazards in Korogocho was raised as another common hazard (see *Table 6*). The respondents noted that a number of diseases were very common in the settlement. The common diseases in Korogocho include TB, asthma, bronchitis, AIDS (due to prostitution), typhoid, cholera, malaria, diabetes and high blood pressure. Cholera and malaria are due to poor hygiene, poor sanitation and lack of clean water.

In addition, the nearby Dandora dump site produces a bad smell and a lot of smoke, especially in the evenings, that affects the health of some residents. The focus group discussions revealed that some residents suffered from respiratory ailments, loosely attributed to the dumpsite, but more analysis in this particular regard is required. There were also cases of malnourishment, particularly during the periods of food stress and general food insecurity in the country as a result of drought and or crop failure.

Table 6: Disease Occurrence, Impacts and Coping Strategies in Korogocho

Year	Disease	Impact	Coping strategies
1998 1999 2000 2002 2003 2004 2006 2009 2010	• Cholera • Malaria • Typhoid • TB	• Some people, especially children died • The cost of medication was too high • People suffered poor health	• Moved to designated areas • Took preventive measures, i.e. boiling water for drinking and improving hygiene conditions • Sought own treatment and medication • The affected people received free treatment, vaccine, medicine and food from Red Cross, the government, NGOs and the church (except in 2004)

(Source: Fieldwork)

The survey found that disease occurrence led to death of people, especially children, increased cost of medication and the general poor health of the community. According to the focus group discussion, the cholera outbreak of 1999 in Korogocho A and B affected a significant but undisclosed number of people. The two villages and Kisumu Ndogo suffered another cholera outbreak in late 2009 and early 2010. About 6 to 10 people were feared dead. In 2003, there was a TB outbreak that was difficult to treat and kept spreading very fast. The situation of health epidemics is made worse by the lack of a government managed public hospital in the settlement. The residents have to travel to Kenyatta National Hospital, which is quite a distance from the area. In addition, during emergencies, making such a trip to the hospital is normally extremely difficult. There is only one low-cost hospital in Korogocho, which is run by a CBO and many private clinics.

The following coping strategies are normally employed by the residents; use of preventive measures like boiling water for drinking and improving hygiene conditions, seeking own treatment and medication. In some instances, the affected people received free treatment, vaccine, medicine and food from Red Cross, the government, NGOs and the church.

4.1.4 Drought and Famine (Socio-climatological Hazards)

Although the respondents noted that droughts and famines which affected the national level had some impact on the economy of Korogocho, the impact was only limited to the issue of food insecurity, water rationing and interruption of the electricity supply (see *Table 7*). This was manifested in the increase of food prices in the area, further contributing to reduced dietary quality, hunger, insecurity and inflation. The focus group discussion noted that hunger is a big concern in Korogocho. Hunger is largely caused by poverty, food insecurity, lack of money, inflation and lack of support networks, hence enhancing their vulnerability. The situation is worse for those who are sick, old or those who cannot engage in any kind of economic activity. One of them noted that "*there can be food in the market but people have no money to purchase it. The situation is getting worse every year. The Ksh 100 that a casual labourer gets per day is not enough even to buy a packet of unga (maize flour)*".

Table 7: Drought and Famine Occurrence, Impacts and Coping Strategies

Year	Impact	Coping strategies
1994 2000 2007 2008 2009	• Food became scarce and expensive • People died of hunger • Led to starvation and malnutrition • People stayed without food for days	• Sought help from the government and church • Those who had food helped those who did not have • Begged for food from the market and along the road • Survived on the little available food • The most affected received relief food (maize, rice, cooking oil & beans) from the government, church and USAID

(Source: Fieldwork)

The impacts of droughts is presented in Table 7 as food scarcity and rise of the food prices, the death of people, general malnutrition, water rationing and starvation. With regard to coping strategies, the residents normally seek help from government and church, communal support

networks are strengthened. The most affected, sometimes, receive relief food aid (maize, rice, cooking oil and beans) from government, church and USAID.

4.2 Hazard Risk Index Analysis for Korogocho

The Community Based Indicator system for Korogocho was generated for a total of 47 individual indicators analyzed according to Hazards (*H*), Exposure (*E*), Vulnerability (*V*) and Coping Capacity (*C*) (*see Table 13, Appendix 6.2*). In the end, a factor scale weighting process was conducted by assigning cut off points to each individual indicator as observed or recorded in the questionnaires and or the focus group discussions according to the likely impact the indicator had on the vulnerability issue being analyzed then.

To compute the vulnerability, the study employed the use of the Vulnerability formula as generated and used by UNDP as captured in *Equation 1* found in the methodology section. After completing the weighting process for all the Hazards (H), Exposure (E), Vulnerability (V) and Coping capacity (C) indicators for Korogocho, the *Equation 2* formula was used to compute the vulnerability risk index.

4.2.1 Hazard (H) Factor Analysis

The rapid hazard/disaster analysis in Korogocho identified floods, droughts, fires and diseases as the most common type of hazards in the area. The impact of these hazards to the vulnerability of Korogocho residents was weighted according to the following hazard Indicators:

1. Hazard probability of occurrence (Frequency in the past 30 years, Probability of possible events)
2. Hazard severity (Intensity of worst event in the 30 years, Expected intensity of possible events)

According to questionnaires, focus group discussions and interviews conducted in Korogocho, the corresponding indicators for hazards in the area were weighted using the following standard scale generated by Bollin (2003). Where the scale: *0 = No impact; 1 = Low impact; 2 = Medium impact; 3 = High impact* is applied.

It is important to note that a hazard specific weight has to be applied based on the respondents, since some indicators are more important than others, contributing differently to each of the factors. The hazard analysis for Korogocho was generated as shown in *Table 8*.

Table 8: Analysis of Hazard Probability and Severity in Korogocho

MAIN FACTOR AND FACTOR COMPONENT	INDICATOR NAME				INDICATOR
HAZARD	FACTOR	Flood	Droughts	Fires	Disease	
Probability	(H1)	3	2	3	3	Frequency in the past 30 years
	(H2)	3	1	3	3	Probability of possible events
Severity	(H3)	3	1	3	3	Intensity of worst event in 30 years
	(H3)	2	1	3	3	Expected intensity of possible events
Total		11/12	5/12	12/12	12/12	Hazard Score over Total Indicators

(Source: Fieldwork)

Where the scale: 0 = No impact; 1 = Low impact; 2 = Medium impact; and 3 = High impact

From *Table 8*, it is clear that in Korogocho slums, the probability and severity of fire, disease and flood related hazards is very high. Unlike droughts, which only have a total score of 5 with regard to frequency, probability, probable severity and expected intensity in possible events, it's clear that for fires, floods, and diseases, the study projects a higher likelihood of occurrence. The predictability of these hazards is a clear manifestation of the quality of livelihood within this informal settlement. As deducted from *Photo 5* and *Photo 6*, the quality and veracity of the waters flowing within River Gitathuru and Nairobi River only serves to exacerbate this scenario.

Photo 5: Flooding and Contamination of Nairobi River

Source: Fieldwork)

Photo 6: Flooding and Contamination of River Gitathuru

(Source: Fieldwork)

4.2.2 Exposure (E) Factor Analysis

The poverty levels within Korogocho slums enhance the level of exposure of the residents to hazards. In addition, lack of gainful employment opportunities to the residents of Korogocho serves to reduce the resilience within the community to respond effectively to the various hazards that occur within this area. This is further reflected by the weak building materials in the settlement. As the study discovered, most of the houses in Korogocho were constructed using weak construction materials and in most cases without evidence of clear planning guidelines from the City Council of

Nairobi. *Table 9* shows that the Korogocho Informal settlements are highly exposed to fire, drought and disease related hazards.

Table 9: Analysis of Exposure Factors in Korogocho

MAIN FACTOR AND FACTOR COMPONENT		INDICATOR NAME				INDICATOR
EXPOSURE	FACTOR	Flood	Droughts	Fires	Disease	
	(E1)	3	2	3	3	Living quarters
Structures	(E2)	3	3	3	3	% of houses with piped water
Sub Total		6	5	6	6	
Population	(E3)	3	3	3	3	Total resident population
Economy	(E4)	2	2	2	2	Total locally generated GDP in constant currency
Total		11/12	10/12	11/12	11/12	Exposure Score over Total Indicators

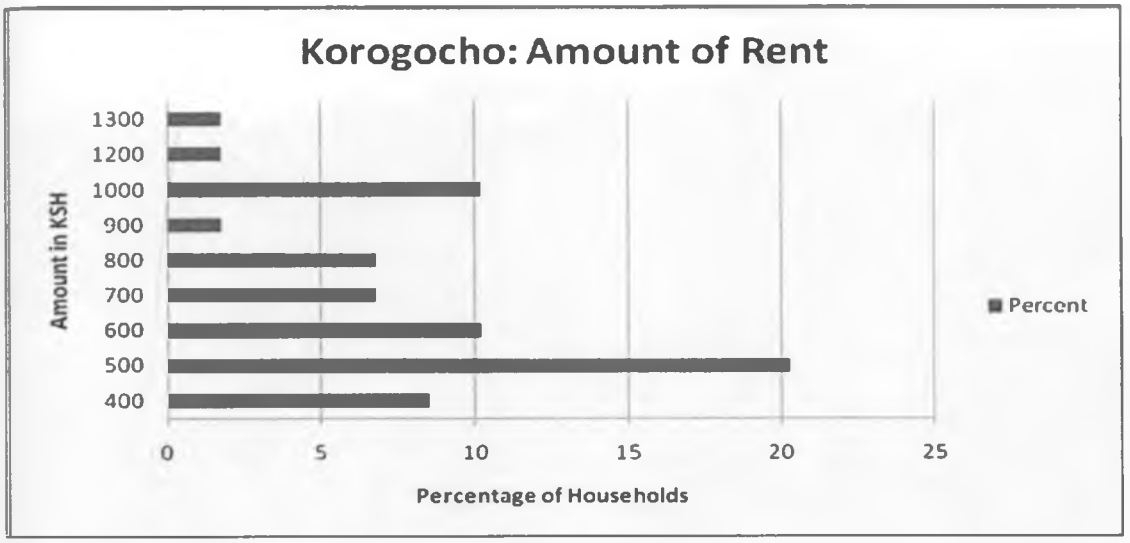
(Source: Fieldwork)

Where the scale: 0 = No impact; 1 = Low impact; 2 = Medium impact; and 3 = High impact

This is attributed to a number of reasons. The poor quality of living quarters in Korogocho enhances the vulnerability of residents to flood related hazards, fire hazards and disease hazards. Most of the participants 78% relied on piped water with 22% relying on private vendors. 86% of the respondents do not harvest water for use, probably due to the quality of roofing materials. Only 13% reported to harvesting the rain water for use, indicating that the rainy season only spells doom for most of the residents here. Hence lack of access to piped water in the houses just enhances the exposure of the residents to such hazards.

In addition, the population density within this settlement exposes more residents to such hazards, especially the fact that the locally generated GDP in constant currency is below the Gini coefficient. The survey reviewed the monthly economic situation of the respondents where it emerged that 70% of the respondents earn less than 5,000 KSh per month. In fact, the study found that the house rent ranged from Ksh 400 to Ksh 1300 per month (*see Figure 3*).

Figure 3: Monthly rent payment in Korogocho



(Source: Fieldwork)

From *Figure 3*, the study revealed that 20 % of the respondents pay 500 KSh per month as rent. Cumulatively, above 90 % of the respondents pay less than 1,000 KSh shillings per month for rent, a clear indication that the quality of housing is weak. Most of the respondents have rented the houses. The houses are constructed hastily without due regard to the safety principles as envisioned in the national legal framework and Nairobi City Council regulatory requirements for safe buildings. The materials used in the construction processes are also of weak quality. Lack of maintenance of the houses over time has led to the continual deterioration of the quality, hence increasing their exposure to vulnerability indicators as presented in *Table 9*.

Photo 7: Exposure of buildings to floods

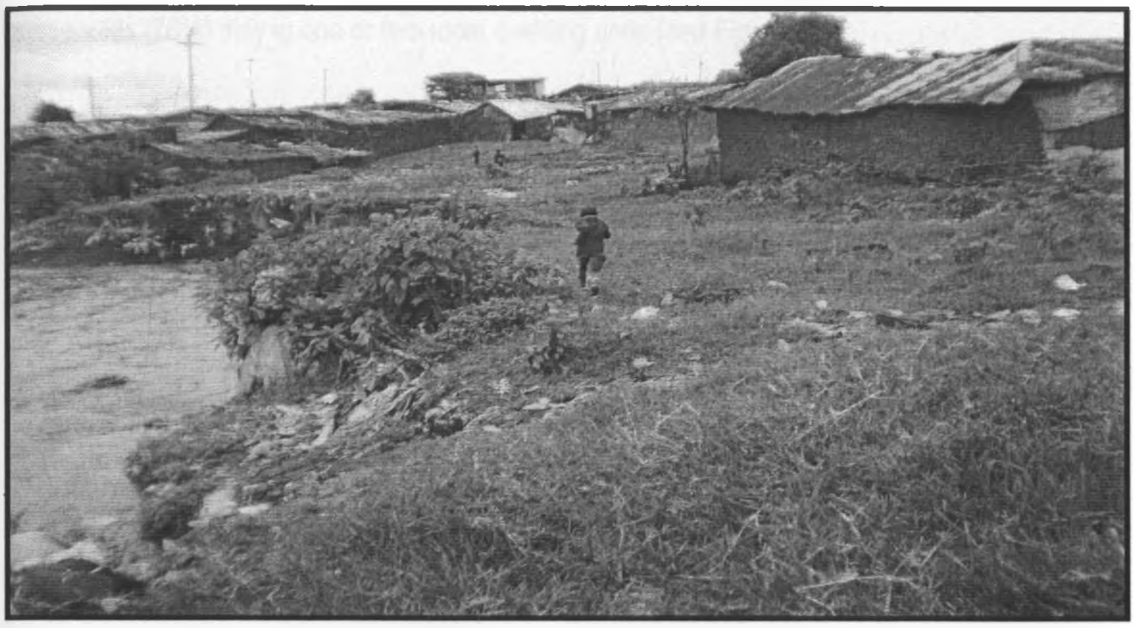


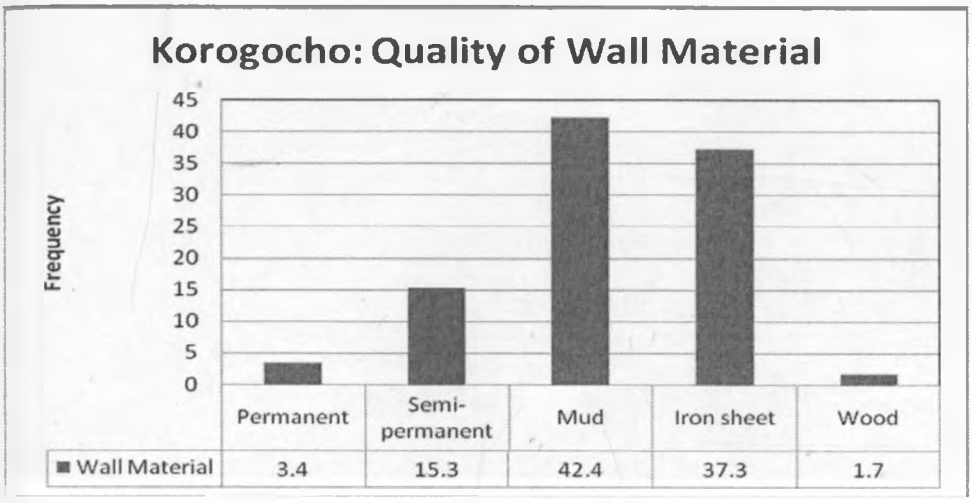
Photo : School located close to the river bank, exposing pupils to vulnerabilities related to flooding during the rainy seasons ***(Source: Fieldwork)***

The floods, droughts, fires and disease hazards in Korogocho have a huge impact on the vulnerability of Korogocho due to the quality of living quarters, % of houses with piped water, total resident population and total locally generated GDP in constant currency. As discernible from *Figure 4*, the study found that a significant proportion of residents lived in poor housing structures comprising of tin, corrugated iron sheets, mud and wood. Most of the houses are constructed using temporary and recycled materials. The walls are made of iron sheet, timber and mud while recycled tin, iron sheet, carton paper, polythene and even sacks are used for roofing.

From the household survey conducted during the study, all the sampled dwelling units had iron sheet roofs and only two houses were permanent. The rest were either semi-permanent, made of mud, iron sheet, tin or wood. The structures belong to individuals but the land is owned by the government. As such, tenants are left at the mercy of the structure owners – more often resulting into conflicts of rent, land and tenure rights. According to the survey results, 70% of Korogocho

households are renting their dwelling units while 30% are living in their own houses. Most of the households (78%) stay in one or two-room dwelling units (*see Figure 4*).

Figure 4: Quality of wall construction materials



(Source: Fieldwork)

These study findings were corroborated by the 2010 findings of the Kenya National Household Survey, which detailed the socio economic characteristics of urban areas including Korogocho. The findings of the 2009 census established that of the 326, 398 households in Nairobi North where Korogocho slums are found, 60% of the households are roofed by corrugated iron sheets, 27% by asbestos sheets, with only 35 % being roofed by either tiles or concrete. The rest are roofed by grass, tin and other material (*KNBS 2010*).

In addition, the census results found that approximately 50% of all households lived in houses constructed using corrugated iron sheets, wood, tin, grass reeds, mud and cement. These are inferior construction materials that fail to respond effectively to hazards and disasters in the area. The study found that a number of houses constructed using corrugated iron sheets and mud are very close to the Dandora dumpsite (*see Photo 8*) and they expose the residents to serious health related hazards.

Photo 8: Exposure of Korogocho: Quality of environment and houses

Photo : Houses constructed next to Nairobi River on the border of Korogocho and the Dandora dumpsite ***(Source: Fieldwork)***

4.2.3 Vulnerability (V) Factor Analysis

The socio economic characteristics of Korogocho were found to be enhancing the vulnerability of the residents to hazards. In this case, it has a large poor population with no access to minimum services, living largely in structures made out of temporary and recycled building materials – or made out of timber, mud walling, and roofing made up of substandard materials such as sacks, carton paper and polythene. There is no proper sanitation and waste management. Water reticulation is limited and the road network is inadequate or non-existent.

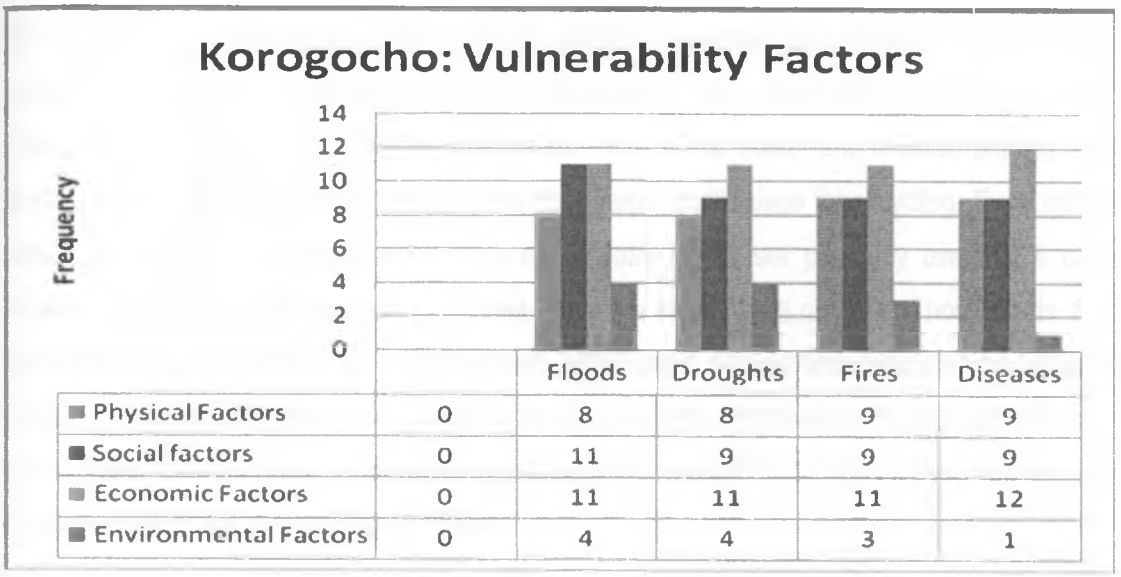
The other indicators which enhance vulnerability in Korogocho include the population density, population growth rate, the homes in hazard prone areas (ravines, river banks), the % of population below poverty level, literacy levels, and the portion of self generated revenues. The other indicators for vulnerability are economic marginalization and environmental degradation. These factors were analyzed based on the questionnaires and the focus group discussions. The results were tabulated as shown in *Table 10.*

Table 10: Analysis of Vulnerability Factors in Korogocho

MAIN FACTOR AND FACTOR COMPONENT		INDICATOR NAME				INDICATOR
VULNERABILITY	FACTOR	Flood	Droughts	Fires	Disease	
Physical/Demographic	(Vl)	3	3	3	3	People per Km2
	(V2)	2	3	3	3	Population growth rate
	(V3)	3	2	3	3	Homes in hazard prone areas(ravines, river banks) etc
Sub-Total		8	8	9	9	
Social	(V4)	3	2	2	2	% of homes with piped drinking water
	(V5)	3	3	3	3	% of population below poverty level
	(V6)	2	2	2	2	% of adult population that can read and write
	(V7)	3	2	2	2	Priority of population to protect against a hazard
	(V8)	0	0	0	0	Portion of self generated revenues of total budget
Sub-Total		11	9	9	9	
Economic	(V9)	2	2	2	2	Voter turnout
	(V10)	2	2	2	2	Total available local budget in US$
	(V11)	1	1	1	2	Economic sector mix
	(V12)	3	3	3	3	% of businesses with fewer than 20 employees
	(V13)	3	3	3	3	Number of interruption of road access in last 30 years
Sub-Total		11	11	11	12	
Environmental	(V14)	0	0	0	0	% of area of the commune covered by forest
	(V15)	3	3	2	0	% of area that is degraded
	(V16)	1	1	1	1	% of agricultural land overused
Sub-Total		4	4	3	1	
Total		32/16	31/16	32/16	31/16	Vulnerability Score over Total indicators

(Source: Fieldwork)

Figure 5: Factors enhancing vulnerability in Korogocho



		Floods	Droughts	Fires	Diseases
Physical Factors	0	8	8	9	9
Social factors	0	11	9	9	9
Economic Factors	0	11	11	11	12
Environmental Factors	0	4	4	3	1

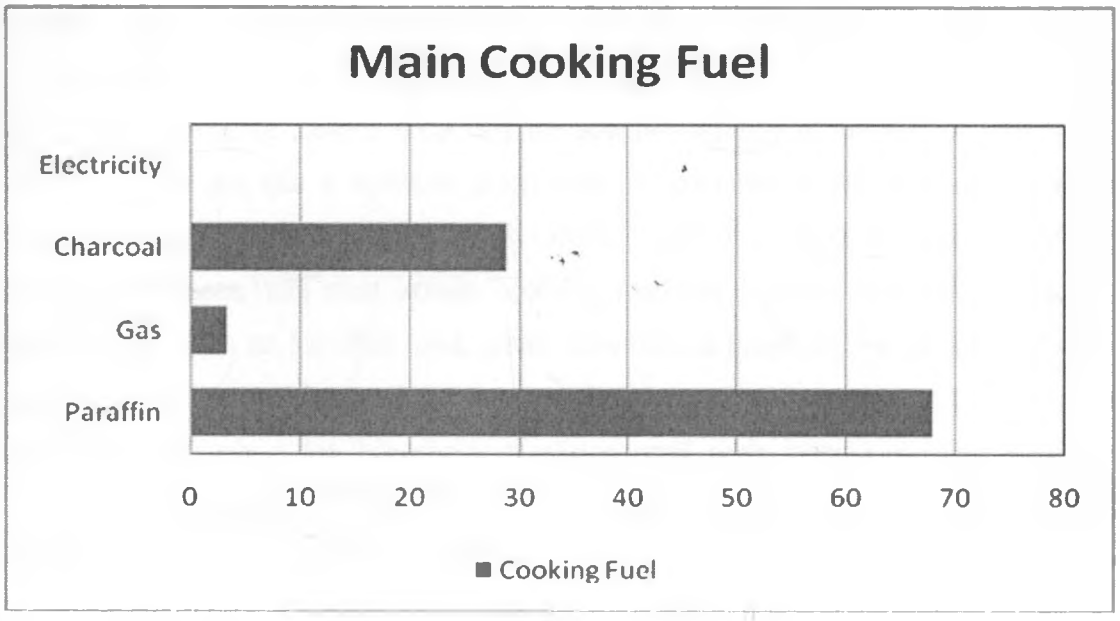
(Source: Fieldwork)

Mostly, vulnerability of Korogocho to environmental hazards is driven by economic factors for all the four hazards (fires, diseases, droughts and floods) identified (*Figure 5*). This is followed closely by social factors which indicate a weak resilience that is only compounded by poor physical infrastructural factors in the area. In defining vulnerability indicators for Korogocho, it's important to note that like other slums in Nairobi, Korogocho suffers from poor drainage, inadequate access to water and sanitation facilities, as well as basic services.

However, the Korogocho Slum Upgrading Programme has re-energized the provision and/or improvement of infrastructure and services in the area. Particularly noticeable are the roads, main sewer line, drains, bridges, and water points where the residents can purchase water. This was manifested by the finding that 76% of the households had access to piped water, 25% used private water vendors and 14% made use of roof catchment. Three-quarters of the households consumed between 1 to 5 twenty-litre jerry cans per day, while the expenditure on water was between Ksh 3 and Ksh 100 per day per household.

With regard to sanitation however, household waste is noticeable in open spaces, near or in rivers and in drains – an indication of lack of waste collection services. Soko Mjinga, a large informal market serving the area, throws most of its raw waste in the Nairobi River. Plastics and other human waste could be seen floating in the river, while at the same time children playing in the water as other people used the water for washing large plastic bags for recycling. Even with the presence of the main sewer line in the area, pit latrines are still popularly used: 87% of the households reported that they use pit latrines. They are shared by a number of households. From the survey, approximately 85% of households interviewed did not have access to a sanitation facility, (septic tank). Some are very close to the houses while others are right next to the rivers. In some cases, the raw sewer (from toilets or the ones that are full) is directly emptied into the rivers or drainage trenches, posing a health hazard.

Figure 6: Main cooking fuel used in Korogocho



(Source: Fieldwork)

As can be discerned from *Figure 6*, most of the respondents in Korogocho use paraffin (67%) followed by 28% who use charcoal. These modes of cooking enhance environmental degradation, and also exacerbate the problem of fire outbreaks in area.

4.2.4 Coping Capacity (C) Analysis

The coping capacity is a key factor of the issue of urban vulnerability. Indeed, community resilience and adaptive capacity can be effectively used to deal with the floods of fires, floods, diseases and droughts. If the community can be able to have physical planning measures such as an enforceable land use plan, applied building code regulations, regular maintenance, natural resource conservation among others.

In addition, communities can be able to have an enhanced capacity to appropriately deal with hazards if strong social measures such as an effective emergency response drills, committees, local organization groups, and frequent public awareness programmes on hazards and disasters. Others include economic capacity including availability of insurance, loans, access to international emergency funds, reconstruction credits and local public works projects.

A closer analysis of the coping capacity of the Korogocho revealed that the coping capacity of Korogocho was very weak. The Korogocho Community Management Committee was recognized as a positive measure towards enhancing the adaptive capacity of the slum to hazards and disasters. There are also a significant organization of community based organizations, women groups and youth groups such as Miss Koch initiative. Some of the residents are employed in the informal businesses, with most women operating road-side business units offering goods at cheaper rates. Men on the other hand, prefer more manual based income generating activities such as carpentry, welding, and construction. There are limited cases of urban farming in Korogocho with only a few households practicing small scale farming of kales, sugarcane, tomatoes and napier grass. This particularly occurs where households border River Gitathuru or Nairobi River and is mostly practiced within clearly established flood plains.

In terms of education facilities, there are only two Nairobi City Council schools, expected to cater for over 4000 children, hence many children in Korogocho do not have access to primary education. However, ingenious individuals have taken advantage of this to establish a number of private schools which are operational within the area. With regard to health, poor hygiene prevalent

in the slum has resulted in the rapid spread of cholera, malaria, typhoid, dysentery, and water and air borne diseases. Sexually transmitted diseases and HIV/AIDS are also wide spread. In addition, increasing violence and crime in Korogocho, which are often met only with a repressive response, create insecurity, reinforcing social and ethnic tensions, and undermine social cohesion in the settlement.

Best Practice: The Korogocho Slum Upgrading Programme as a coping intervention

The efforts of the Korogocho Slum Upgrading Program need to be hailed as a positive step towards improving the coping capacity of residents to deal with environmental hazards. The Korogocho Slum Upgrading Programme is a joint initiative of the Government of Kenya with funding support through a debt for development swap entered into by the Government of Italy and the Government of Kenya. The initiative seeks to upgrade Korogocho in order to improve the living and working conditions of residents. This will be achieved through coordinated support to the community to provide the residents of Korogocho with security of tenure through an appropriate land tenure system and to prepare and implement improvements of the physical, economic and social living conditions of the Korogocho communities. Significant progress has since been made in the implementation of this programme.

As a coping intervention with respect to vulnerability, the project has begun widening the roads, setting up new infrastructural networks, clearly demarcating the boundaries of the villages within Korogocho, community discussions on matters of social welfare of residents among various other measures. The main objectives of the project are detailed as:

- To have a detailed appreciation of Korogocho
- To prepare an Advisory Physical Plan for Korogocho
- To build capacity of various actors/Institutions
- To prepare a Sustainable Integrated Plan for upgrading Korogocho
- To provide collective security of tenure to the residents of Korogocho

The Korogocho Slum Upgrading Programme has recorded a number of successes evident on the ground and they include the finalization of constructing the foot bridge linking Korogocho and Dandora estate. This bridge has secured the livelihood of the residents since they used to cross River Gitathuru using the using a sewer pipeline that runs across the river. This would expose the residents especially children and women to the risk of drowning in the river. Another notable success is the finalization of the construction of a community office. This office serves as the information centre to the community and also hosts the residents committee. The office has a boardroom and two offices. In fact, the focus group discussion conducted in the course of this study was held in this office. These are some of the evidence based successes that were identified as crucial components of enhancing the coping capacity of the residents to environmental hazards.

The coping capacity as shown in *Table 11* is an important element of vulnerability management in Disaster Risk Reduction (DRR). For urban informal settlements, the resilience of the communities can in effect reduce significantly the harmful impacts of the hazards/disasters to the livelihood of the people. Unfortunately for Korogocho informal settlements, the economic capacity of the residents does not have significant impact in terms of alleviating the vulnerability potential in the area. The management through frequency meetings of the Korogocho Resident Committee is a positive indicator in this regard.

Table 11: Analysis of Coping Capacity Factors within the Korogocho Informal Settlement

MAIN FACTOR AND FACTOR COMPONENT	INDICATOR NAME					INDICATOR
CAPACITY MEASURES Physical Planning	FACTOR	Flood	Droughts	Fires	Disease	
	(C1)	1	1	1	1	Enforced land use plan or zoning regulations
	(C2)	2	1	1	1	Applied code regulations
	(C3)	0	0	0	0	Applied retrofitting and regular maintenance
	(C4)	1	1	1	1	Expected effect of impact-limiting structures
	(C5)	1	1	1	1	Measures that promote and enforce nature conservation
Sub Total		3	4	4	4	
Societal capacity	(C6)	2	2	2	2	Frequency of public awareness programmes
	(C7)	0	0	0	0	Scope of relevant topics taught at school
	(C8)	0	0	0	0	Ongoing emergency response training and drills
	(C9)	3	3	3	3	Emergency committee with public representatives
	(C10)	3	3	3	3	Grade of organization of local groups

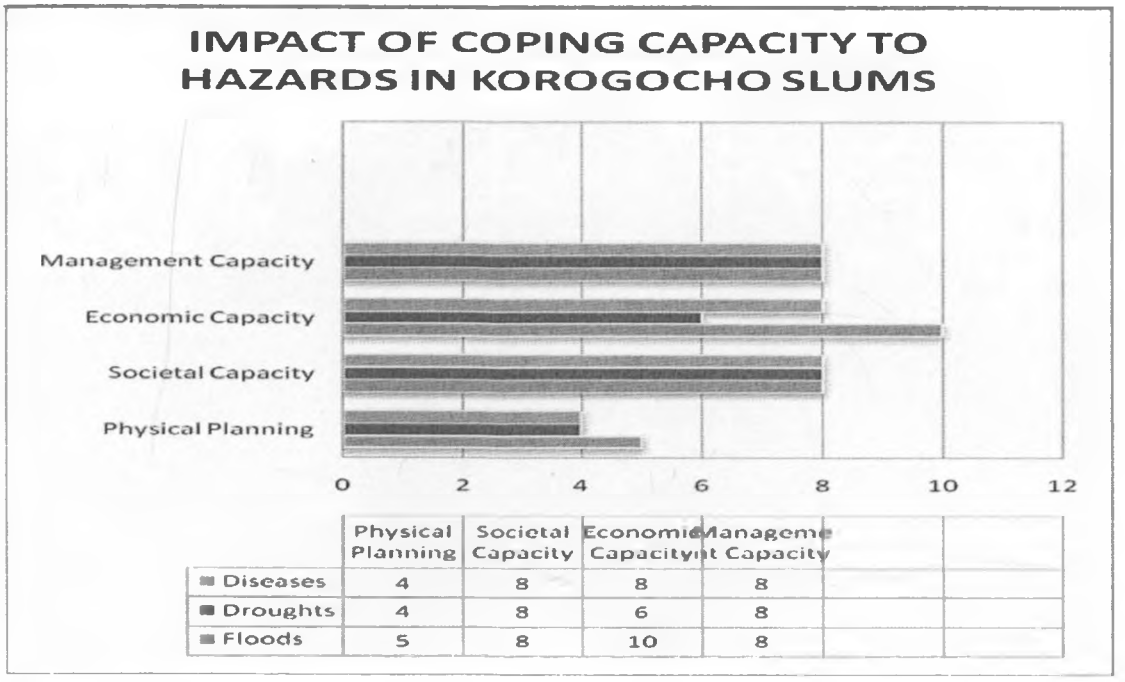
Sub Total		8	8	8	8	
Economic Capacity	(C11)	1	1	2	1	Local emergency funds as % of local budget
	(C12)	2	1	2	1	Release period of national emergency funds
Economic Capacity	(C13)	2	1	2	2	Access to international emergency funds
	(C14)	0	0	0	0	Availability of insurance to buildings
	(C15)	2	1	2	2	Availability of loans for disaster risk reduction measures
	(C16)	1	1	2	1	Availability of reconstruction credits
	(C17)	2	1	2	1	Magnitude of local public works programmes
		10	6	10	8	
Management and institutional capacity	(C18)	3	3	3	3	Meeting frequency of a commune community
	(C19)	1	1	1	1	Availability and circulation of risk maps
	(C20)	1	1	1	1	Availability and circulation of emergency plans
	(C21)	1	1	1	1	Effectiveness of early warning systems
	(C22)	2	2	2	2	Meeting frequency of a commune
	(C23)	0	0	0	0	Availability and circulation of risk maps
Sub-Total		8	8	8	8	
Total		34/23	32/23	34/23	31/23	Coping Score over Total indicators

(Source: Fieldwork)

Table 11 shows that with regard to coping capacity in Korogocho, the lack of societal and economic capacity related indicators are the most significant. This means that the resilience levels within residents need to be enhanced through social empowerment schemes in order to increase their ability to respond to the hazards identified. Issues like frequency of public awareness programmes, relevant school curriculum, emergency response drills, early warning systems and organization of the community into effective groups are some of the issues that boost a community's resilience. This is then followed by lack of proper physical plans (enforced land use plans, applied building code regulations, measures that conserve the environment among such other indicators). All these indicators were generated for Korogocho and analyzed as a means of establishing the coping capacity within the area of study.

The Korogocho Informal Settlements needs more efforts to ensure that the coping capacity of the community to effectively respond to environmental hazards identified (floods, fires, diseases, droughts) is enhanced. More work should be done in this regard but the Korogocho Residents Committee would definitely provide a solid platform for the efforts in this regard. *Figure 7* presents a graphical representation of the factor levels for the coping capacity indicators generated for Korogocho.

Figure 7: Impact of coping capacity to hazards in Korogocho



	Physical Planning	Societal Capacity	Economic Capacity	Management Capacity
Diseases	4	8	8	8
Droughts	4	8	6	8
Floods	5	8	10	8

(Source: Fieldwork)

The 2005/06 Kenya Integrated Household Budget Survey (KIHBS)1 estimated the *food poverty line* in monthly adult equivalent terms as being Kshs 1,474 in urban areas (compared with Kshs 998 in rural areas). The absolute poverty line in monthly adult equivalent terms was computed as Kshs 2,913 for urban areas compared with Kshs 1,562 for rural areas. In addition, households are deemed to be hardcore poor if they cannot afford to meet their basic food requirements with their total expenditure (food and non-food).

In terms of employment as a measure of enhancing coping capacity, the study found that some of the residents are casual labourers in the nearby factories or in construction sites. Others are engaged small-scale informal businesses of selling clothes, electrical wares, fruits, vegetables and cooked food – either by the roadside, in makeshift kiosks or in *Soko Mjinga* market (*see Photo 9*). Some of the residents make a living from the nearby Dandora dump site by scavenging for food or plastics, scrap metal and other recyclable materials for sale to industries that use them. Very few of the respondents are in formal employment.

Photo 9: Soko Mjinga market in Korogocho

Photo : The Soko Mjinga market is a socio economic hub for Korogocho and thrives with business on most days of the week. ***(Source: Fieldwork)***

With these activities, over half of the respondents (59%) have a monthly income situation of up to Kshs 5,000 per month, while the large majority of the rest earning between Kshs 5,001 and Kshs 10,000 per month. Social networks, especially the *merry-go-rounds,* are also important as a source of livelihood, especially for women. Despite the overcrowded conditions, small-scale farming is practiced along the river banks. The crops cultivated include sugar cane and arrow roots (in Highridge and Grogan B), bananas (in Grogan B) and *sukuma wiki* (kale, in Grogan A). Livestock such as sheep, pigs, goats and chicken were seen roaming about the area. This finding conforms to the findings by Mwangi & Foeken (1996) that 30% of households in Korogocho could be categorized as urban farmers. Almost half of the cultivated plots were found to be along the river.

Due to the high rate of employment in the area, social challenges such as prostitution, drug addiction, alcoholism, rape, criminality, domestic violence, street children, social and ethnic

tensions, and HIV/AIDS are common. These are all evidences of a weak coping capacity of the residents to effectively cope with hazards and disasters.

4.3 Computing the Risk Index for Common Hazards in Korogocho

Since the indicators for Hazards (H), Exposure (E), Vulnerability (V) and Coping capacity (C) have been generated, the *Equation (ii)* is now applied to compute the total risk index for the common hazards in Korogocho. As shown in *Table 12*, Korogocho is more susceptible to fires, floods, drought and diseases. The likely impact of these hazards is aggravated by the levels of exposure of the residents and socio-economic characteristics that reduce their resilience. Lack of measures that seek to boost their adaptive capacity, coupled by the failure to institutionalize disaster risk reduction strategies only serves to enhance their vulnerability. While a number of useful coping strategies, including the Korogocho Slum Upgrading Programme are acknowledged, it is important to scale up such efforts with more direct government support to the area.

Table 12: Vulnerability risk weighted scales for hazards, exposure, vulnerability and coping capacity in Korogocho

MAIN FACTOR AND	INDICATOR NAME						REMARK
HAZARD	FACTOR	Flood	Droughts	Fires	Disease	TOTAL	
		11	5	12	12		Residents are daily faced with hazards
EXPOSURE		11	10	11	11		The socio-economic characteristics enhance exposure to hazards
VULNERABILITY		32	31	32	31		Vulnerability is a factor of poverty and poor governance
CAPACITY MEASURES		34	32	34	31		The residents' resilience is not sufficient to enhance their ability to fully cope with hazards
TOTAL DISASTER RISK		6.6	4.62	6.93	7.59		Diseases, fires, floods and droughts in that order are the top hazards affecting Korokocho residents.

(Source: Fieldwork)

In this regard, in computing the Total Risk Index for floods in Korogocho Informal settlement using the E*quation (ii)* below:

R = (wHH + wEE + wVV) – wCC

The Disaster Risk Index for floods ($R_{Floods\ (H)}$)

$R_{Floods\ (H)}$ = (0.33*11 + 0.33*11 + 0.33*32) – (0.33*34)
= 6.6

The Disaster Risk Index for droughts ($R_{Droughts(H)}$):

$R_{Droughts(H)}$ = (0.33*5 + 0.33*10 + 0.33*31) - (0.33*32)
= 4.62

The Disaster Risk Index for fires (R_{fires}):

R_{fires} = (0.33*12 + 0.33*11 + 0.33*32) – (0.33*34)
= 6.93

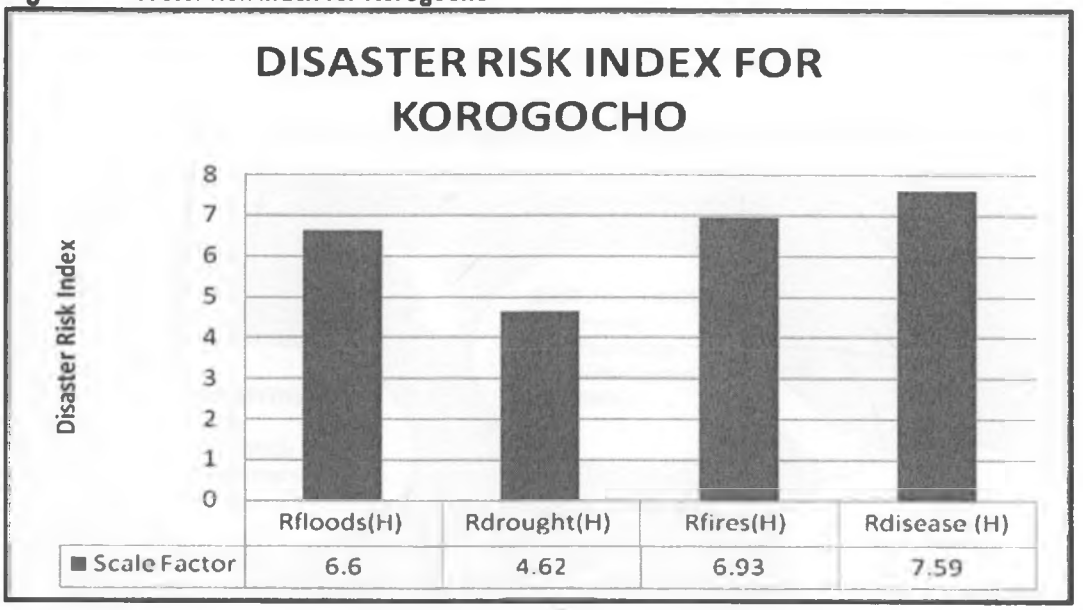
The Disaster Risk Index for diseases ($R_{diseases}$):

$R_{diseases}$ = (0.33*12 + 0.33*11 + 0.33*31) – (0.33*31)
=7.59

Discussion on Implications of these Findings

These findings *(see Figure 8)* indicate that the risk index associated with disease hazards is highest in the area of study. Many residents are therefore vulnerable to different types of diseases. The risk index associated with fires is also quite high, further emphasizing the finding that residents in this slum live in perpetual fear of a fire outbreak. The floods are also reported particularly during the rainy seasons. The risk index for droughts was not as high as the rest due to the over reliance on agricultural produce from other regions. Interestingly, hazards and disasters like landslides, earthquakes, and storms were not reported in the area.

Figure 8: Disaster risk index for Korogocho



(Source: Fieldwork)

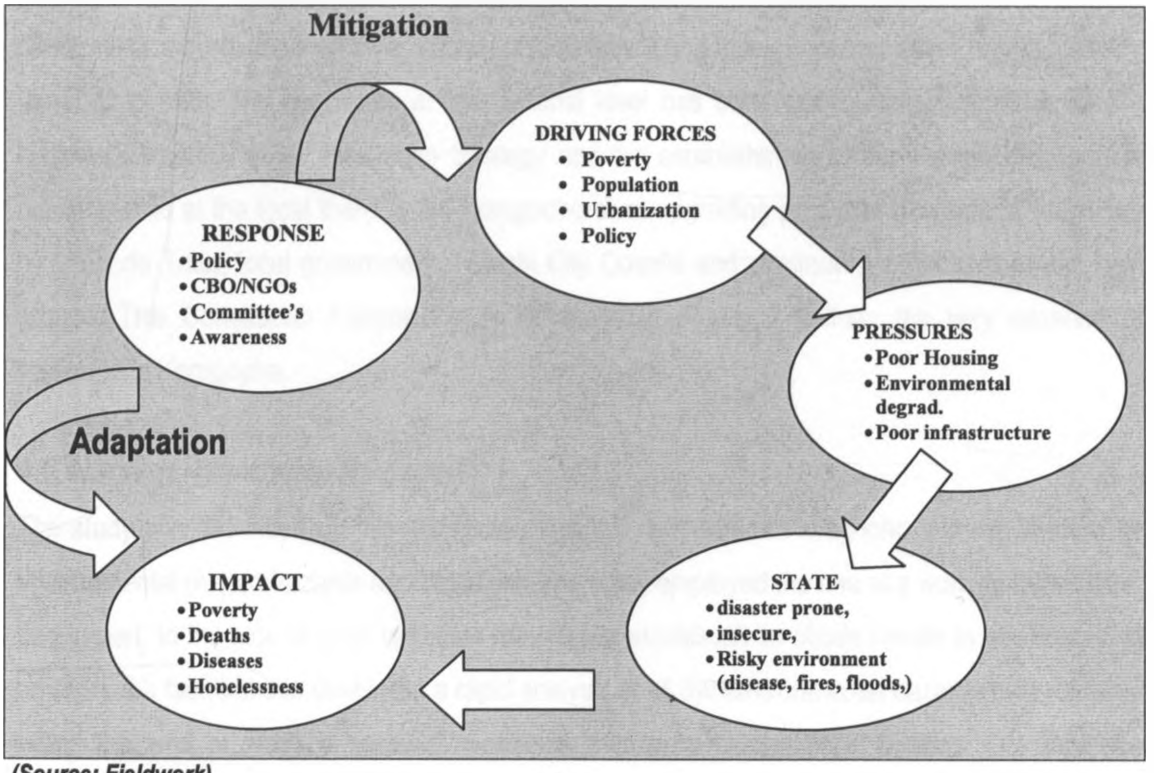
4.4 The Conceptual Framework Revisited: The DPSIR Framework for Vulnerability in Korogocho

This survey was conceptualized and framed using a combination of the Model for Holistic approach to disaster risk assessment and management (*see Figure 2 in the Introduction*) and the Driving-force, Pressure, State, Impact and Response (DPSIR) framework (*see Figure 9*). The Model for Holistic disaster risk was useful in generating the hazards with regard to their likely impacts (hard risk / soft risk) and how these hazards could contribute to potential social, economic and environmental consequences. The DPSIR was useful in presenting the environmental statistics generated in a logical frame that captured the driving forces, the pressure, state, impact and response indicators for vulnerability within Korogocho.

As indicated in *Figure 9*, there are two main ***driving forces*** for vulnerability of Korogocho Informal Settlements to hazards and disasters. These are: Policy failure, Poverty and Population growth. Poverty drives the urban dwellers and the new immigrants from the rural area to settle in areas within urban centers that are marginalized and neglected due to economic exclusion. Increasing

population growth contributes to the overcrowding within these urban slums, further exposing the residents to stress.

Figure 9: The DPSIR Framework for Vulnerability of Korogocho to Hazards/Disaster



(Source: Fieldwork)

The driving forces results in a number of ***pressures*** within the informal settlement, which is almost similar to what can be found for other slums like Mukuru, Kibera, Kiambiu etc. The resultant pressures include environmental degradation, poor houses, weak infrastructure, lack of basic amenities and general marginalization. The ***State*** of informal settlements is thus rendered as unsafe, disaster prone, insecure, polluted and risky to the livelihood of the people resident here. This results in a number of harmful ***impacts*** within the slums. Pervasive cyclical poverty, low incomes, food insecurity, poor dietary quality, deaths and diseases, all permeate within the slums resulting into reclusive attitude by the settlers. In most cases, some give hope and retire themselves to the ugly unfolding.

But within the slums, a spirit of general resilience can also be found through their ***response*** strategies. Communities, sometimes through government support develop creative coping strategies. The use of drama, community meetings, women groups, youth groups, sports, merry go rounds, religious groupings and local security welfare groups is evident. The residents are taking decisions on how to cope with the hazards and disasters and in some cases, development partners move in to help. The ***response*** at the national level has been government formulation of the National Climate Change Response Strategy and the establishment of the Nairobi Metropolitan ministry while at the local there is the Korogocho slum upgrading program, bio centers supported by Umande Trust, local government, Nairobi City Council and community organizations/self help groups. This Conceptual Framework as illustrated in *Figure 3* defines the very essence of livelihood in Korogocho.

4.5 Working Hypothesis Revisited

The study was premised on the hypothesis that the residents of Korogocho are not affected by environmental related hazards and disasters. The study employed the use of a working hypothesis, due in part, to the lack of clear variables to correlate statistically to obtain results in this regard. In addition, the fact that this study was a rapid analysis of all the environmental hazards ever reported within the area of study, a working hypothesis effectively presents the findings. The evidence presented using Bollin's methodology clearly suggests that the residents of Korogocho are affected by environmental hazards and disasters due to their weak socio economic characteristics. The community is most vulnerable to disease related hazards then fire related hazards due to the high population, poor infrastructural network and weak housing structures. The community is periodically vulnerable to meteorological hazards, especially floods, particularly for the residents who lived in direct flood plains or river banks.

CHAPTER FIVE
SUMMARY OF RESEARCH FINDINGS, CONCLUSION AND RECOMMENDATIONS

This is the final chapter that provides a summary of the research findings, conclusion and recommendations.

5.1 Summary of Findings

The findings as presented in *Chapter Four* should be able to support ongoing efforts by the key stakeholders in developing an appropriate urban disaster management strategy in the country. If effectively implemented, they should be able to improve the capacity of decision makers at local and national level to measure key elements of disaster risk and vulnerabilities for communities, with particular regard to urban informal settlements. In addition, these findings should provide a tool for comparative parameters for monitoring changes in disaster risk as a measure for evaluating effects of policies and investments in disaster management.

For developing countries like Kenya, the issue of urban informal settlements will be a long term one, hence such information and data will continually remain useful to the planners. This study has highlighted the major deficiencies in dealing with natural disasters and indicates possible intervention measures. In future, there is need for the collection of timely information on the hazards, disasters, exposures and vulnerabilities is systematically collated, compiled and presented by the Nairobi City Council and the disaster institutions in the country.

5.1.1 Summary of Types of Hazards in Korogocho

The issue of fires and health disasters in Korogocho are real challenges that residents have to grapple with almost on a daily basis. They have developed some local adaptation strategies, which are short term and reactive, but will be able to benefit from the Korogocho Slum Upgrading Programme which has demolished some houses in order to expand the infrastructure. During rainy

seasons, the River Gitathuru also swells, sometimes breaking the banks and sweeping away the houses. Above normal rainfall can indeed have catastrophic consequences for the Korogocho dwellers, and if the evidence from the 1998 El Nino episodes are anything to go by, more efforts should be applied to ensure that the residents are cushioned from the rather increasing frequencies of flood events associated with climate change settlements.

The issue of vulnerability of Korogocho to such hazards is a factor of the quality of houses, livelihoods and socio economic resilience. Indeed, there is need for research and application of cheaper construction materials for houses within the informal settlements. There exist numerous models for constructing cheap but durable and more resilient houses internationally, but no efforts whatsoever at Korogocho level to introduce better building materials. The lack of a cogent land use plan for the area further complicates the problem. People seem to build anywhere, even within clearly established flood plains and river banks. Houses have even been constructed right next to the Dandora dumpsite, further exposing the community to immeasurable health related hazards.

The health situation is complicated by the over reliance on pit latrines and the failure by the City Council to provide an articulate network of sewer line to facilitate sanitation and hygiene. There are many exposed sewer lines, even right next to houses. These gaping trenches flowing with raw sewer need to be dealt with, before they explode into a fully fledged cholera and typhoid epidemic. The water piping network in Korogocho is not secured, and in some cases, the pipes had even burst. Hence the risk of contamination is eminent.

5.1.2 Summary of Coping Strategies and Emerging Challenges

The coping strategies by residents of the Korogocho slums are wide and varied. Mostly, these coping strategies exhibit the inherent socio economic characteristics of the residents. This is specifically driven by poverty, since the cheaper of the houses are located in areas within Korogocho that are even more marginalized, probably located in a riverine, next to a dumping site, adjacent to the open sewer lines and/or close to some neglected dumpsite. These are the areas where the qualities of houses are weakest. To such people, the issue of vulnerability to hazards

doesn't occur. The quest to survive seems to override the obvious dangers associated with health, floods, fires and drought hazards. The key challenges to mainstreaming disaster reduction in informal settlements in Korogocho are presented as:

1. Neglect of Urban Disasters and Risks

From the foregoing, there was insufficient evidence of deliberate efforts to deal with the problem of DRR within urban informal settlements in Nairobi. It seems that the key players have decided not develop proactive strategies to effectively deal with the problems that are likely to occur within informal settlements that have huge populations. To a large extent, local authorities have been ignoring urban risk from extreme hazards. And worse, national governments and international organizations have been neglecting cities in setting DRR priorities and providing funding support, respectively. Hence, physical vulnerability of existing environment constitutes one of the biggest threats to urban dwellers.

2. Weak Institutional Arrangements

In most developing countries, legislative and institutional arrangements inhibit rather than enable local action. While it is recognized that disasters are initially local events, accountability, authority and resources are not sufficiently decentralized to enable local governments to assume ownership and take actions to manage disaster risk effectively.

3. Lack of Political Feasibility

Politicians, administrators, and community leaders all face conflicting priorities, and DRR almost invariably takes the back seat to other needs which may be considered more pressing or easier to solve. Risk is not managed preemptively, but thought of in terms of something to be dealt with when disaster strikes through emergency response and humanitarian assistance. Further, the inadequate of experience, methodology and standards for benchmarking make DRR an unattractive proposition for local officials.

4. Insufficient Knowledge, Experience and Capacity

Disaster risk reduction is complex. It takes time, effort, tools, and training to assimilate disaster risk reduction in city functions and ongoing operations. Significant deficiencies remain throughout cities and megacities in terms of inter-institutional coordination, warning systems, incident command and control, resources for response, relief, recovery, and rehabilitation practice.

5.2 Policy Recommendations: Sustainable Management of Hazard Vulnerability

The study proposes the need for policy makers and stakeholders in Nairobi City to:

- Develop appropriate land use systems for urban areas including Korogocho.
- Develop dynamic models that would serve to provide a responsive link between poverty and vulnerability within urban informal settlement.
- Enhancing the adaptive capacity of Korogocho residents through enhancing the role of community structures in managing hazards and disasters.

With regard to national level responses, the study proposes that the government has to set in place legislative frameworks that will effectively:

- Address the issue of ownership rights of land for people living in urban informal settlements.
- Promote good governance at the city level as a measure of enhancing the responsiveness of the local authority to disasters and hazards in informal settlements.
- Promote the adoption of sustainable livelihoods at the local level as a means of increasing the resilience within communities resident in urban informal settlements.
- Enhance disaster risk awareness, preparedness, management and risk reduction at the local urban informal settlement level.
- Reduce the informal settlements' vulnerability to hazards and disaster through application of best practice strategies.

5.3 Conclusions

Towards shaping the path of urban development

Poverty-environment linkages are dynamic and context-specific – reflecting both geographic location and scale and the economic, social, and cultural characteristics of individuals, households, and social groups. In rural areas, poor people are particularly concerned with secure access to and the quality of natural resources - arable land and water, crop and livestock diversity, fish and bush-meat resources, forest products and biomass for fuel.

For the urban poor, water, energy, sanitation and waste removal, drainage, and secure tenure are key concerns. Poor women regard safe and physically close access to potable water, sanitation facilities, and abundant energy supplies as crucial aspects of well-being, reflecting women's primary role in managing the household. As urban centers develop into new frontiers of human settlement, the quest for sustainable urban development needs to be guided by appropriate legal frameworks, good urban governance principles, sound housing/infrastructural plans and a realization that disaster risk reduction as captured under the Hyogo framework guides the expansionist tendencies of urban growth.

Towards adaptation as a sustainable recourse

In this regard, the concept of sustainable development recognizes that both inter and intra generational equity needs to be safeguarded even as societies seek to develop. Sustainable development introduces very strongly moral responsibility, social justice, equity and equality in sharing of natural resources. It proposes for the utilization of environmental resources for industrial actions to be done with sufficient safeguard mechanisms that will ensure that such use does not result in gross plunder of the same resources.

5.4 Recommendations for Further Studies

As established, the process of conducting vulnerability assessment is a comprehensive exercise that requires an analysis of detailed myriad important variables that have strong bearings on the issue of vulnerability. Indeed, the scope of this study was to conduct a rapid analysis of hazard

vulnerabilities and disasters within an informal urban settlement in a developing country. This study has succeeded in detailing a broad vulnerability assessment to understand the risks inherent in the myriad of informal settlements that have sprouted within Nairobi City.

During the study, the following were identified as important components of vulnerability within urban informal settlements that would benefit from further studies:

1. An analysis of the vulnerability of urban informal settlements to health related hazards and disasters.
2. The assessment of the socio economic characteristics of urban informal settlements to the projected scenarios of climate change.
3. The use of GIS to map out all the hazards/disaster hotspots within urban informal settlements in Nairobi's informal settlements.
4. Fire response strategies as a measure of disaster risk reduction in Nairobi.

References

Action Aid (2006). *Climate change, urban flooding and the rights of the urban poor in Africa. Key findings from six African cities.* A report by ActionAid, October 2006, Action Aid International Books for Change (London).

Adger, W.N., S. Agrawala, M. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi (2007), Chapter 17: *Assessment of Adaptation Practices, Options, Constraints and Capacity* in Parry, Martin, Osvaldo Canziani, Jean Palutikof, Paul van der Linden and Clair Hanson (editors) *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge and New York, pages 717-743.

Alistair Hunt, Paul Watkiss (2007). *Literature Review On Climate Change Impacts On Urban City Centres: Initial Findings: Working Party On Global And Structural Policies* Paul: Watkiss Associates, United Kingdom.

Anderson, M. B. (2000). *Vulnerability to Disaster and Sustainable Development: A General Framework for Assessing Vulnerability.* Pp. 11–25 in R. Pielke, Jr. and R. Pielke Sr., eds. Storms (Vol. 1). London: Routledge.

Awuor, C.B., V.A. Orindi & A.O. Adwera (2008)., *Climate Change and Coastal Cities: The Case of Mombasa, Kenya.* Environment and Urbanization 20 (1): 231-242.

Ben Wisner and Mark Pelling (2009)., Disaster Risk Reduction: Cases from Urban Africa, United Kingdom *Earthscan Press.*

Birkmann, J. (2006) Measuring Vulnerability to promote disaster-resilient societies: Conceptual Frameworks and Definitions in Measuring Vulnerability to Natural Hazards: Towards Disaster resilient Societies, Tokyo:United Nations University Press pg. 23-33.

Blaikie, P., T. Cannon, I. Davis, and B. Wisner. (2004)., *At Risk: Natural Hazards, People's Vulnerability, and Disasters.* London: Routledge. Hewitt, 1997).

Boko M., Niang I., Nyong A., Vogel C., Githeko A., Medany M., Osman-Elasha B., Tabo R. & Yanda P. (2007) Africa. In: M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson (eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press, pp. 433-467.

Bollin, C., C. cardenas, H. Hahn and K.S. Vatsa (2003) *Natural Disasters Network: Comprehensive Risk Management by Communities and Local Governments*, Washington DC: inter American Development bank, available at www.gtz.de/disaster-reduction, English.

Burton, I., R. W. Kates, and G. F. White. 1993. *The Environment as Hazard (2nd ed.).* New York: Guildford.

Cardona, O.D. (2000) *"Environmental Management and Disaster Prevention: Two Related topics: A Holistic Risk Assessment and Management Approach"*, in J.Birckmann ed., *Measuring Vulnerability to Natural Disasters: Towards Disaster Resilient Societies*, Hong Kong, United Nation University.

Centre for Research on Epidemiology of Disasters, CRED (2008) *Annual Disaster Statistical Review 2008:* Belgium: Jacoffset Printers.

Christian Kuhlicke & Annett Steinführer, Johann Heinrich (2010),. *Social capacity building for natural hazards:A conceptual frame*, Helmholtz Centre for Environmental Research – UFZ, Leipzig WP1 report (Unpublished).

Cutter, S.L., Boruff, B.J. & Shirley, W., 2003. *Social Vulnerability to EnvironmentalHazards*. Social Science Quarterly (Blackwell Publishing Limited), 84(2), 242-261.

Government of Kenya & UNEP (2006),. *The City of Nairobi Environmental Outlook,* UNEP, Nairobi.

Government of Kenya (2007). *Kenya Vision 2030.* Ministry of Planning and National Development and the National Economic and Social Council (NESC), Office of the President. Nairobi accessible at www.planning.go.ke,

Government of Kenya (2009) *National Climate Change Response Strategy*. Nairobi: Ministry of Environment and Mineral Resources.

Government of Kenya (2009); *The Draft National Disaster Management Policy* (Unpublished)

Government of Kenya (2010)., The New constitution 2010, Government Printers, Nairobi.

Government of Kenya, CBS (2002). *Housing census.* Central Bureau of Statistics (CBS), Nairobi.

Government of Kenya; Kenya National Population Household Survey (2009),KNBS 2010, Nairobi.

Gunilla Kaiser (2006). *Risk and vulnerability analysis to coastal hazards – an approach to integrated assessment.* Germany: Karlsruhe University Press.

IPCC, 2001: Climate Change (2001): *The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Houghton, J.T.,Y. Ding,D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, 881 pp.

IPCC, 2007b. Climate Change (2007): *Impacts, Adaptation and Vulnerability. Summary for Policymakers. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Summary approved at the 8th Session of Working Group II of the IPCC, Brussels, April 2007.

Kasperson, J., R. kasperson, B.L. Turner, W.Hsieh and A. Schiller (2005) " *Vulnerability to Global Environmental Change,*" in J.Kapserson and R.Kasperson, eds, The Social contours of Risk. Volume II: Risk Analysis, Corporations & the Globalization of Risk, London: Earhscan, pp.245-285.

Kothari C.R (1990),. *Research methodology: Methods & Techniques*, New Age international (P) Limited, Publishers. New delhi) (Best, J.W. (1983). Research in Education. New Delhi: Prentice Hall.

Kumar, R. (2005). *Research Methodology: A step by step guide for beginners*. London, Thousand Oaks, Delhi, Sage Publications.

Mugenda, A and Mugenda, O. (1999). *Research Methods: Quantitative and qualitative Approaches*. Acts Press, Nairobi.

Owuor(2010). Climate Change Vulnerability, Risk, Impact and Adaptation in Nairobi's Informal Settlement of Korogocho and Mukuru Kwa Njenga. Oxfam GB project, Nairobi (Unpublished).

Oxfam 2009, Urban Poverty in Nairobi: Analysis and Appraisal. A Report for Oxfam GB, (Unpublished)

Satterthwaite, David (2004), *The Transition to a Predominantly Urban World and its Underpinnings*, IIED Working Paper, 90 pages.

Sattherwaite, D., Huq, S., Reid, H., Pelling, M. & Lankao P.R., (2007). *Adapting to climate change in urban areas: the possibilities and constraints in low- and middle income nations. Human settlements discussion paper series. Climate Change and Cities 1.* International Institute for Environment and Development.

Susan Cutter (2003). *Vulnerability to environmental hazards*. Department of Geography, University of South Carolina, Columbia SC 29208, USAS: SOCIAL SCIENCE QUARTERLY, Volume 84, Number 2, June 2003 *r*2003 by the Southwestern Social Science Association

Turner, B.L. et al., (2003). *A framework for vulnerability analysis in sustainability science*. Proceedings of the National Academy of Sciences of the United States of America, 100(14), 8074-8079.

UK Climate Impacts Programme (2001) *Socio-economic scenarios for climate change impact assessment*. A guide to their use in the UK. Climate Impacts Programme. UKCIP, Oxford, 137 p.

UNEP (2002). *Africa Environment Outlook: GEO 4*. United Nations Environment Programme, Nairobi.

UNEP (2009). *Kenya Atlas of Our Changing Environment*, accessible at www.enep.org.

UNFPA 2009. *State of world population (2009): Facing a changing world: women, population and climate,* UNFPA, New York

United Nations Development Program (UNDP) (2004) *Reducing Disaster Risk. A challenge for development. A Global Report*, New York: UNDP – Bureau for Crisis Prevention and Recovery (BRCP), available at http://www.undp.org/bcpr/disred/rdr.htm

United Nations Development Program (UNDP). (2000). *Human Development Report 2000*. New York: Oxford University Press.

United Nations Development Programme (UNDP) (1992)., *An Overview of Disaster Management, 2nd edn*, Washington, D.C.: UNDP

United Nations Human Settlements Programme (UN-HABITAT 2008) *The State of African Cities (2008): A Framework for Addressing Urban Challenges in Africa.* Nairobi: UN-HABITAT.

United Nations Human Settlements Programme (UN-HABITAT 2009b) *Strengthening Coordination Response on Urban Vulnerability in Kenya.* Nairobi: UN-HABITAT.

United Nations Human Settlements Programme (UN-HABITAT) (2003) *The Challenge of Slums,* Global Report on Human Settlements, Earthscan Publications Ltd., London, UK

United Nations Human Settlements Programme (UN-HABITAT) (2006), Nairobi *Urban Sector Profile,* Regional Office for Africa and the Arab States, Nairobi

United Nations Human Settlements Programme (UN-HABITAT), and Government of Kenya (2001). *Collaborative Nairobi Slum Upgrading Initiative,* Nairobi Situation Analysis Consultative Report, Nairobi

Wafula Nabutola (2005). *Affordable Housing: Upgrading Informal Settlements in Kenya* Pharaohs to Geoinformatics: FIG Working Week 2005 and GSDI-8, Cairo, Egypt 2005

World Bank (2006), *Inside Informality: Poverty, Jobs, Housing and Services in Nairobi's Slums.* Report No. 36347-KE, Kenya, May 31, 2006, Water and Urban Unit 1, Africa Region

Website Resources

1. Korogocho Slum Upgrading Programme website: http://www.ksup.org/
2. Annual Disaster Review: http://www.cred.be/sites/default/files/ADSR_2008.pdf
3. WHO Report 2006: http://www.who.int/whr/2006/en/
4. KMD website: http://www.meteo.go.ke/customer/climat/temp.html
5. World Population 2007:

http://www.prb.org/publications/datasheets/2007/2007worldpopulationdatasheet.aspx

6. Safer Cities Initiative: http://www.unhabitat.org/content.asp?cid=4590&catid=375&typeid=2&subMenuId=0

7. UN 2005, Hyogo Framework for Action 2005-2015: [1] http://www.unisdr.org/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf
8. http://www.fp2p.org2: Poverty and Inequality
9. http://www. Kenya Human Development Index Report, 2007
10. http://www. Nairobi Urban Surveillance and Health Demographic System, 2004
11. http://www.unep.org/roa/Nairobi_River_Basin/Images/maps/NairobiAdministrative-map.jpg
12. http://www.unisdr.org/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf
13. *http://www.unisdr.org/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf*
14. *D.N. Friday October 1, 2010*
15. *The Kenya National Climate Change Response Strategy*
16. *http://www.unhabitat.org/content.asp?cid=4590&catid=375&typeid=2&subMenuId*

Appendices

Set of Community-Based Hazards/disaster Risk Indicators

Table 13: Set of community-based hazards Indicators for hazards (H), exposure (E), vulnerability (V) and coping capacity (C)

MAIN FACTOR AND FACTOR COMPONENT	INDICATOR NAME	INDICATOR
HAZARD Probability	(H1) Occurrences (Experiences)	Frequency in the past 30 years
	(H2) Occurrences (Possible hazards)	Probability of possible events
Severity	(H3) Intensity (Experienced hazards)	Intensity of worst event in 30 years
	(H4) Intensity (Possible hazards)	Expected intensity of possible events
EXPOSURE Structures	(E1) Number of housing units	Living quarters
	(E2) Lifelines	% of houses with piped water
Population	(E3) Total resident population	Total resident population
Economy	(E4) Local Gross Domestic Product	Total locally generated GDP in constant currency
VULNERABILITY Physical/Demographic	(VI) Density	People per Km 2
	(V2) Demographic pressure	Population growth rate
	(V3) unsafe settlements	Homes in hazard prone areas(ravines, river banks) etc
Social	(V4) Access to basic services	% of homes with piped drinking water
	(V5) Poverty level	% of population below poverty level
	(V6) Literacy level	% of adult population that can read and write
	(V7) Attitude	Priority of population to protect against a hazard
	(V8) Decentralization	Portion of self generated revenues of total budget
Economic	(V9) Community participation	
	(V10) Local resource base	Total available local budget in US$
	(V11) Diversification	Economic sector mix
	(V12) Small businesses	% of businesses with fewer than 20 employees
	(V13) Accessibility	Number of interruption of road access in last 30 years
Environmental	(V14) Area under forest	% of area of the commune covered by forest
	(V15) Degraded land	% of area that is degraded
	(V16) Overused land	% of agricultural land overused
CAPACITY MEASURES Physical Planning	(C1) Land use planning	Enforced land use plan or zoning regulations
	(C2) Building codes	Applied code regulations
	(C3) Retrofitting/maintenance	Applied retrofitting and regular maintenance
	(C4) Preventive structures	Expected effect of impact-limiting structures
	(C5) Environmental management	Measures that promote and enforce nature conservation
Societal capacity	(C6) Public awareness programmes	Frequency of public awareness programmes
	(C7) School curricula	Scope of relevant topics taught at

		school
	(C8) Emergency response drills	Ongoing emergency response training and drills
	(C9) Public participation	Emergency committee with public representatives
	(C10) Local risk management/emergency groups	Grade of organization of local groups
Economic Capacity	(C11) Local emergency funds	Local emergency funds as % of local budget
	(C12) Access to national emergency funds	Release period of national emergency funds
	(C13) Access to Int'l emergency funds	Access to international emergency funds
	(C14) Insurance market	Availability of insurance to buildings
	(C15) Mitigation loans	Availability of loans for disaster risk reduction measures
	(C16) Reconstruction loans	Availability of reconstruction credits
Economic Capacity	(C17) Public works	Magnitude of local public works programmes
Management and institutional capacity	(C18) Risk management/emergency committee	Meeting frequency of a commune community
	(C19) Risk map	Availability and circulation of risk maps
	(C20) Emergency plan	Availability and circulation of emergency plans
	(C21) Early warning system	Effectiveness of early warning systems
	(C22) Institutional capacity building	Meeting frequency of a commune
	(C23) Communication	Availability and circulation of risk maps

(Source: Adopted from the Community-based risk index: Pilot implementation in Indonesia by Christina Bollin and Ria Hidajat (Pg.277)

Questionnaire

Department of Geography & Environmental Studies
University of Nairobi

A rapid assessment of climate change vulnerability, risk, impact and adaptation in Nairobi's informal settlements of Korogocho and Mukuru Kwa Njenga

Date of interview	Name of interviewer
Name of the respondent	Area of interview *[1]* Korogocho *[2]* Mukuru Specify village _____

FORM 1: HOUSEHOLD CHARACTERISTICS AND CONDITIONS (2010)

Q1.1: Household characteristics at the time of survey:

Name	Relation to Hh head	Sex	Age	Education level	Occupational status	Type of occupation (*describe the nature of occupation*)

Relation to household head
[1] Household head
[2] Spouse
[3] Son/daughter
[4] Brother/sister
[5] Father/mother
[6] Other relative
[7] Non relative
[8] Worker
[9] Other (specify _____)

Sex
[1] Male [2] Female

Age **(in completed years)**

Education level
[1] None
[2] Primary
[3] Secondary
[4] Above secondary
[5] Not stated/don't know

Occupational status
[1] Regular (formal) employment
[2] Temporary (formal) employment
[3] Self employed/informal sector
[4] Casual labour
[5] Unemployed (looking for a job)
[6] None (student/child)
[7] Home maker
[9] Other (specify _____)

Q1.2: **Determine** the number of household members _____

Q1.3: In which year did you come to Nairobi? _____
Q1.3a: In which year did you come to Mukuru Kwa Njenga/Korogocho? _____
Q1.3b: Have you ever lived in another informal settlement? *[1]* Yes *[2]* No
Q1.3c: If yes, which one(s)? _____

Q1.4: What is your tenure status? *[1]* Own house *[2]* Rented *[9]* Other (specify: _____)
Q1.4a **If rented**, how much do you pay per month? _____

Q1.5: How many habitable rooms does this dwelling unit contain? ____

Q1.6: **Observe** roofing material of house: *[1]* Iron sheet *[2]* Tin *[3]* Grass *[9]* Other (specify: _____)

Q1.7: **Observe** wall material of house *[1]* Permanent *[2]* Semi permanent *[3]* Mud *[4]* Iron sheet *[5]* Tin *[6]* Wood *[9]* Other (specify: _____)

Q1.8: What are your sources of water? *[1]* Piped/tap water *[2]* Borehole *[3]* Well *[4]* Private vendors *[5]* Roof catchment/rain water *[6]* Surface water *[9]* Other (specify: _____)

Q1.8a: Probe for **main source** of water? _____

Q1.8b: What is your daily consumption of water? _____ *[Indicate the units and quantities given]* Indicate *[9]* for metered water *[99]* Don't know

Q1.8c: How much does this household spend on water?
[1] Per day _____ **or** *[2]* Per month (bill) _____ **or** *[3]* Included in the rent

Q1.9: What do you use for cooking? *[1]* Electricity *[2]* Paraffin *[3]* Gas *[4]* Firewood *[5]* Charcoal *[9]* Other (specify: _____)

Q1.9a: Probe for **main source** of cooking fuel _____

Q1.9b: What is your daily consumption of main source of cooking fuel? _____ *[Indicate the units and quantities given]* Indicate *[1]* Monthly for gas _____ *[9]* Main source is electricity *[99]* Don't know

Q1.9c: How much does this household spend on the main cooking fuel?
[1] Per day _____ **or** *[2]* Per month (bill/gas) _____ **or** *[3]* Included in the rent

Q1.10: What do you use for lighting? *[1]* Electricity *[2]* Paraffin *[9]* Other (specify: _____)

Q1.10a: Probe for **main source** of lighting _____

Q1.10b: What is your daily consumption of main source of lighting? _____
[Indicate the units and quantities given] [9] Main source is electricity *[99]* Don't know

Q1.10c: How much does this household spend on the main source of lighting?
[1] Per day _____ **or** *[2]* Per month (bill) _____ **or** *[3]* Included in the rent

Q1.11: What type of sanitation facility do you have access to? *[1]* Main sewer *[2]* Septic tank *[3]* Pit latrine *[9]* Other (specify: _____)

Q1.11a: Do you pay to access this facility? *[1]* Yes *[2]* No

Q1.11b: **If yes**, how much do you pay *[1]* Per day _____ **or** *[2]* Per month _____

Q1.12: What mode of transport do you normally use? *[1]* Walking *[2]* Bicycle *[3]* Public bus/*matatu* *[4]* Train *[9]* Other (specify: _____)

Q1.12a: Probe for **main mode** of transport _____

FORM 2: LIVELIHOODS, INCOME AND EXPENDITURE

Q2.1: What are the household's sources of livelihood (i.e. income and food-generating activities)?
(Probe on the basis of 'type of occupation' in Q1.1 including urban farming, rural farming, social networks, etc)

Q2.2: What is the household's present income situation per month (in Kshs)?
[1] Up to 5,000/= *[2]* 5,001-10,000/= *[3]* 10,001-20,000/= *[4]* more than 20,000/=

Q2.3: Roughly how much does this household spend on food per month? _____

Q2.4: Roughly how much does this household spend on health care per month? _____

FORM 3: KNOWLEDGE ON CLIMATE CHANGE

Q3.1: Have you ever heard about climate change? *[1]* Yes *[2]* No

Q3.2: **If yes,** how did you know about it and what do you know about it?

Q3.3: Do you believe that climate in this locality is changing? *[1]* Yes *[2]* No *[3]* Don't know?

Q3.4: **If yes,** in what way(s)?

Q3.5: What do you think are the causes of climate change?

Q3.6: Do you think that climate change can affect the people of Korogocho/Mukuru? *[1]* Yes *[2]* No

Q3.7: **If yes,** in what way(s)?

FORM 4: DISASTERS IN THE SETTLEMENTS

Q4.1: Has this area ever experienced any of these disasters and when?

Disaster	**Yes/no**	**Which year(s)?**
Floods/storms	*[1]* Yes *[2]* No	
Landslides	*[1]* Yes *[2]* No	
Fires	*[1]* Yes *[2]* No	
Health epidemic *(specify them)*	*[1]* Yes *[2]* No	
Drought	*[1]* Yes *[2]* No	
Famine	*[1]* Yes *[2]* No	
Others (specify)		

IF ANY OF THE DISASTERS IS YES:

Q4.2: How did it affect the people of this area? *(Explain in the appropriate space)*

(=Floods/storms)	(=Landslides)
(=Fires)	(=Health epidemic)
(=Drought)	(=Famine)

Q4.3: How did the people cope with the situation? *(Explain in the appropriate space)*

(=Floods/storms)	(=Landslides)
(=Fires)	(=Health epidemic)
(=Drought)	(=Famine)

Q4.4: Did the affected people receive any assistance? *[1]* Yes *[2]* No *[3]* Don't know?

(=Floods/storms)	(=Landslides)
(=Fires)	(=Health epidemic)
(=Drought)	(=Famine)

Q4.5: **If yes**, what kind of assistance and from who? *(Explain in the appropriate space)*

(=Floods/storms)	(=Landslides)
(=Fires)	(=Health epidemic)
(=Drought)	(=Famine)