Environmental Problems and Human Health in Urban Informal Settlements: A Case Study of Mukuru Kwa Njenga, Nairobi.

by

Gichuki, Geoffrey Rukenya

A Project Paper Submitted in the Department of Geography, Faculty of Arts, in partial fulfillment of the Requirements for the Award of the Degree of Master of Arts in Environmental Planning and Management of the University of Nairobi.

March, 2005

DECLARATION

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

GICHUKI, G. R.

March 30, 2005.
DATE

This Project Paper has been submitted for examination with our approval as University Supervisors.

MR. J. K. MUSINGI

30/3/05
DATE

PROF.G. CHRIS MACOLOO

April 7, 2005
DATE

DEDICATION

To my parents Gideon Gichuki and Miriam Wanja Gichuki

ACKNOWLEDGEMENTS

I wish first of all to acknowledge the Department of Geography of the University of Nairobi through the Chairman Dr. E. M. Irandu, for providing me the opportunity and an enabling environment necessary for the study of environmental planning and management.

This study would not have been possible without the guidance and support of my supervisors Prof. G. Chris Macoloo and Mr. J. K. Musingi, who reviewed the project proposal and gave useful insights and guidance on study material which helped in the carrying out of the research and preparation of this document.

Also acknowledged are Mr. Stephen Wainaina, head, Human Resources and Social Services Department, Ministry of Planning and National Development, for availing some valuable study material, and Dr P. J. Muriithi, lecturer, Department of Community Health, University of Nairobi for useful consultations on the study design. The helpful contribution of Mr. Clive Mutunga of the Kenya Institute for Public Policy Research and Analysis, in the data processing and analysis is also acknowledged. Clinton Mbaluku, Maxwell Kuria, Vincent Opondo, and Charles Kyalo all undergraduate students of the University of Nairobi are acknowledged for their supportive role in administering the interviews.

The chief of Mukuru Kwa Njenga location Mr. John Mutai, an elder of Sisal Zone, Mr. Joshua Maweu and his security youths are thanked for helping in the logistics which made possible the interviewing of households in a free environment. My student colleagues John Wafula, Jamila Mohammed, Wamukui, G., Otieno, A. and Kinyanjui, K. are also acknowledged for their valued comradeship and encouragement

In closing, I wish to acknowledge my wife Rose and daughters Netta, Cynthia, and June for their understanding and support, despite the sacrifices they had to make to enable me to undertake the study. Cynthia, a law student, is especially acknowledged for taking time to read and editing the document.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AMREF	- African Medical and Research Foundation
APHRC	- African Population and Health Research Centre
CBS	- Central Bureau of Statistics
CBO	- Community Based Organization
DPSEEA	- Drivers Pressure State Exposure Effects Action
GNP	- Gross National Product
HEADLAMP	- Health and Environment Analysis for Decision Making
IFAS	- Institute of Food and Agricultural Sciences
KDHS	- Kenya Demographic and Health Survey
MCC	- Mukuru Community Centre
NCPD	- National Council for Population and Development
NGO	- Non Governmental Organization
OECD	- Organization for Economic Cooperation and Development
PSR	- Pressure State Response
SPSS	- Statistical Package for Social Scientists
UF	- University of Florida
UNCHS	- United Nations Centre for Human Settlement
UNDP	- United Nations Development Programme
UNEP	-United Nations Environment Programme
USDP/NCC	- Urban Slums Development Project/Nairobi City Council
WHO	- World Health Organization
WRI	-World Resources Institute

ABSTRACT

Rapid urbanization especially in developing countries coupled with poor economic performance has led to the proliferation of urban informal settlements which currently house 850 million people or approximately one in seven people in the world. The disease burden is high though not known with any degree of certainty. Methods for analyzing the relationships are not fully developed, and the quality of available data generally poor (Briggs *et al.*, 1996). This study aims at furthering knowledge on the interactions between the living environment and quality of life in informal settlements. The study investigates and analyses whether human health in informal settlements is significantly related to environmental problems and whether households link incidence of diseases to their living environment. The study also investigates whom the households think is responsible for the improvement of their living environment.

The dependent variables considered are the following diseases: malaria or fever, diarrhoea, cough and skin diseases. The independent variables (environmental status) considered include: quality and quantity of water, sanitation facilities, cooking and lighting fuel, disposal of household waste, housing conditions and ownership of household assets as a proxy of socio-economic status. A sample of 200 households was chosen through multistage cluster sampling and simple random sampling. The study used observational design employing both interview and observation, to answer descriptive research questions. Linear probability models to denote regressions were run to answer relationship research questions.

The study found that there is a significant relationship between environmental problems and human health in informal settlements. Respondents were also able to link incidence of diseases to environmental problems. However, respondents do not think that individual households have a significant role in improving their environment; a role they think should be taken by the government. The study recommends that although environmental awareness in informal settlements is high, there is need to sensitize residents on ways in which individual households can improve their living environment. Further research is required to examine the contribution of work environment on health, whether environmental problems affect all sectors of the population equally, and to quantify the contributions of specific environmental problems to the disease burden.

CHAPTER 1: THE INTRODUCTION

1.1 Introduction

Environmental problems in urban informal settlements exert serious impacts on human health. They contribute to ill-health and disablement of hundreds of millions of people and are responsible for tens of millions of preventable deaths every year (UNCHS, 1989). Residents of these areas experience high incidence of diseases such as diarrhoea, intestinal worms, upper tract respiratory diseases, malaria, fever, tuberculosis and other communicable and infectious diseases which are clear manifestations of the deficient urban environmental services they have to contend with (UNCHS, 1996). Environmental problems characteristic of informal settlements include: lack of piped water systems for homes and businesses, inadequate provision for sanitation, lack of disposal service for solid and liquid wastes, and inadequate and overcrowded housing. The residents of these settlements are poor in income and assets, and therefore tend to be vulnerable; and with greater levels of exposure to environmental problems they are more likely to get sick and remain sick.

The proliferation of informal settlements has to a large extent been the result of the urban transition that characterized the twentieth century, the last phase of which is still taking place in developing countries. The world's urban population trebled from 734 million to 2,390 million people between 1950 and 1990. By 2025, it is expected that two thirds of the world's population will be living in urban areas. 93% of this urban growth will occur in developing countries. Secondly, developing countries experiencing rapid urbanization have also faced severe economic constraints characterized by runaway inflation, spiraling unemployment and very high levels of external debt, thereby limiting the ability of governments to provide housing and other basic social services to populations. The majority of residents of cities in developing countries, therefore, have no alternative but to live in overcrowded slums or informal settlements where the physical environment as well as health and livelihood conditions are life threatening. The scale and scope of environmental problems of third world cities are therefore very serious and likely to be increasing (UNHCS, 1989).

The toll on human health associated with degraded urban environments in informal settlements is likely to undermine the productive potential of third world cities and affect social economic progress of countries. Current initiatives such as site and service or slum upgrading schemes are expensive to implement and benefit only a small section, and are therefore unlikely to substantially reduce the burden of informal settlements in the short term (Macoloo, 1988). The resulting improved houses also become too expensive to benefit the targeted poor residents. There is therefore an urgent need

to deal with environmental problems that currently plague these areas, which are not only increasing but are also daunting. However; there is evidence from third world cities that the most pressing environmental problems can be greatly reduced at a relatively modest cost (UNCHS, 1989). Change in approach, governance and policy directions is necessary and must be rooted in the recognition that governments should concentrate on supportive and facilitative actions (Macoloo, 1998a). Cities must capitalize on the efforts of the poor to manage their environments. It is also important to recognize and support the rights of the poor to know the risks to which they are exposed, to determine their priorities, and to meet their own needs through community initiatives (UNCHS, 1996).

Kenya's urbanization patterns are reflective of situations found elsewhere in developing countries (APHRC, 2002). Between 1980 and 1998, its urban population almost doubled from 16 to 31 percent. Nairobi, the economic and administrative capital of Kenya, and one of the fastest growing cities in Africa experienced population growth from below 120,000 in 1948, to the 1999 size of about 2.1 million people (CBS, 2001). Kenya's rapid growth of urban population has also been marked with urbanization of poverty. Between 1992 and 1997, poverty in urban areas increased from 29% to about 50%. In comparison, rural poverty only rose from 48 to 53 percent (APHRC, 2002). In Nairobi, more than half of the residents are poor and cannot afford rent charged for houses in planned and serviced areas. The supply of low-cost housing has also not kept pace with the increase in population. A large proportion of Nairobi's population estimated to be between 50 and 70% therefore live in informal settlements where environmental problems and health conditions are very poor (Matrix Development Consultants, 1993).

This study investigates and assesses the prevalence of diseases, which are linked to environmental problems in informal settlements of Nairobi using Mukuru Kwa Njenga slum as a case study. The analytical core of the study concentrates on establishing whether there is a significant relationship between environmental problems and human health in informal settlements. The most threatening environmental problems are usually those close to home; this study therefore focuses on the household and neighborhood environments. It investigates whether the residents recognize environmental problems within their households and neighborhoods, and what they do and consider most appropriate to solving these problems. The study also investigates what residents think should be done to improve their living environment and whom they consider responsible for undertaking this.

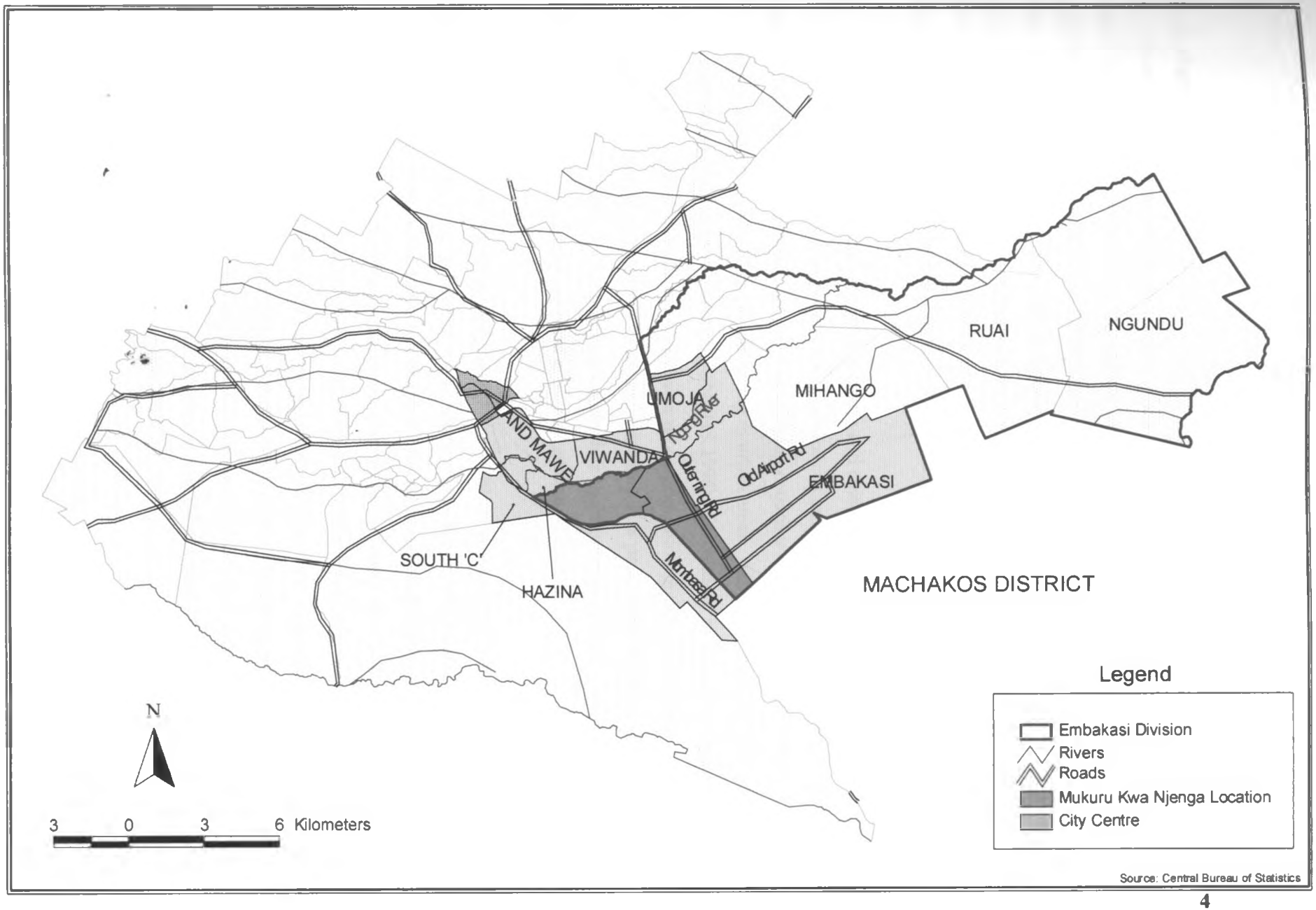
Study Area

Mukuru Kwa Njenga is an administrative Location in Embakasi Division, Nairobi (see Fig.1.2). The Location comprises two sub-locations; Imara Daima and Mukuru Kwa Njenga, the study area, from which the location gets its name. Mukuru Kwa Njenga sub location is primarily an informal settlement though high cost housing estates like Kenya Pipeline and Avenue Park, a number of industries and business premises including the Automobile Association of Kenya are also located within its boundaries. As per the 1999 census, the population of the location was 36,165. Mukuru Kwa Njenga had 29,214 of the people, with a density of 5,259 persons per square kilometer. However, according to the provincial administration, the population may have doubled especially in the period prior to the general elections of 2002 when the then ruling elite settled a lot of people there to persuade them vote for them. The land occupied by the informal settlement is both privately and publicly owned.

The administrative head of the location is a chief appointed by the provincial administration. The two sub locations are headed by an assistant chief. Each of the sub locations are further subdivided into zones or villages which are administered by three elders per zone assisted by security youths elected by the community. Mukuru Kwa Njenga sub location is divided into eight zones: Mukuru Community Centre, 48, Wape Wape, Milimani, Sisal, Riara, Vietnam, and Moto Moto. The area has one Nairobi City Council primary school and a government secondary school (see Fig 1.1). The Catholic Church runs a primary school, vocational centre and a health centre. Nairobi City Council has no health center in the area. Security is provided by two police posts situated in the location.

Fig. 1.1 Embakasi Girls Secondary School, one of the few communal facilities

Fig. 1.2
MAP OF NAIROBI - LOCATION OF STUDY AREA



1.2 Background

The twentieth century witnessed a massive urban transition not experienced any other time in history. In 1950 the world's urban population was only 734 million. By the year 1990, urban population had more than trebled to 2.390 billion people. Between 1995 and 2025, the number of people living in urban areas is expected to double from 2.4 billion to more than 5 billion. This will be about two thirds of world's population. It is, however, worth noting that as recently as 1975 the world urban population was only a third of total population. Of concern is the fact that most of this growth will take place in developing countries (UNCHS 1996).

In 1950, less than 300 million people lived in towns and cities of developing countries. By 1985 the figure had increased to 1.1 billion people, and continues to increase at 50 million per year. 150,000 people are added to the urban population of developing countries every day (UNCHS 1989). As of 1995, Latin America had 70% of its peoples living in urban areas. Africa and Asia had 30% to 35% of their population residing in urban areas (UNCHS 1996). It is indeed in these two regions with low levels of urbanization that the most explosive urban population growth is underway, at roughly 4% per year and expected to continue for several decades. It is projected that Africa and Asia will be 54% urbanized by 2025. Urban population growth is therefore most pronounced in the poorest regions and those regions undergoing rapid economic growth.

Urbanization is not necessarily a bad thing; it represents a profound economic and social transformation produced by processes of modernization and development. Urban areas are remarkable engines of economic and social progress offering unmatched employment opportunities, entertainment and other amenities. Urban areas therefore develop into centers of commerce, industry, education, culture and political power. Generally urban areas offer marked advantages in the delivery of education, health, other social services and easier lives than rural areas. However, these benefits do not extend to the poorest groups within cities and towns. In 1994 only 30% of Africa's urban residents were served by municipal water services of any form. In cities of developing countries 30% - 60% of their peoples live in substandard housing, often in informal settlements not served with municipal services (UNCHS, 1996).

In developing countries with large rural populations, rural to urban migration accounts for as much as 60% of urban population growth and will remain a major factor in the coming years. The main reason for this is that urban areas offer better prospects for jobs and higher incomes at a time when

the rural areas are faced with declining agricultural work. Land parcels in rural areas are continuously sub-divided into smaller and smaller uneconomic units as it is passed on from generation to generation, leading to reduced agricultural productivity and thereby exacerbating rural poverty. The agrarian economy of developing countries is also modernizing with emphasis on technology-based and markets-oriented production. A big proportion of the urban population growth in developing countries therefore comprises of rural migrants, who flock to urban areas in search of employment and better lives. As they strive to find a foothold in urban economy, few of them find formal employment, as the formal economy of developing countries faced with stagnation and decline is unable to absorb the enormous influx of workers (with an estimated demand of 35 million jobs per year as of 1990). The majority of these people therefore engage in informal employment and subsistence activities. Informal employment accounts for 75% of urban employment in many countries of sub-Saharan Africa. Informal jobs pay less than formal jobs, and offer little security or benefits. Income received in the informal sector is well below official poverty lines and these people join the ranks of the urban poor, thereby exchanging rural poverty for urban poverty. This has led to the growing urbanization of poverty. In 1988 only one quarter of the developing world's absolute poor lived in urban areas but by the turn of twentieth century one half of developing world's absolute poor lived in urban areas.

The urban poor with their meager assets and income are unable to find affordable housing in planned and serviced settlements in the city as supply of low-cost housing has also not matched the population increase. Cash strapped governments of developing countries are unable to provide the most basic of urban services, including low-cost housing. These people consequently end up in squatter or informal settlements referred to as "poverty areas" normally the result of illegal land subdivisions ((Lamba, 1994). Housing conditions in informal settlements are characterized by serious environmental problems of overcrowding, poor quality housing, lack of piped water systems both for home and business, inadequate provision for sanitation and disposal of solid and liquid wastes. These informal settlements are also often located on land no one wants, such as flood plains or steep hillsides where the threat of eviction is minimal. The desire of the poor to live near places of employment often results in the poor seeking housing close to polluting industries.

Despite the fact that the poor in urban informal settlements suffer environmental and social ills of staggering proportions, official policy often fails to respond to their needs. Most initial official reactions towards informal settlements were to demolish them. They were denied municipal

services as doing so was viewed as legitimizing their illegal status and encouraging further squatting. Governments for a long time failed to accept that land invasions were not a threat to established institutions, but a growing movement that emerges out of the poor people having no alternative way to secure shelter and livelihood. Governments have also taken long to accept the need to tackle environmental problems in informal settlements. The reason mainly for little action is because the problem affects the poor and powerless and the fact that their contribution to formal economy is downplayed. There have also been claims that extending piped water, sewer and drains to poorer areas are too expensive and have no chance of cost recovery.

Development policies have also tended to ignore urban poverty and instead focus on programs for rural poverty alleviation ostensibly to check rural to urban migration. This policy paralysis on urbanization springs from the failure to recognize that urbanization in the developing countries is not undesirable, avoidable or even reversible (UNCHS,1989). It also fails to acknowledge the contribution of cities to economic growth, accounting for 60 percent of gross national product (GNP) of developing countries. Secondly, despite the realization that most of world's population will soon live in developing world's cities, environmental problems most prominent in these cities remained conspicuously absent from global environment agenda that shifted focus away from local to regional problems and then toward global concerns such as ozone depletion and global warming. However, it is encouraging to note that this disconnect between the "green" agenda and the problems confronting cities has been recognized and a number of researchers, international donor agencies and NGOs have over the past few years advocated for a renewed focus on the "brown" agenda that is concerned with the problems of pollution, poverty and environmental hazards in cities (WRI *et al.* 1996).

The main solutions governments have offered towards improving environmental conditions in informal settlement slums have been the site and service, and slum upgrading programmes. This is a curative, high cost and reactive approach. Because of the high cost of upgrading, most governments of low-income developing countries only afford to fix the urban informal settlements problem for a relatively small section of the population; consequently the rate of improvement does not match the rate of formation of informal settlements (Macoloo, 1988). Non-governmental organizations have on their part made tremendous efforts focusing mainly on health care delivery systems and especially on curative services. Upgrading schemes, will therefore, not improve lives of the bulk of urban poor in informal settlements. Concentrating on curative health care will also not remove the problem, as

new infections will continue to arise as conditions worsen and new settlements form. Yet others argue that efforts should be geared towards increased economic growth, as this would remove poverty and solve the problem of informal settlements. Evidence from rapidly industrializing countries of third world disproves this. Environmental improvement cannot, therefore, simply wait for better economic times, as some opine, but must be an integral part of the strategy for economic development. As informal settlements are unlikely to be soon transformed into healthful housing with the current strategies and programmes in place, it is imperative that environmental problems which pose immediate threats to the health and livelihood of the residents be understood, prioritized and addressed.

The burden of disease and other social ills related to the urban environment in most developing countries is great. As earlier discussed, confronting the urban environmental challenge is clearly beyond the financial means of governments alone in such key areas as infrastructural services and housing. However evidence of successful community efforts in developing world cities suggest that the most pressing urban environmental problems can be greatly reduced at a modest cost. Experience shows that there is a need to shift away from centralized systems towards more flexible community oriented strategies. The most threatening environmental problems are usually those close to home and the neighbourhood. Generally, the poor create problems for themselves and their neighbours, while the wealthy create problems for wider public which require city wide or even regional approach.

The main thinking today is to build on the efforts of the urban poor to improve their environments. There is need for recognition and support of the rights of the poor to know the risks they are exposed to and to determine their priorities (Macoloo, 1998b). If cities harness the energy and creativity of their citizens and build on the inherent advantages that urbanization provides, they can be part of the solution to the problems of poverty and environmental degradation. Community mobilization and education will be crucial and governments should not underestimate the ability of the urban poor to contribute to solving problems that plague them. There is therefore a need to assess whether or not people have daily information on interactions between the urban environment and their quality of life. It is imperative to have an informed citizenry that demands environmental quality and holds governments accountable. Most innovative strategies for improving urban environment are emerging from the bottom up, from neighbourhood and communities that have the most at stake.

1.3 Statement of Research Problem

The state of people's health is known to be the result of interactions between their human biology and lifestyle, the environment and healthcare systems, but historically, the environment has always had a major role. There is increasing documentation of environmental problems and their impact on human health which confirm the existence of differences and inequities between the urban poor living in informal settlements and other better-off residents. According to the World Health Organization, in many informal settlements an infant is 40 to 50 times more likely to die before the age of 5 than an infant born in a western country (WHO, 1993)

Informal settlements of developing countries currently house eight hundred and fifty million people who represent approximately one in seven people in the world. This number is projected to reach 1.5billion by 2025(WRI *et al.* 1996). In Nairobi, informal settlements occupy 6% of all land area used for residential purposes. The settlements, however, house 56% of the city's population leading to very high population densities. Morbidity and mortality rates among the city's poor are significantly higher than those among other residents of Nairobi (APHRC, 2002). This is attributed to diseases stemming from poor environmental conditions. Although residents in informal settlements experience environmental impacts at various spatial scales i.e. household, neighbourhood, city and regional scales, it is at household and neighbourhood levels where it is most critical.

The layout of houses in Nairobi's informal settlements is usually along rows with narrow paths of about 1.2m (4ft) between them. Houses are constructed of earth or cement floors, walls of any combinations of metal sheets, flattened tin cans, timber, cardboard, plastic sheets, mud or wattle, with the most common type of roofing being corrugated iron sheets. The crowding of buildings means that the structures are prone to fires. Room sizes range from 10x10ft to 12x12ft (3x3 metres to 3.7x3.7 metres) and are poorly ventilated. A single room usually accommodates households of three to five people. Lamba (1994) notes that households averaging four persons occupy an average of 1.4 rooms; and in some cases a single room may accommodate as many as ten people which is accomplished by subletting beds for an agreed number of hours per day. 85% of the households live in only one room, and 85% are tenants. It therefore means that majority of families use the same room for cooking, living and sleeping (Lamba, 1994). Crowded and cramped conditions provide ideal conditions for transmission of diseases from one person to another. Diseases associated with these conditions are upper respiratory infections which include tuberculosis, influenza and meningitis. Households use polluting fuel for cooking and lighting. Where open fires

influenza and meningitis. Households use polluting fuel for cooking and lighting. Where open fires or relatively inefficient stoves are used for cooking and or heating, smoke can cause serious respiratory problems for inhabitants. The impact on women and children is the most serious as they spend most of their time at home. Household accidents are common, for when as many as five or more people live in one room, there is little chance of the occupants avoiding accidental fires from stoves and kerosene heaters. It is also hardly possible to prevent children from coming into contact with harmful chemicals used in the households or to keep medicines in a secure place when whole families live in one or two rooms.

Only 4% of the households in Nairobi's informal settlements have their own source of water. 75% purchase their water from water kiosks or vendors carrying water in hand carts, the remaining 21% obtain their water from communal taps (Lamba, 1994). Even where communal taps exist, water shortages and the limited numbers of connections result in residents paying vendors five to ten times the official price for water. Those unable to afford the price draw water from nearby polluted rivers The residents do not get adequate supply of water as the quantity of water is greatly influenced by the price paid for it and the distance people have to carry it. Limited supplies of water means hardly enough water is available for bathing and personal hygiene, and for washing of food, utensils and clothes This results in the proliferation and poor control of diseases that include eye and ear infections, skin diseases, scabies, lice and fleas. The source, the manner the water is conveyed and the way it is stored also often result in its contamination leading to diarrhoeal diseases.

Poor sanitation has been illustrated in a number of studies. Lamba (1994) reports that in a study undertaken by AMREF in 1990 of four slum villages located in Nairobi's central industrial area, communities had on average one pit latrine for every 19 households. This however varied between villages, with a range of 8-80 households per pit latrine. The study also notes that pit latrines are in a poor state of repair, filthy, inaccessible, offered little privacy, and are unsafe to use especially at night as there is no street lighting. High densities in informal settlements make more difficult the protection of people from contact with excreta. Health problems resulting from unhygienic disposal of excreta are therefore prevalent. As many as fifty different infections are caused by contamination with excreta, and the resulting diseases rank among the chief causes of sickness and death in the third world.

Informal settlements of Nairobi have no garbage collection service as they are given low priority and garbage trucks are unable to drive through the narrow paths. Apart from the resulting smells, disease vectors and pests attracted by garbage, and drainage channels (where they exist) are also clogged. Uncollected garbage is also a serious fire hazard as well as a serious health hazard for children playing on the site.

Waterlogged soil and stagnant pools of water accumulate due to lack of proper drainage. Pools of stagnant water can convey enteric diseases and provide breeding grounds for mosquitoes, which transmit malaria and other diseases. Even where water is provided, it is not accompanied by adequate disposal systems once it is used. Most illegal housing in Nairobi has developed on steep sites which are prone to flooding. Some informal settlements are also located close to industries and quarries from which numerous hazards have been found to originate from. Sewage emptying into open drains running through the slums, has been found to contain industrial effluent including: animal waste, caustic soda, bleaching agents, lime and other unknown by-products emitted by nearby factories.

Efforts being made to improve the health status of Nairobi's urban poor have concentrated on health care and income generating projects. In particular, there is a lack of primary health care services which points to the failure to apply the basic knowledge that human health and well being are largely dependent on the quality of environment (Lamba, 1994). Improvement interventions must build on the knowledge and information people have, in order to mobilize individuals and the community and to ensure that such efforts are sustained. This study investigates the relationship between environmental problems and human health in informal settlements by finding out whether incidence of diseases universally linked to environmental conditions is more prevalent in the areas.

The study investigates the state and adequacy of environmental services: water, treatment of solid wastes, drainage, housing condition, household size, type of sanitation and cooking fuels; and seeks to establish the household income status using ownership of certain household assets as a proxy. The incidence of environmentally related disease infection documented include: malaria or fever, cough/respiratory infections, diarrhoea and skin diseases. The residents' perception on the link between environmental problems and prevalence of disease was also assessed. The dynamics of the interrelationship between problem perception and impact perception is a result of what affects people most in their daily lives. The study investigates the difficulties informal settlement dwellers

face and the reasons that guide their behaviour in the search to resolve problems Environmental awareness is also assessed as well as what households feel should be done to improve the neighbourhood environment.

1.4 Aim and Objectives of the Study

The main aim of this study is to examine and assess the extent to which human health is related to the environmental problems in urban informal settlements.

The specific objectives of the study are:

1. To document environmental problems and assess availability of urban services to the dwellers of informal settlements at the household and neighbourhood levels.

2. To determine whether environmental problems can be related to diseases in Mukuru Kwa Njenga

3. To assess whether residents have knowledge on the linkage between the incidence of diseases and environmental problems existing in slums.

4. To determine whom residents of informal settlements consider responsible for improvement of their living environment.

1.5 Hypotheses

This study formulated research hypotheses to be validated with empirical data collected from the field.

The formulated hypotheses are as follows:

1 H_o: There is no significant relationship between incidence of common infectious and Communicable diseases and environmental problems in Mukuru Kwa Njenga

H_1: There is a significant relationship between incidence of common infectious and Communicable diseases and environmental problems in Mukuru Kwa Njenga

2 H_0: Residents of Mukuru Kwa Njenga do not relate incidence of disease to environmental Problems they face.

H_1: Residents of Mukuru Kwa Njenga relate incidence of disease to environmental problems they face.

3 H_0: Residents of Mukuru Kwa Njenga do not think they have a significant role in improving their environment.

H_1: Residents of Mukuru Kwa Njenga think they have a significant role in improving their environment.

1.6 Justification

At the turn of the twentieth century, the urban population of the world surpassed that of the rural areas. 51% of the world's 6.3 billion people live in urban areas. Two thirds of this number lives in developing countries of Africa, Asia, Latin America and Oceania. In developing countries more than 50% of the urban population lives in informal settlements. Environmental problems characteristic of these illegal settlements exert an enormous toll in terms of losses to human health and quality of life, natural resources and economic productivity. Problems of inadequate and safe water supplies, inadequate sanitation and drainage, high levels of pollution at home and work and contaminated rivers and sites pose an immediate threat for most citizens of third world's cities. However, these environmental problems remained conspicuously absent from the global environmental agenda for some period.

The urban environment has however received unparalleled attention since the United Nations Conference on Environment and Development (the Earth Summit) in Rio de Janeiro in 1992 (UNCHS, 1997). Agenda 21, Chapter 7 articulated and highlighted the importance of sustainable human settlements. The Second United Nations World Conference on Human Settlements (Habitat II-the City Summit) in Istanbul took this point further in its global agenda for cooperation by acknowledging the direct and vital contribution that productive and sustainable cities can make to social and economic advancement. The selection of urban health as a subject of Technical Discussions at the Fourty Fourth World Health Assembly in 1993 was also a highly significant

turning point for recognition of environmental problems and human health in the global development agenda (WHO, 1993).

Developments which jeopardize human health are clearly not sustainable. Principle 1 of the Rio Declaration clearly states the case:

> *"Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature."* (UN, 1993)

Chapter 6 of Agenda 21 takes this principle further by emphasizing the fundamental commitment within sustainable development of protecting and promoting human health. Most of the Millennium Development Goals are also compatible with urban poverty reduction and improvement of access to water and sanitation (Satterthwaite, 2003). One of the goals is to significantly improve the lives of at least 100million slum dwellers by 2020; this includes increasing proportion of people with access to improved sanitation and access to secure housing. There is therefore a compelling case for actions geared towards addressing these problems.

Environmental problems of informal settlements have been addressed through reactive actions such as providing curative health care, improving the physical living environment through site and service and squatter upgrading schemes as is now happening in the Kibera slums of Nairobi. These actions are beyond the financial means of governments alone and reach only small sections of the urban poor. Policy directions today, point towards decentralized efforts at the community level. Governments should concentrate on a supportive and facilitative role. NGOs working in informal settlements have demonstrated that residents are willing to participate in improving their neighborhoods and are willing to share some of the costs.

WHO (1993) notes that at the heart of urban policies will always be the popular perception of what the important issues are. Whereas external and central directives may influence policy in the short term, in the longer term what will succeed are policies based on the core values of the local community. Where there is local interest in health related policies, or where raising awareness can bring about such an interest, it usually leads to a flowering of different models of effective local practice.

Intervention strategies and projects at the local community level will need more data and documentation for design and monitoring. However, information about environmental problems in third world cities is relatively scarce. In Nairobi there is no systematic data collection on environmental conditions in informal settlements. What is available comes from select community studies, usually carried out in preparation for a project or as project evaluation; such studies are limited in scope (Lamba, 1994). This study therefore helps fill the existing gaps in data and information and also help understanding the scope of the impact of environmental conditions in informal settlements. The study provides insights on perception of the residents on the environmental problems they face and their health. This study may also bring further awareness of the problem and elicit efforts towards further research and provoke action by governments and non-governmental organizations. Mukuru Kwa Njenga was chosen as the study area for it has all the environmental variables that exemplify informal settlements in Nairobi. The study could therefore be replicated, and the results likely to be valid elsewhere in informal settlements.

1.7 Scope and Limitations

This study does not consider the contribution of the workplace environment to the health of the residents of Mukuru Kwa Njenga. However, people spend most of their time in their houses, and the majority of people are engaged in informal employment within the area hence the household and neighbourhood environment play a more critical role in their health outcomes. The study also deals with the physical environment and does not investigate the contribution of the social environment, for example, marital status, alienation, violence and various family structure variables that bear a reliable relationship with health. It must however be remembered that purely social – environment variables can still mediate or modify the effects of the household environment.

The study also limits itself to physical health and specifically the most obvious infectious and communicable diseases attributable to the living environment of the households in informal settlements such as Mukuru Kwa Njenga. Psychosocial illnesses, urban violence, drug abuse, HIV-AIDS, for which urban environment contains direct threats were considered beyond the scope of the study.

In this study an 'environmental problem' is taken to mean both the inadequate supply of a resource essential to human health or urban production or the presence of pathogens or toxic substances in the human environment which can damage human health (UNCHS,1989). The study restricts itself

to the household and neighbourhood environment, and the effects of city wide or regional environmental problems are not assessed. However, as noted earlier, it is the household and neighbourhood environments that impact most seriously on the health of the urban poor.

Although natural features combined with economic activity of the surrounding area including geography, topography and climate are determinants of the nature of environmental problems and health outcomes these were not separately documented by the study, for; in any case they manifest themselves in the neighbourhood conditions.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The review of literature begins by looking at the factors which have led to the proliferation of informal settlements in urban areas of developing countries. These are shown to include high population growth marked by rapid urbanization principally the result of rural urban migration, stagnation of economic growth, sharpened urban poverty, inappropriate policies and the slow rate at which institutions respond to the needs of the urban poor. This is followed by a discussion of literature that links environment and human health. This involves looking at the literature that pinpoint the environmental problems commonly found in informal settlements and showing how they impact on human health. Lastly is a review of literature that documents what responses and interventions are currently being undertaken including research, policy improvement and reform. The literature reviewed discusses the solutions offered and why they have been inadequate; and the gaps in the literature to which this study will contribute to fill.

2.2 Urbanization and Informal Settlements

Reviewed literature shows that rapid urbanization has been instrumental in the proliferation of informal settlements. According to WHO (1993), the world's urban population trebled from 701 million in 1950 to 1.983 billion in 1985. This in effect means that over this period the proportion of the total population living in urban areas rose to 41% from 25%. Most of the increase took place in cities of developing countries where urban population quadrupled from 285 million in 1950 to 1.114 billion in 1985. At the turn of the twentieth century urban population for the first time surpassed that of the rural areas. From 1990 to 2030, global population will grow by 3.7 billion people. Ninety percent (90%) of this will take place in developing countries. Ninety percent of this population growth will be urban; virtually all of it will therefore accrue from urban settlements in developing world (UNCHS, 1991). In coming decades, population growth in developing countries will virtually be synonymous with urban growth.

A review of literature indicates that we will be looking more and more to cities for economic growth and jobs for future generations (UNCHS, 1989). This is so because urban transition represents a profound social economic transformation produced by the processes of modernization and development of which the recent dramatic demographic shifts are mere surface manifestations (UNCHS, 1989). There is a new and expanding economic role for cities and towns due to exigencies imposed on developing countries as a consequence of integration with the international economy.

Current trends in the liberalization of the global as well as national economies are accelerating urbanization and the economic importance of cities. 60% of the Gross National Product (GNP) of developing countries is produced in urban areas. In the near future urban areas in these regions will not only account for about two thirds of population growth but also some four fifths (80%) of the GNP.

Existing literature however, points to the fact that rapid urbanization in developing countries has taken place at a time of economic stagnation and decline. UNCHS (1996) notes that local governments are often strapped for cash and do not have the resources to provide even the most basic of environmental services for their residents. Ferguson and Navarrete (2003) note that faced with growing population and poor economic performance, formal housing production falls below new household formation. The resulting huge gap between formal sector supply of housing and household formation is met by informal housing. Current literature identifies rural-urban migration as the most important factor for urbanization in countries of the third world, especially those with low levels of urbanization (WHO, 1993; and UNCHS, 1996). Literature reviewed indicates that numbers of the urban poor are growing as a consequence of urban economic growth not being able to keep up with demographic growth. Few of the new migrants therefore find formal jobs; and majority of them end up in the informal service sector. They end up transforming their unemployment to underemployment often exchanging their rural poverty for urban poverty. UNCHS (1996b) notes that the mass exodus to cities has already led to sharpened urban poverty. Consequently the majority of the urban poor cannot afford the least expensive housing unit in planned settlements. WHO (1993) observes that new comers to towns and cities have always been likely to find themselves living in the most adverse surroundings.

Nairobi's informal settlements are nearly as old as the city (Lamba, 1994). Kibera was started in 1912, when Sudanese Nubian soldiers who had served in Kings African Rifles were allowed to settle in the area. The new residents were only allowed to build semi permanent structures and the government reserved the right to reclaim the land. Despite this, the population of Kibera continued to grow and is today said to be the biggest slum in Africa. Other slums that have developed include Huruma, Mathare, Korogocho, Kawangware, Kangemi, Kariobangi, Majengo, Gorofani, Mukuru Viwandani, and Mukuru Kwa Njenga. Emergence of slums in Nairobi is also attributed to a legacy of neglect and mal-development. Lamba (1994) argues that little provision for housing was made for the African population; and left on their own, the people; majority of them rural migrants to the city

constructed their shelters, found sources of water wherever they could and organized for their own services. This may well explain why most of Nairobi's informal settlements grew along river valleys. It was argued that providing these areas with urban services would confer legitimacy to illegal settlements and encourage squatting (Macoloo, 1994a). It was not until a cholera outbreak in 1971 that city authorities began providing water to Nairobi's informal settlements (Lamba, 1994).

CBS (2004), also attributes the growth of informal settlements to the fact that Kenya has experienced a high population growth in the last few decades. Its population increased from 10.9 million in 1969 to 28.7 million in 1999. Secondly, the economy has also in the last few decades performed dismally. Though it grew by 7 percent in the decade following independence it has suffered a consistent decline reaching the lowest GDP growth level of about 2 percent between 1996 and 2002. Historically a negative 0.2% real GDP was recorded in 2001. Poor economic performance faced with spiraling population growth has led to increased poverty. High population growth and poor economic performance has concomitantly been experienced with rapid urbanisation. Urban population increased from 10 percent in 1969 to 19 percent in 1999. The increase in urbanization levels have mainly resulted from rural-urban migration (CBS, 2004). With the government unable to invest in low cost housing or urban infrastructure, slums or informal settlements currently house most of the urban residents of Nairobi.

2.3 Urban Environment and Human Health

Good health depends to a large extent on a good living environment. The urban settings will therefore, play a major role in determining the health status of residents, especially those in areas experiencing rapid urbanization (WHO 1993). The knowledge that environmental factors directly influence human health is over 2000 years old. Hippocrates, founder of western medical tradition believed that environmental conditions, behaviour and physiology all contributed to a person's health. He viewed human health and well being as largely dependent on the quality of environment (Lamba, 1994). However, Briggs and Nurminen (1996) note that the extent of health impacts is not known with any degree of certainty; the methods for analyzing the relationships are not fully developed and the quality of existing data generally poor. They however stress the importance of having the ability to link health and environment and thereby understand the relationships between levels of environmental pollution and health outcomes in order to design interventions to control exposures and protect health.

An analysis of the literature on environment and health shows that there have been many attempts to connect human health and environmental conditions. Eckholm (1997), notes that variations in health conditions reflect the differences in social and physical environments. Forces that shape health patterns are set in motion by human activities and decisions. He reasons that given particular environmental conditions, health patterns within societies can be predicted. He further avers that "Indeed, in creating its way of life, each society creates its way of death" (Eckholm, 1997: 19). According to Kotcheeva and Singh (1998), the status of human health is a reflection of a whole variety of complex interactions between the internal biological and the total external environmental systems. Many of the threats to human health are intrinsic parts of ecosystems. Hinkle and Loring (1977) observe that the traditional foci of public health administration to prevent disease and injury in a human population has been to change conditions in its physical environment and that historically, numerous ideas for such interventions were acted upon even before definitive research had determined the nature of the relationship between a particular condition and a disease.

Evidence that urban environmental conditions not only have obvious effects on human health and well being, but also impede socio economic development is captured by the reviewed literature. It is noted that cities exert environmental impacts at different spatial scales (UNCHS, 1989; UNCHS, 1996).The house and the immediate surrounding conditions like: contaminated water, inadequate sanitation and indoor air pollution, lead to diseases such as diarrhoea, dysentry, skin diseases and respiratory diseases. At the neighbourhood level diseases such as malaria, filariasis and accidents are attributed to lack of drainage, unpaved roads and paths, and lack of garbage collection. The city environment presents problems attributed to economic growth and industrial production. These problems include air pollution from motor vehicles and industrial waste. At times toxic wastes that can cause cancer and other conditions are discharged from nearby factories and carried by open drains through slums and informal settlements. Cities also cause tremendous environmental impacts at regional and global levels such as damage caused by city-based consumption and city generated wastes, motor vehicles pollution and garbage dumpsites. City based production has an impact on climate change and global warming. According to UNCHS (1989) and UNCHS (1996), the urban poor in informal settlements are exposed to both hazards from economic growth such as industrial emissions and to hazards that accompany poverty reflective of poor environmental conditions.

2.4 Responses and Search for Solutions

The literature reviewed indicates that urban areas have received low priority in allocation of resources for development. According to UNCHS (1989), the negative image of cities created by generations of urban writers has exercised a powerful image on those who make decisions in regard to development priorities particularly in the donor countries. UNCHS(1996) states that despite the fact that most of the world's population will soon live in developing countries, majority in informal settlements, environmental problems most prominent in these cities have not featured in the global environmental agenda. However, UNHCS(1989), notes the disconnect between the green agenda and the problems of cities has been recognized and there is now increased advocacy for renewed focus on the brown agenda concerned with problems of pollution, poverty and environmental hazards of cities.

Urban environmental health is not a new phenomenon. In nineteenth century industrializing Europe, public health was born out of concerns for environmental health, similar to what is being faced in the informal settlements of developing countries. This marked the introduction of legislation and use of specially trained environmental health workers, trained to address predominantly environmental threats to health (WHO, 1993). This was followed by the preventive phase based on personal preventive actions made possible by advances in bacteriology, immunology and promotion of mechanical methods of birth control.

The therapeutic era superseded the preventive phase in the 1930s following the advent of antibiotics, insulin and sulfonamide drugs. This phase also marked the involvement of governments in direct patient care. In the 1970s, difficulties in funding public health and systems brought the idea of "new public health" which combined environmental change and personal preventive measures with therapeutic interventions and sought to get the balance between urban health conditions and urban environmental problems. The new concentration is on the environment and an understanding of public health based on ecology rather than mere limited mechanical concepts of sanitation. There are now two agendas for environmental health in urban areas. There is the "old" agenda which focuses on tackling basic health problems of large numbers of the urban poor, who are inadequately housed and lack urban services. This is now the agenda in many of the cities of developing countries. Industrialized developed countries are currently preoccupied with the "new" agenda dealing with the ecological problems that are rapidly storing up threats to human habitats around the world (WHO, 1994).

UNCHS (1996) argues that the most threatening environmental problems in urban informal settlements are those within their households and neighbourhood. The search for solutions must therefore focus on the efforts of individual households and the cooperative efforts of the community at the neighbourhood level. Efforts should capitalize on building on the efforts of the poor to manage their environment. There must be a recognition and support of the rights of the poor to know the risks they are exposed to, to determine their priorities and to meet their own needs through community initiatives.

Eckholm (1997) notes that, forces that shape health are set in motion by human activities and decisions. Public education and community organizations are therefore important in enabling people to tackle the adverse environmental conditions in their households and neighbourhood (WHO 1993). The policing style of public health officials is not effective. Health education and health promotion have an important part to play in setting the agenda and raising awareness so that local models of practice can be developed. WHO (1993) indeed argues that where there is a local interest in health related policies or where such an interest can be brought about by raising awareness, it usually leads to flowering of different models of effective practice that depends on local culture.

A review of literature shows that research efforts have focused on urban health inequities between different income and economic strata in cities. There have been studies on environmental problems and household perception between economic strata in the city of Sao Paulo, Jakarta and Accra (Jacobi, 1994). In Sao Paulo City, the approach to environmental issues was developed from the standpoint that considered a whole range of households in the context of both the urban problems and the perception of people who are directly affected by them. The study considered six socio-economic strata and different spatial locations so that findings from high, middle, and low-income households could be compared.

This research found evidence that there are differences as to what people of different strata consider as the most important environmental problems. The poor are for example more concerned with access and quantity of water while the rich are concerned with quality of air and water. The studies also confirmed that disparities in health exist between the different economic strata. Stephens *et al.* (1996) showed that it is possible to use existing data to identify the extent of intra-urban differentials

in environmental and health conditions. Results revealed both the scale of inequality and the proportions of people who have not experienced the benefits of living in urban areas. APHRC (2002) documented health inequities in Nairobi, with the objective of disseminating the findings to decision makers and to foster policy formulation and implementation regarding reduction of health gaps between the urban poor living in the slums and other better off residents. The Kenya Demographic Health Survey 2003(CBS, 2004) also points to the existence of health disparities between the poor and the non-poor of urban and rural areas. They point out that children in Nairobi's informal settlements have the lowest percentage of those immunized. Children in Nairobi's informal settlements exhibit the highest rates of morbidity from cough, fever and diarrhoea, and when they suffer from these conditions they are less likely to be taken to hospital. Children in Nairobi's informal settlements are also more likely to die before their first birthday than those living in other parts of Kenya. AMREF (1990&1991) found that the environmental and sanitary situation in slum villages was poor. Housing conditions, access to treated water and sanitation were identified as inadequate and the level of disease burden disproportionately high. The literature reviewed shows that there is a clear understanding that urban poor in informal settlements or slums suffer disproportionate ill health due to their living environments.

APHRC (2003) documented the demographic and health conditions of Nairobi's informal settlements residents, though they perceived a link between environmental problems and health, they failed to analyze the environment-health linkage. The Kenya Welfare Monitoring Survey (CBS, 2000) in assessing the poverty in the country correctly states that the quantity and quality of water affects human welfare but is more emphatic on economic factors. Interestingly, this report analyses the distribution of malnourished children by food poverty, by education of household head, by the source of water, and by type of toilet facility; an appreciation that environmental conditions affect human health. AMREF Kenya and other NGOs have concentrated on health provision and access to water, sanitation, other environmental services and income generation. There is also a growing body of literature that documents inequities between urban residents of different economic status; APHRC in partnership with National Council for Population and Development (NCPD), and Nairobi City Council's Urban Slums Development Project (USDP/NCC) through the Nairobi Urban Health Equity Gauge are championing these efforts by highlighting the health inequities facing the urban poor in Nairobi (APHRC, 2002).

There are, therefore, gaps in literature which focus on the links between environmental problems and human health in the informal settlements; or seeks to understand perceptions people have on the said link. Hinkle and Loring (1977) observe that even though many countries routinely collect health outcome data in the form of morbidity and mortality statistics, attempts are rarely made to link them to environmental or other factors in order to attribute outcomes to their causes. They therefore observe that analysis of data on the health impact of environmental problems, and setting priorities for action thus remains an urgent need in many parts of the world. Lamba (1994) notes that in Nairobi there has been little application of the knowledge that environmental factors influence human health in research, policy and action. The HEADLAMP approach, Briggs (1996), emphasizes the importance of health data in environmental health studies as they provide indicators of the effects of known exposures to environmental pollution and human health. Data on health outcomes when linked to appropriate environmental data can then be used to confirm exposure–effect relationships within the study area, or to quantify the contribution of specific exposures to total morbidity.

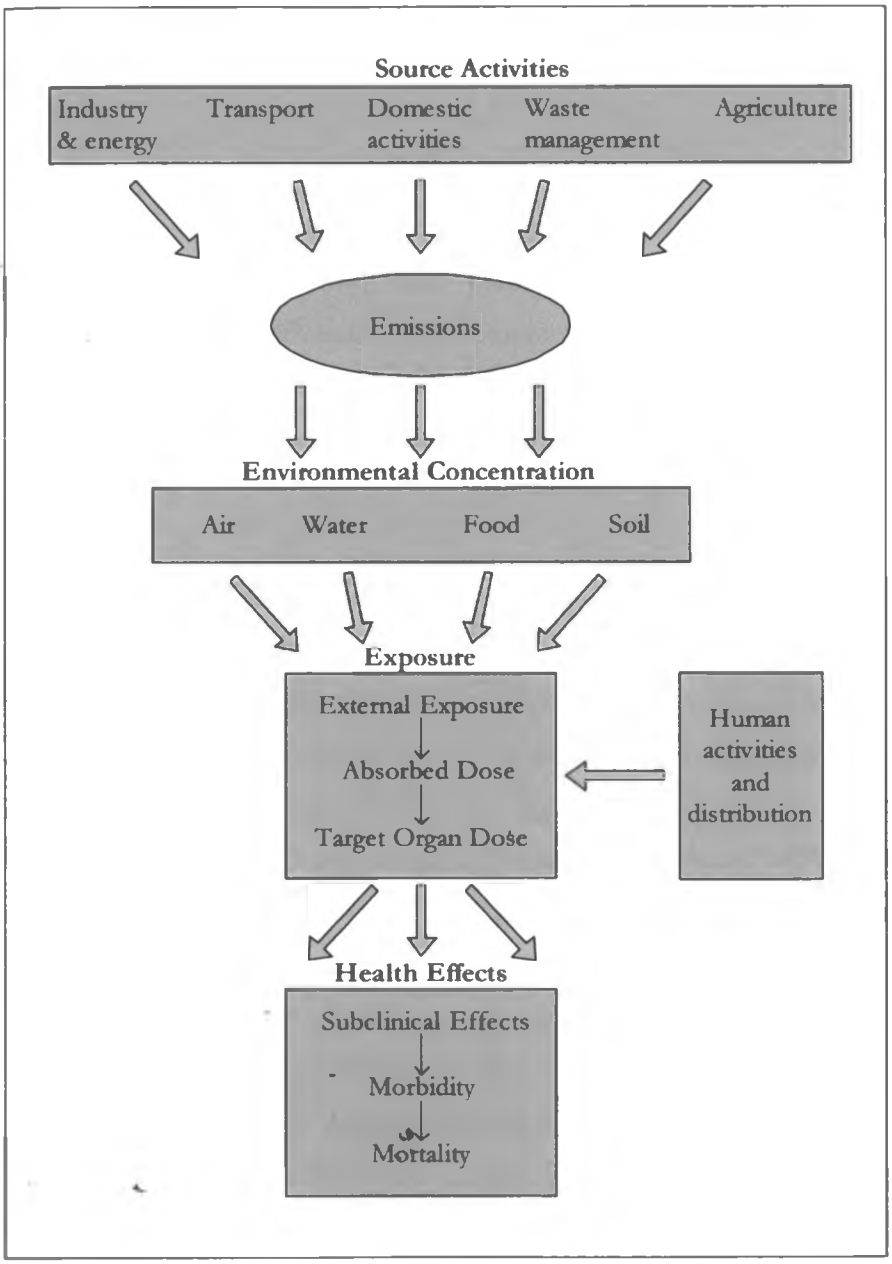
This study documents and analyzes the link between environmental problems and human health in Nairobi's informal settlements, an area not adequately covered by the existing body of literature. The study collected morbidity and environmental data and analyzed the linkages. The study further investigates whether or not the urban poor have information on interactions between environment and health, and who they think has the responsibility to address these problems. The study provides data and information necessary for the design of interventions that would capitalize on the information of the environment-health link. Such interventions could also benefit from perceptions, knowledge and resources residents have in determining priorities and actions to meet their needs. This is in tandem with the emerging concept of human development that advocates the centrality of man in development as an alternative to growth-led approaches to development. According to UNDP (2002), human development involves the process of expanding human capabilities and access to opportunities in social, economic and political arenas. It is noted that the most basic of these capabilities lead to healthy lives, knowledge and access to decent standards of living.

CHAPTER 3: METHODOLOGY

3.1 Theoretical Framework

The link between environment and human health operates through exposure of humans to environmental problems or hazards as illustrated in Figure 3.1. Human activities such as human settlements, mining, quarrying, energy production, manufacturing, transport, agriculture and waste management are responsible for most environmental pollution.

Fig. 3.1. The environment health chain: example of pollution



Source: Briggs *et al*, 1996:27

Environmental pollutants are released into the environment in a variety of ways, and may be dispersed and accumulated in different environmental media such as air, water, soil, living organisms and human products. When human beings encounter the pollutants in any of the media, health effects (outcomes) may then occur ranging from sub-clinical effects through illness to death. The severity of the health outcome depends on the intrinsic harmfulness of the pollutant, the degree of exposure and susceptibility of the individuals concerned. Forces which both motivate the creation of the hazard and increase the likelihood of exposure are at the root of the problem for they propel and keep the whole process going. These include population growth, economic development and technological change; often the product of socio-political organization.

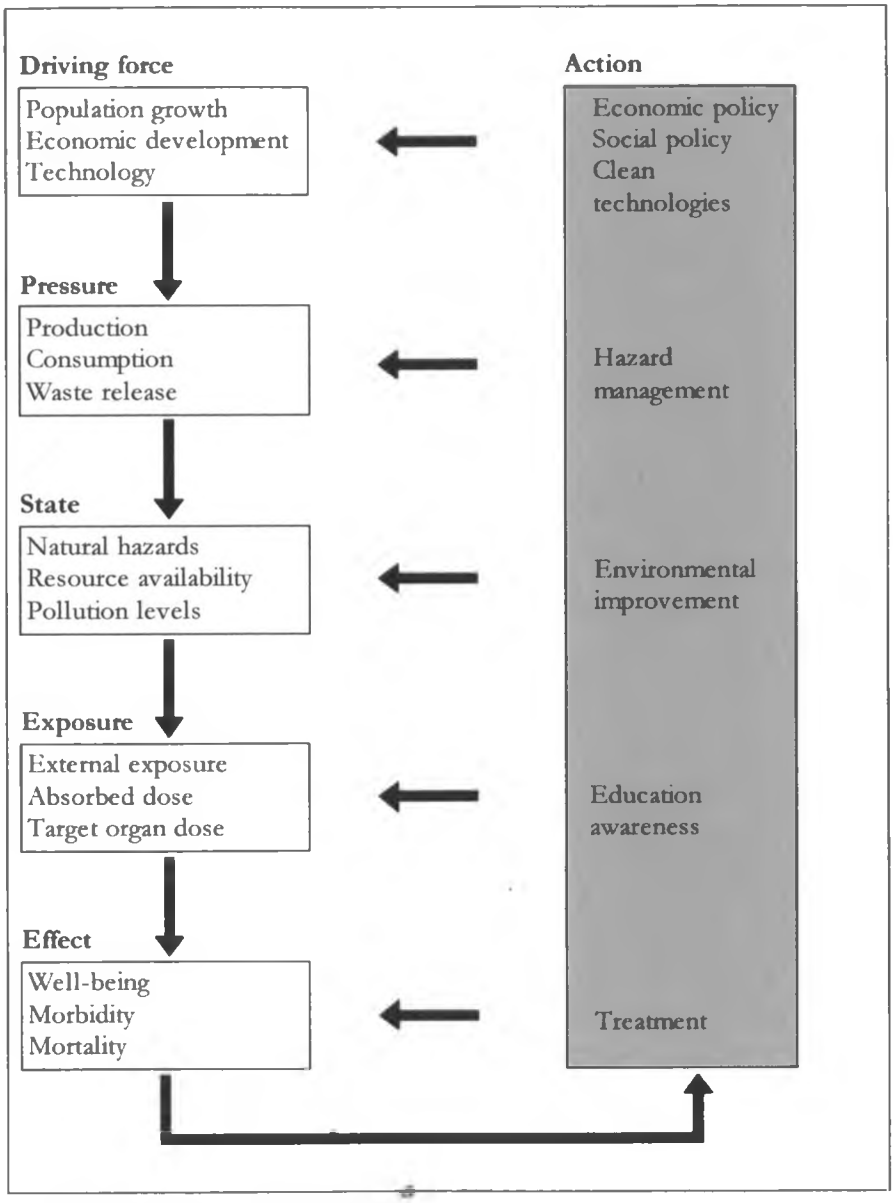
3.2 Conceptual Framework

The pressure state response (PSR) sequence initially applied by OECD as a framework for state-of-environment reporting, has been the most widely adopted attempt at devising conceptual frameworks for environment-health indicator development. However the HEADLAMP project has further adapted it to provide for specific framework known as the DPSEEA (Drivers-Pressure-State-Exposure-Effects-Action) framework illustrated in Figure 3.2, and elaborated for human settlements in Figure 3.3

Within the DPSEEA framework, **driving forces** refer to the factors which motivate and push the environment process involved. In human settlements, and more specifically informal settlements population growth, urbanization and poor economic growth have been the most important driving forces. The driving forces result in the generation of **pressures** on the environment. Pressures are normally expressed through human occupation and exploitation of the environment in the form of some economic activity. In the context of human settlements pressures manifest themselves in the form of rapid urbanization and proliferation of informal settlements. One of the outcomes of pressures is the release of pollutants into the environment, which results in the **state** of the environment being changed. Informal settlements result in overcrowding, inadequate environmental infrastructure, reduced availability and quality of water, lack of garbage collection, indoor pollution and inadequate housing which lead to environmental problems and pollution. For **exposure** to take place people must be present at both the place and the time the hazard occurs. A wide range of health **effects** result from exposure to environmental problems. Initial effects, and least intense, are the sub-clinical, merely involving some reduction in function or some loss of well being. This may be followed by more intense effects in the form of illness or morbidity. Given known exposures and

knowledge of dose-response functions, it is possible to make reasonable estimates of the health burden of specific environmental problems. In informal settlements, diseases such as respiratory diseases, diarrhoea, skin diseases, malaria and other infectious and communicable disease are manifestations of exposure to deficient environmental conditions.

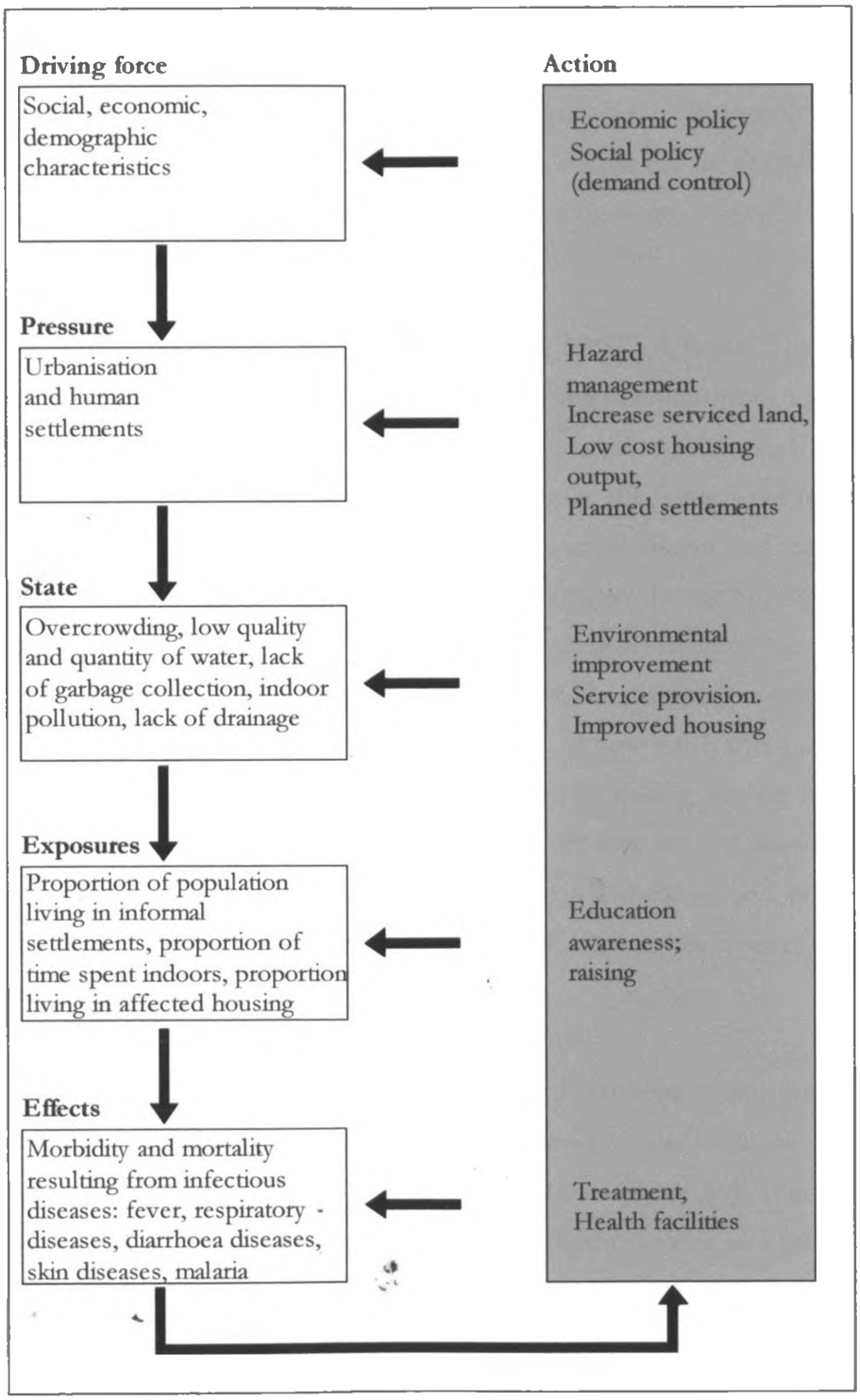
Fig. 3.2 DPSEEA Conceptual framework



Source: Briggs *et al*, 1996:28

3.3 Conceptual Framework at Informal Settlements Level

Fig. 3.3 Conceptual framework at informal settlements level



Modified from Briggs *et al*, 1993:

When confronted with the various health effects, society invokes a number of **actions** in many forms targeted at different stages of the environment-health chain. These include short-term remedial actions such as treatment, or the longer term protective measures such as changing lifestyle or behaviour to prevent exposure. Action may also be taken to reduce or control the environmental problems by providing environmental infrastructure as happens in squatter upgrading. Briggs and Nurminen (1996), note that the most effective long-term actions are those which are preventive in approach, aimed at eliminating or reducing the forces which drive the system.

3.4 Operational Framework

Urban problems and human health were studied using the DPSEEA model. The ***driving*** forces and the resultant ***pressures*** are normally addressed by controlling demand through policy interventions, which this study intends to address when making recommendations. This study therefore begins to give operational definitions to the concepts by looking at the ***state*** level in the chain of the DPSEEA conceptual framework. The state of the living environment was captured by assessing overcrowding through observing the number of rooms occupied by the household and the size of the households. Observations were also made on the crowding of structures themselves. The quality of water was assessed by investigating the sources of water, the manner it is stored and the way it is conveyed. Quantity of water was investigated by finding out how much they pay for water and the time it takes to fetch it. Indoor pollution was investigated by finding out the type of cooking and lighting fuel and whether households cook in the same room they live and sleep in, or whether they had a separate kitchen. Observations were made on the site drainage, and how solid and liquid wastes are managed. Sanitation levels were assessed by investigating the types of toilet facilities used and how many people share it.

The next stage looks at the ***exposure*** to the environmental problems. Population characteristics are captured by documenting the ages of respondents, their level of education, the number of children in a household, the period the respondents have lived in the area, as well as assessing their socio-economic status by investigating ownership of specific household items as a proxy for income and well being. Health ***effects,*** result due to exposure to environmental problems. This manifests itself in form of various health outcomes and this study investigates the prevalence of diseases such as malaria/fever, diarrhoea, skin diseases and coughs. The ***actions*** society takes are documented by finding out what they do when they get sick, and whether they seek to protect themselves against

infection. The study also investigated whether the residents of the informal settlements have awareness and information on the link between environment and health by asking householders whether they treat their drinking water, and whether they are able to connect health outcomes to specific environmental problems. Regarding long term action, the households identify what should be done to improve the area and whom they think is responsible for this.

3.5 Study Design

This was a cross sectional household survey aimed at documenting the environmental problems and the incidence of environmentally related diseases in Mukuru Kwa Njenga informal settlement. The study was designed to answer both descriptive and relationship research questions. Descriptive design questions employed observational designs executed through interviewing people so as to describe their perceptions and through observing their behaviour. Relationship questions concern prediction as to whether we can predict variable X from variable Y. The core relationship question was: Is there a relationship between environmental problems and incidence of certain diseases? A regression/correlation design was used. This design is *ex post facto*, for data was gathered at one time, and independent variables were not to be manipulated. Regression/correlation design is similar to observational design except that it hypothesizes a correlation between variables, and both therefore use the same data set.

3.6 Study Variables

Dependent Variables(Y):

This is a binary response variable which will assume a value of 1 if, for example, any member of the household has suffered an environmentally related infection in the last two weeks; and a value of 0 if otherwise. The diseases considered in this study are:

- *malaria/fever (due to difficulty of differentiating the two)*
- *cough/respiratory infection*
- *diarrhoea*
- *skin disease*

Independent (explanatory) Variables(X):

Environmental problems were studied by considering the following variables:

- *Housing conditions*

Construction materials for floors, walls and roofs were documented.

- *Water quality and quantity*

The source of water will be established as to whether:-

-It is from a standpipe in the compound

-It is from a public outdoor pipe and how many people share it

-It is from a vendor, or

-It is from a well

How the water is stored

Time taken to fetch water and the price paid

- *Solid waste disposal*

Where the solid waste is kept – in a communal dump or scattered

If there is any disposal service

- *Sanitation facilities*

Establish whether the type of toilet:-

- is water borne

- Ventilated improved latrine or

- Open pit latrine

How many people share it.

- *Cooking fuel*

The type of fuel used will be investigated to establish whether it is:-

- Firewood

- Charcoal

- Paraffin

- Gas or

- Electricity

- *Socio-economic variables*

According to Briggs, *et al.* (1997), relationships between the environment and human health are rarely simple and unitary as they are usually affected by a variety of confounding variables many of which are partially known. Therefore for interpretations of linkages between environment and human health to be valid allowance for potential confounding has to be made. Socio-economic variables denoted by expenditure on a number of household assets (as a proxy) are used in this study as the confounder data.

3.7 Sample Design

The population consisted of households of the informal settlement of Mukuru Kwa Njenga sub-location. The sampling unit was taken as an individual household taken from a sampling frame of the housing structures. The interviewees were selected from households and had to be adult persons who had been resident in the area for at least six months so as to capitalize on genuine experiences. The sampling method used was probability sampling.

The sample size was determined through application of the following formula recommended by the University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS). The criteria used are the level of precision, the level of confidence and the degree of variability.

$$n_0 = \frac{Z^2\ pq}{e^2}$$

Where n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area at the tails. e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p. The value of Z is found in statistical tables which contains the area under the normal curve.

Assuming that the estimated proportion of the attributes present in the population is 80% (as the population is homogeneous) p=0.8 and q=0.2, and at 95% confidence or risk level and ± 5% level of precision; the sample size is calculated as follows:

$$n_0 = \frac{(1.96)^2\ (0.8)(0.2)}{(0.05)^2} = 246 Sampling Units$$

For a small population the sample size is reduced slightly because a given sample provides more information for a small population than for a large population. It is adjusted using the equation below:

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$ Where n is the sample size and N is the population size; $$= \frac{246}{1 + \frac{246 - 1}{672}}$$

This works out to 180 sampling units. Kish (1965) also says that 30 to 200 elements are sufficient when the attribute is present 20 to 80% of the time i.e. the distribution approaches normality. 200 sampling units were therefore taken for the study.

A random sample of 200 households was then selected from Mukuru Kwa Njenga sub-location which consists of eight zones namely: Mukuru Community Center (MCC), Fourty-Eight, Wape Wape, Milimani, Sisal, Riara, Vietnam and Moto Moto. A multi stage cluster random sampling method was employed, whereby one zone, Sisal, was randomly selected from the eight villages that make constitute the settlement. The next stage involved using Microsoft Excel to generate a random sample of 200 structures from a list of all the 672 housing structures in the sisal zone. The next stage involved choosing the household to interviewed, a housing structure comprises of between 4 to 14 households, but most have 6 households. From each of the selected housing structures, one household was randomly picked, from which an adult member especially the head of household was interviewed.

3.8 Data Collection

Primary data was collected through interviewing residents using a structured questionnaire, reproduced in Appendix 1. Data on housing conditions was done through observation.

3.9 Data Processing and Analysis

The data from the questionnaires was put into a table in Microsoft Excel. The data was then exported to the Statistical Package for Social Sciences (SPSS) software for cleaning and processing, and then analyzed using STATA version 8 software (see Appendix 2).

The study employed the linear probability model. This type of model is used to denote regression in which the dependent variable Y is a binary variable taking the value 1 if the event occurs and 0 if otherwise.

The linear probability model is written as:-

$Y_i = \beta_o + \beta_i X_i + \epsilon_i$

Where:

Y =1 if any individual in the household has had an environmentally related infection two weeks prior to the date of interview and 0 if otherwise

β_o =intercept term

β_i= vector of explanatory variable coefficients

X_i = a vector of explanatory household and neighbourhood characteristics

ϵ_i = error term

The calculated value from the regression equation gives the estimated probability that the event will occur given the particular value of X.

The model is estimated using Ordinary Least Squares (OLS) which is based on the following assumptions:

1. E (ϵ) =0: The observable characteristics do not depend on the value of X. The observed characteristics and the error terms are uncorrelated. If the X_i and ϵ_i are correlated then the conditional mean assumption is violated, and OLS estimates are biased.

2. E (ϵ/X) =0: The average value of ϵ does not depend on the value of X. The observed characteristics and the error terms are uncorrelated. If X_i and ϵ_i are correlated then the conditional mean assumption is violated and OLS estimates are biased.

3. Observations have been drawn at random for the population and are independent of each other.

4. Population variance of ϵ_i is constant for all i. (constant variance)

5. Normality assumption: The error term is normally distributed. This will be especially useful when doing hypotheses testing.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Household characteristics

Out of the total sample of 200 respondents, 52% of them were male and 48% female with a mean sample age of 31 years. About 90% of them had attended school (50% had completed primary school, 38% completed secondary school, and 1% had tertiary education) while 10% had no formal education.

The mean household size was 4.3 members, with the mean length of respondents stay in the particular dwelling being 58 months (4 years and 10 months) while the mean stay of the respondents in Mukuru Kwa Njenga was about 8 years. 70% of the respondents were living in rented dwellings.

Water supply

The source of water, time taken to draw water, the cost, and manner it was stored was investigated. Respondents were also asked to indicate whether they boiled their drinking water or any other purification method; and whether cost of water or distance taken to fetch water was the main limiting factor as to the amount of water used.

Majority of the households 99% obtained their water from outdoor selling points connected to the city supply (see Fig. 4.1). However these connections are illegally done, and water is conveyed through plastic piping which could allow contamination. The selling points are also located in very unhygienic places surrounded by uncollected garbage and drains into blocked open channels.

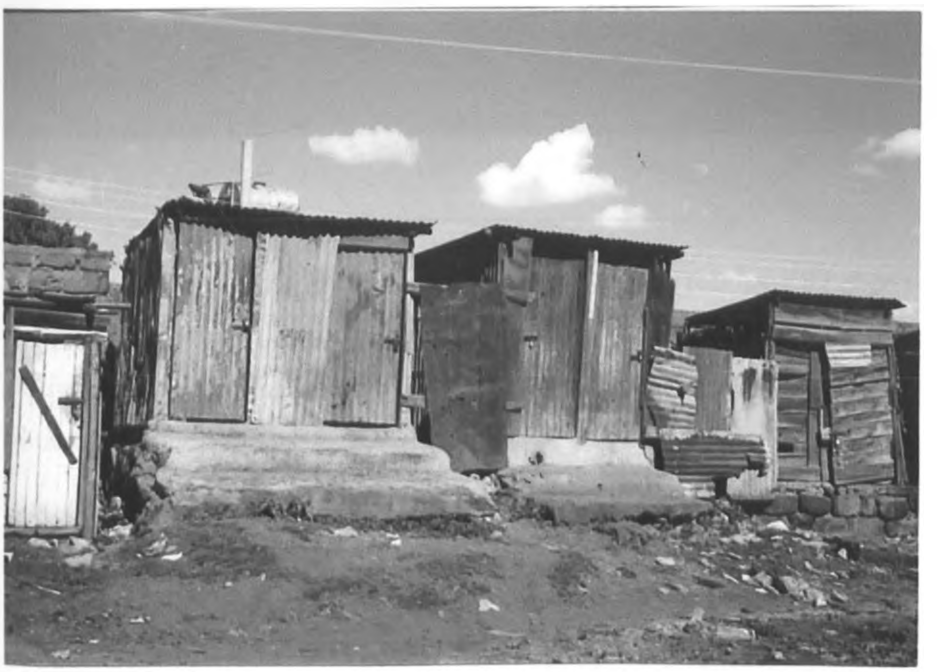
An average of 13 minutes was spent by the households to travel to get water, with them paying about 3 Kshs. per 20 litre container for water. 45 % of the households always boil their drinking water while similar proportions (45%) use chemical treatment for their drinking water. Over 90% of the households store their drinking water in closed containers.

Fig. 4.1 Water Selling Point in Mukuru Kwa Njenga (note the filth around)

Sanitation

About 88% of the households have access to a traditional pit latrine, 6 % of them to Ventilated-Improved Pit (VIP) latrine, and 6% had no toilet facility. An average of 15 households share one pit latrine.

Fig. 4.2 Pit Latrines in Mukuru Kwa Njenga (see the poor state of repair)



Pit latrines were found to be in a poor state of repair (see Fig. 4.2), and did not have facilities for washing hands. They were also grouped together, therefore not very accessible to some households especially at night when it is dark.

Solid waste disposal

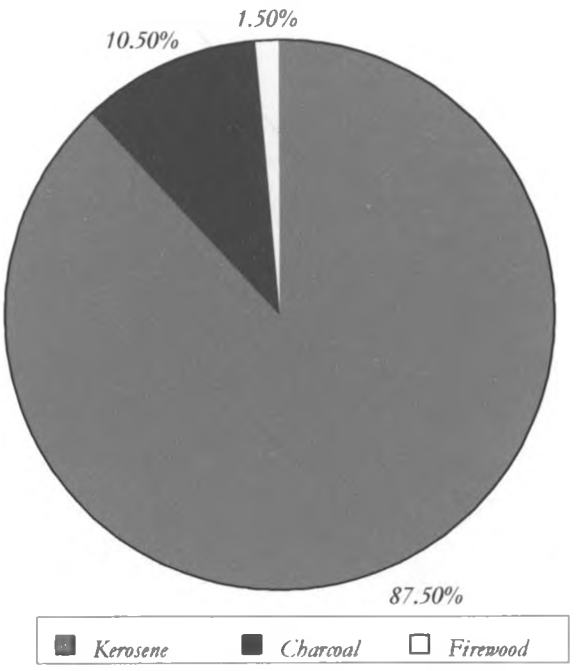
Almost all of the household garbage is dumped haphazardly into the streets, empty plots or into the Ngong River. Plastics form a substantial proportion of the garbage. There is no organized garbage collection service.

Fig. 4.3: Haphazard Dumping of Garbage in Mukuru Kwa Njenga

Cooking fuel

Kerosene is the major source of cooking fuel (87.5%), followed by charcoal (10.5%) and firewood (1.5%) (See fig 5.1). Majority of the households (91%) cook in the same room which they also use as living room and bedroom with only 9% of them having a separate room for cooking. On households' lighting fuel, kerosene is the most popular (94.5%) while 4.5% of them use electricity.

Fig 4.4 Type of Cooking fuel



Housing conditions

Houses are poorly constructed, and built in rows with very narrow spaces between them (see Fig. 4.5). The houses are poorly lit as they do not have glazed windows. Table 4.1 illustrates the construction materials used. The main floor material for the dwellings is predominantly cement (85%) and earth (15%). Corrugated iron sheets ('mabati') are the main roofing material for the dwellings while flattened tins make up the remaining proportion. As for the main material for the walls, corrugated iron sheets account for 75%, flattened tins 15%, wood planks 7% and earth 3%. Construction materials and planning of structures do not meet the standards set by building by laws and regulations of Nairobi City Council and are therefore classified as illegal.

Table 4.1 Housing Construction materials

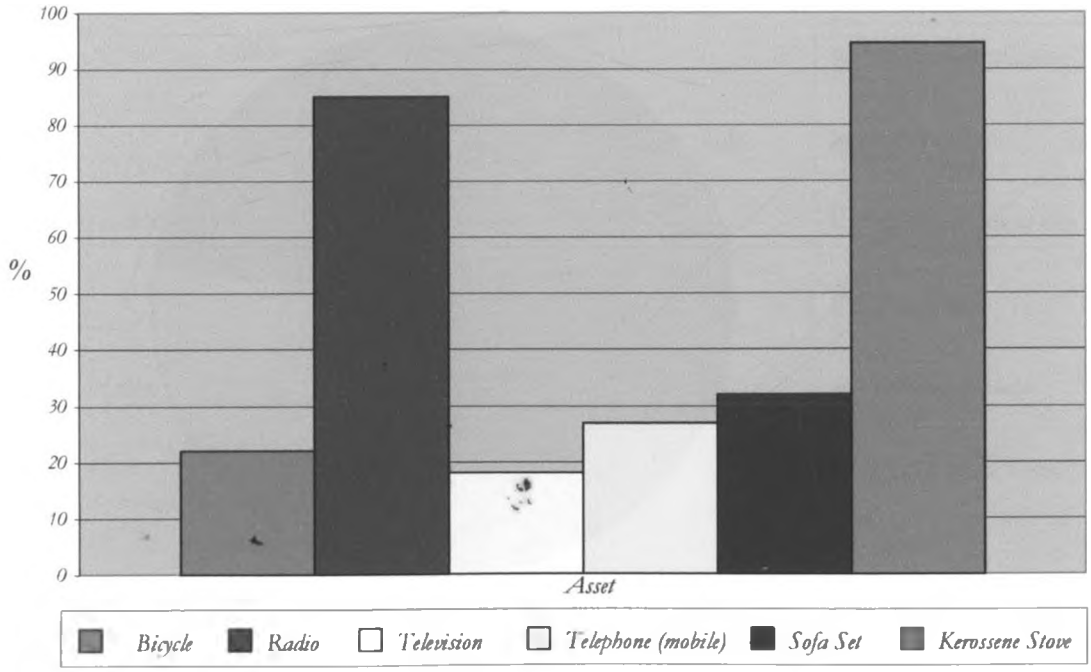
Components	Material	Proportion of houses
Floor	Cement Earth.	85% 15%
Walling	Corrugated iron sheets Flattened tins Wood plunks Mud	75% 15% 7% 3%
Roofing	Corrugated iron sheet Flattened tins	96% 4%

Fig. 4.5 Overcrowded and Poorly Constructed Structures

Social economic variables-ownership of assets

On households' ownership of assets, 22% have bicycles, 85% have radios, 18% have television, 27% have mobile telephones, 32% have sofa sets and 94.5% have kerosene stoves (see Fig 4.6).

Fig 4.6: Ownership of Household Assets



Disease prevalence

Proportion of households which had at least one of their members suffering from environmentally linked diseases two weeks prior to the date of the interview is captured by Table 4.2 below.

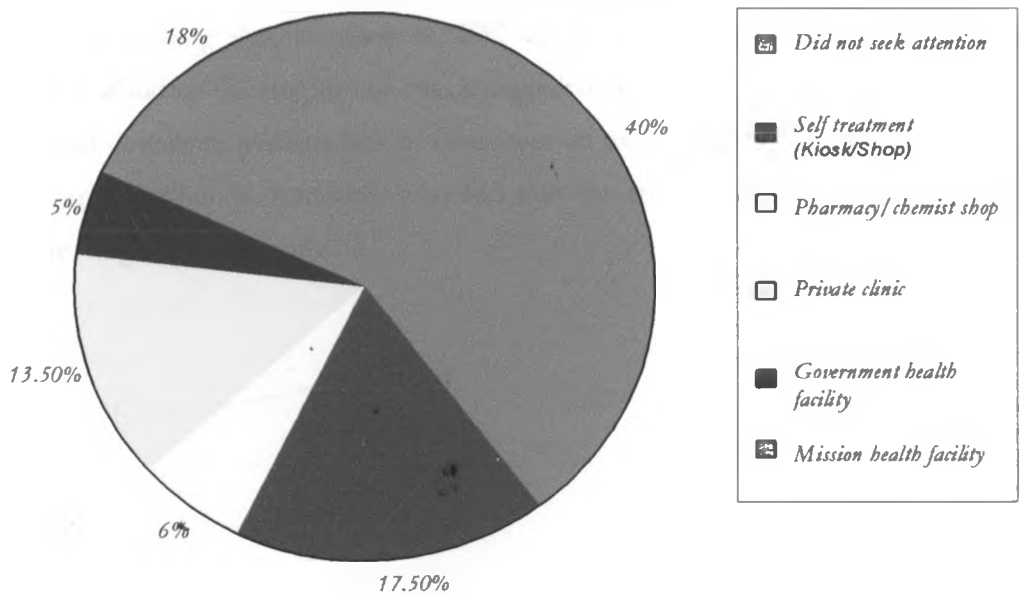
Table 4.2: Proportion of Households Affected By Environmentally Linked Diseases

Disease	Households affected
Malaria	45%
Cough	40%
Diarrhoea	21%
Skin Infection	12%

Where Medical Treatment Was Sought

The respondents reported that 60 % of those affected sought medical attention; with 18% seeking medical attention from mission health facility, 17.5% through self treatment ('kiosk'/shop), 13.5% from private clinics, 6% from pharmacy or chemist and 5% from government health facility as shown in Fig 4.7 below.

Fig 4.7: Where Household Sought Medical Treatment



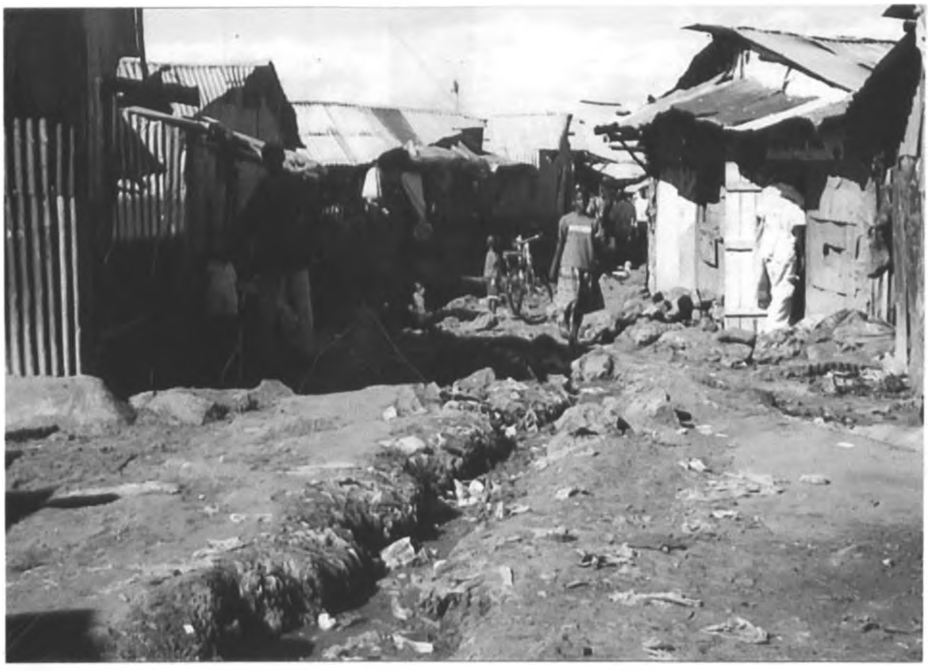
Households Perception of the State of Their Environment

Figs. 4.8 and 4.9 show the poor state of neighbourhood environment residents have to contend with. On the peoples' perception towards their environment, 8%, 21% and 70% of those interviewed opine that the status of their environment is good, fair and poor respectively.

Fig. 4.8 Stagnant Pool of Water next to Housing Structures in Mukuru Kwa Njenga

It was rather surprising that as many as 29% of the residents think that the neighbourhood environment is good or fair despite the much degraded environment of the area. This may reflect some degree of despair or perhaps lack of awareness on the adverse effects the environment has on their health and livelihoods. Residents who feel that the environment is good may not see much need in improving their environment.

Fig. 4.9 Water Gullies on a Road in Mukuru Kwa Njenga

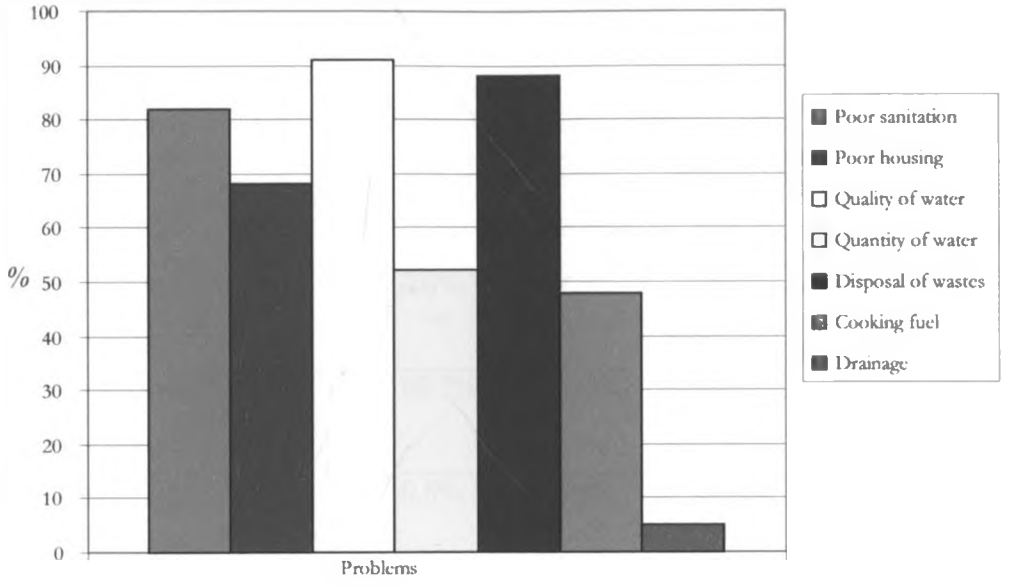


Linkage of Diseases to Environmental Problems

As shown in Figure 4.10, about 91% of the respondents think that poor water quality leads to diseases such as cholera, diarrhoea and typhoid. 52% think that poor water quantity leads to diseases such as diarrhoea, typhoid and skin infections. 88% of the respondents think that poor disposal of waste leads to diseases such as cholera, diarrhoea, typhoid and malaria.

Of those interviewed 68% of them think that poor housing condition leads to diseases such as malaria, pneumonia, tuberculosis and other respiratory tract infections. 82% of the respondents think that poor sanitation does lead to diseases such as cholera, typhoid, dysentery and worms. 48% of the respondents think that using polluted sources of cooking fuel, does lead to respiratory diseases such as tuberculosis, pneumonia, coughs and flu. Only 5% of the respondents think that poor drainage leads to diseases such as malaria and cholera.

Fig4.10 Linkage of Environmental Problems to Diseases



Responsibility for the State and Improvement of the Environment

Majority of the households (69%) feel the government is responsible for the current poor state of supply of water, 80% of them think that both the government and individual households are responsible for lack of collection and disposal of solid waste, 68% of them think that both the government and individuals are responsible for the poor housing conditions, 74% of them think that the government, the private sector and individuals should be held responsible for the poor provision and maintenance of sanitation facilities, while about 34% of them believe that the government is to blame for the poverty that leads to the use of polluting fuel.

Table4.3 shows that only 2.0 percent, 4.5 percent, 15.9 percent, 17.9 percent of the respondents think individual households are solely responsible for improvement of water, waste management, housing conditions and sanitation facilities respectively. Of the respondents, 68.7 percent, 49.8 percent 53.2 percent and 23.9 percent think the government is solely responsible for improvement of water, waste management, housing conditions and sanitation facilities respectively. Regarding cooking fuel 57.2 percent, 38.2 percent of the respondents think that the government and individual households respectively are responsible for a better type of cooking fuel.

The need for partnership is also expressed as 12.9 percent, 33.8 percent, 11.4 percent, and 28.9 percent think that households and government are jointly responsible for improvement of water,

waste management, housing conditions and sanitation. The respondents perceive a very minimal role for NGOs and the private sector in the improvement of their living environment.

Table 4.3 Responsibility for Improvement of the Environment

	Water	Solid Waste	Housing	Sanitation	Cooking fuel
Individual households	2.0%	4.5%	15.9%	17.9%	57.2%
Government (Local/Central)	68.7%	49.8%	53.2%	23.9%	38.3%
Private Sector	0.5%	1.5%	2.5%	12.9%	0.5%
Civil Society (NGOs, CBOs)	0.5%	0%	0.5%	3.5%	0%
Individual Households and Government (Local and Central)	12.9%	33.8%	11.4%	28.9%	0%
Individual households and Private sector	0%	0%	0%	0%	0%
Individual households and Civil Society (NGOs, CBOs)	0%	0%	0%	0.5%	0%
Government (Local/Central) and Private Sector	2.0%	2.5%	3.0%	6.0%	0%
Government (Local/Central) and Civil Society (NGOs, CBOs)	11.4%	6.0%	10.9%	3.5%	0%
Private Sector and Civil Society (NGOs, CBOs)	0%	0%	0%	0%	0%

4.2 Regression Results

Linear probability models are used to denote regression models in which the dependent variable Y is a binary variable taking the value of 1 if the event occurs and 0 otherwise. The four dependent variables in each of the regressions are incidence of four environmentally related diseases namely: malaria/fever, diarrhoea, cough and skin disease while household and neighbourhood environmental conditions and socio-economic variables are the explanatory variables.

Malaria/Fever

Table 4.4: Regression Results with Malaria/Fever Incidence as the Dependent Variable

Independent Variables	Coefficient	Standard Error	Z-Value
Waste dumped into street, empty plot	2.376863	0.9432	2.52
Household size	0.462617	0.209329	2.21
Household with children less than 3yrs	1.723806	0.604844	2.85
Household with children greater than 3yrs	-1.52753	0.727393	-2.1
Has primary education	-1.41996	0.537865	-2.64
Time taken to get water less than 10 mins	-2.16088	0.956143	-2.26
Time taken to get water greater than 10 mins	-2.51309	0.875643	-2.87
More than 4 households sharing toilet facility	5.625423	1.435057	-3.92
Mud main material for floor	1.440753	0.52391	2.75
Cement main material for floor	-2.52304	0.589495	-4.28
Household has electricity	-2.66716	0.820664	-3.25
Household has telephone (mobile)	-1.64643	0.575674	-2.86
Household has radio	-1.38676	0.4638	-2.99
Household has bicycle	-1.44507	0.521685	-2.77
Household always boils drinking water	-1.09642	0.498375	-2.2
Household cooks using kerosene	5.92345	1.839582	3.22
Household cooks using charcoal	5.00933	2.044624	2.45
Household has separate room for kitchen	-1.72647	0.834045	-2.07
Constant	10.42976	2.963	3.52

As shown in Table 4.4, there exists a significant positive relationship between the incidence of malaria and haphazard dumping of waste, household size, households sharing toilet facilities with three or more other households, households that use both kerosene and charcoal as their main source of cooking fuel and households whose dwelling had earth as the floor material. This means that there was increased probability of malaria occurring in these households. At the same time, there is a significant negative relationship between incidence of malaria and time taken to get drinking water, households with cement as the main floor material, households with electricity and those that have a separate room for kitchen. This implies reduced probability of malaria occurring in such households.

Households which dump waste haphazardly into the street have an increased probability of contracting malaria, due to the fact that the garbage especially the plastic bags trap water and block drains leading to breeding of mosquitoes next to their houses. Use of polluting fuel, sharing of toilets by many people or staying in houses with earth floors, is an indicator of the relative poverty of households. Higher probability of malaria infection occurring in such household could be attributable to the fact that they may not have the means to protect themselves. Richer households with houses with separate kitchens, have electricity, live in better built structures and own assets such as radios, telephone and bicycle have reduced probability of contracting malaria because they are more likely to have the means to protect themselves.

Diarrhoea

Table 4.5 shows that there exists a significant positive relationship between diarrhoea incidence and households sharing toilet facilities with three or more other households, households taking more than ten minutes to fetch drinking water, households dumping waste haphazardly and household size as would be expected. The same positive relationship was found to exist in households using kerosene and charcoal as cooking fuel, and households with earth as the main floor material. This means that there is increased probability of diarrhoea occurring in these households.

Higher household size increases the chances for transmission of diarrhoea due to increased contact, and the limited quantity of water available has to be shared among more people hence inadequate. Toilets shared by many people are not easily kept clean, thereby facilitating contamination with faecal matter leading to increased incidence of diarrhoea. The more time households take to fetch water, the more likely those households do not get adequate quantity of water. Reduced amounts of water mean that personal hygiene is difficult to achieve as there is a limited amount of water to wash utensils or for washing hands and bathing. Haphazard dumping of garbage also increases the chances of people getting into contact with diarrhoea causing pathogens.

There is a significant negative relationship between incidence of diarrhoea and households taking less than ten minutes to fetch drinking water and those who always boil drinking water as anticipated. Significant negative relationship also exist in households with cement as the main floor material for their dwellings, households with electricity, those that have a separate room for kitchen and own radios, telephones and bicycle; factors that point to relative affluence. Relatively well-off

households have reduced probability of contracting diseases as they are capable of protecting themselves and could also be less vulnerable due to better nutrition.

Table 4.5: Regression Results with Diarrhoea Incidence as the Dependent Variable

Independent Variables	Coefficient	Standard Error	Z-Value
Household always boils drinking water	-1.28437	0.419729	-3.06
Time taken to get water less than 10 mins	-2.11345	0.741562	-2.85
Time taken to get water greater than 10 mins	1.38498	0.512955	2.7
More than 4 households sharing toilet facility	-0.73899	0.21358	-3.46
Waste dumped into street, empty plot or river	1.91026	0.670267	2.85
Mud main material for floor	1.058298	0.52391	2.02
Cement main material for floor	-3.47212	0.589495	-5.89
Household size	0.545567	0.183076	2.98
Household with children less than 3yrs	1.734553	0.540359	3.21
Household with children greater than 3yrs	-1.85451	0.626525	-2.96
Has primary education	-0.84124	0.41237	-2.04
Household has electricity	-1.36721	0.676838	-2.02
Household has telephone (mobile)	-1.0904	0.514338	-2.12
Household has radio	-2.3638	0.71414	-3.31
Household has bicycle	-1.25275	0.452258	-2.77
Household cooks using kerosene	4.65929	0.572394	8.14
Household cooks using charcoal	1.98112	0.47623	4.16
Household has separate room for kitchen	-1.90918	0.660617	-2.89
Constant	8.772372	1.317173	6.66

Coughs

According to the results presented in Table 4.6, there exists a significant positive relationship between the incidence of cough and households that use charcoal and kerosene as their main source of cooking fuel, households living in poorly constructed structures with earth floors and household size (proxy for congestion and possible poor ventilation); all factors that account for possible indoor pollution. This relationship also occurs for households sharing toilet facilities with three or more

other households, households haphazardly dumping waste and households. This implies increased probability of cough occurring in these households.

Table 4.6: Regression Results with Cough Incidence as the Dependent Variable

Independent Variables	Coefficient	Standard Error	Z-Value
Household cooks using charcoal	3.87124	0.56432	6.86
Household cooks using kerosene	3.54158	0.673305	5.26
Household has separate room for kitchen	-2.45633	0.742092	-3.31
Household size	0.774453	0.222544	3.48
Time taken to get water less than 10 mins	-4.69751	0.852543	-5.51
Time taken to get water greater than 10 mins	-2.18121	0.669083	-3.26
More than 4 households sharing toilet facility	-2.92151	1.163949	-2.51
Waste dumped into street or empty spaces	1.370326	0.56392	2.43
Mud main material for floor	4.196682	0.639738	6.56
Cement main material for floor	-1.0602	0.2356	-4.5
Household size	0.774453	0.222544	3.48
Household with children less than 3yrs	1.639276	0.598276	2.74
Household with children greater than 3yrs	-4.30542	1.103955	-3.9
Has primary education	-1.17435	0.515065	-2.28
Household has electricity	-2.88148	0.957301	-3.01
Household has telephone (mobile)	-1.37148	0.626245	-2.19
Household has radio	-1.79772	0.74286	-2.42
Household has bicycle	-1.75463	0.693529	-2.53
Household always boils drinking water	-1.76597	0.513362	-3.44
Constant	8.309572	1.794724	4.63

Households living and cooking in the same room, and using polluting fuel are more likely to suffer indoor pollution especially when there is also congestion denoted by large family size; thereby leading to higher probability of incidence of cough. Poorer households living in poorly constructed houses with earth floors and large numbers sharing toilets had increased probability of suffering coughs as the houses offer little protection from weather conditions, and they were less likely to have the means to protect themselves.

At the same time, a significant negative relationship was noted between probability of cough occurring in households that have a separate room for kitchen and households with electricity; factors which point to reduced indoor pollution.

Skin Diseases

As for the incidence of skin disease infections, Table 4.7 shows rather unexpectedly that a significant negative relationship exist between the incidence of skin diseases and time taken to fetch water; a proxy for quantity of water. It should however be noted that majority of households identified cost of water as the main limiting factor in the quantity of water used.

The same negative relationship was found for households with cement as the main floor material, households with electricity, and those that have a separate room for kitchen; factors that point to well-off households. The reduced probability of skin disease infections occurring in such well- off households could be due to the fact that they are more capable of protecting themselves than poorer households.

It was also noted that there does exist a significant positive relationship between skin disease and household size (proxy for congestion), households sharing toilet facilities with three or more other households, households that use kerosene and charcoal as main source of cooking fuel and households with earth as the floor material. This means that there is an increased probability of skin disease infections occurring in these households despite there being no known direct linkage factors. This could be due to the fact that bigger household size translates to more people thereby increasing the probability of contact hence easier transmission of disease. Poverty in households indicated by higher members sharing toilets and living in houses with earth or mud floors showed increased probability of skin infections because such households may have reduced means of protecting themselves.

However, a positive relationship was noted between skin disease incidence and haphazard disposal of waste. This could be explained by the fact that dumped garbage increases the chance of people especially children, getting into contact with pathogens that could cause skin infection.

Table 4.7: Regression Results with Skin Infection Incidence as the Dependent Variable

Independent Variables	Coefficient	Standard Error	Z-Value
Time taken to get water less than 10 mins	-2.26384	0.788796	-2.87
Time taken to get water greater than 10 mins	-1.04432	0.485729	-2.15
Household always boils drinking water	-0.91826	0.413631	-2.22
Household size	0.444494	0.164627	2.7
Household with children less than 3yrs	1.820934	0.498886	3.65
Household with children greater than 3yrs	-1.76868	0.636217	-2.78
Has primary education	-0.91454	0.417596	-2.19
More than 4 households sharing toilet facility	-1.95352	0.842032	-2.32
Waste dumped into street, empty plot or river	1.591816	0.591753	2.69
Mud main material for floor	1.85328	0.67392	2.75
Cement main material for floor	-3.27487	0.498459	-6.57
Household has electricity	-1.45561	0.51254	-2.84
Household has telephone (mobile)	1.106659	0.494044	2.24
Household has radio	-1.73994	0.67179	-2.59
Household has bicycle	-1.44305	0.476254	-3.03
Household cooks using kerosene	3.80753	0.50971	7.47
Household cooks using charcoal	3.89992	0.436721	8.93
Household has separate room for kitchen	-1.82074	0.687071	-2.65
Constant	7.134937	1.505261	4.74

4.3 Hypotheses Testing

Four linear probability models described earlier on were run to test the first hypothesis. In addition descriptive statistics were used to validate the other two hypotheses.

The formulated hypotheses for the study were:

1. H_o: There is no significant relationship between environmental problems and incidence of common infectious and communicable diseases in Mukuru Kwa Njenga.

H_1: The alternative

From the four regressions, the null hypothesis is rejected. There exists a significant relationship between the incidence of all the four diseases and environmental problems in Mukuru Kwa Njenga. The coefficients for all the variables have the expected signs and the Z-values have absolute values greater than two which means that they are significant at the 95% confidence level.

The four regressions indicate that the time taken to fetch drinking water is significantly related to the incidence of environmentally related infections. Although the major limitation to the amount of water fetched is the cost rather than distance, the more the time taken to fetch water the greater the probability of the household having environmentally related infections.

Households sharing toilet facilities with three or more households have significantly increased probability of having the diseases the study investigated in Mukuru Kwa Njenga. This is evidenced by the significant positive coefficients (and absolute Z-value greater than two) of this variable in all the four regressions.

The type of cooking fuel is significantly related to all the four diseases investigated in Mukuru Kwa Njenga. Households using kerosene and charcoal (both polluting fuels) are more probable to have poor health as evidenced by the significant (absolute Z-value greater than two) positive coefficients of the two variables in all the four regressions.

Poor housing conditions especially denoted by structures with earth floor and household size (proxy for congestion) was found to have significant relationship to all the four diseases investigated.

2 H_o: Residents of Mukuru Kwa Njenga do not relate the incidence of diseases to the environmental conditions they face.

H_1: The alternative

Residents of Mukuru Kwa Njenga are able to relate the incidence of environmentally related infections to the prevailing environmental problems, which means that the null hypothesis is rejected. It is evident that households have ample awareness that boiling or treating their drinking water reduces infections which is also confirmed by the regression which indicates reduced probability of getting infections for those who treat water. Table 4.4 and descriptive statistics show

that residents of Mukuru Kwa Njenga clearly relate the incidence of disease to their poor living environment and to specific environmental problems.

3 H_o: Residents of Mukuru Kwa Njenga do not think they have a significant role in improving their environment.

H_1: The alternative

The null hypothesis that Residents of Mukuru Kwa Njenga do not think they have a significant role in improving their environment is adopted. Descriptive statistics as summarized by Table 4.3 show that only 2.5 percent, 4.5percent, 15.9 percent, 17.9 percent think individual households are solely responsible for improvement of water, waste management, housing conditions and sanitation facilities respectively. 68.7 percent, 49.8 percent, 53.2 percent and 23.9 percent of the respondents perceived the government as solely responsible for improvement of water, waste management, housing conditions and sanitation facilities respectively.

4.4 Conclusion

This study documents environmental problems in Mukuru Kwa Njenga, and also assesses the availability and adequacy of urban services at household and neighbourhood levels. Environmental problems were found to be serious, and affected the entire neighbourhood. The level of urban services was very low; electricity was available to only about 4% of households, there was no garbage collection service in place, there was no water connection to individual households, and an average of 15 households shared a pit latrine. Most households used paraffin for cooking and lighting followed by charcoal and wood fuel; few respondents reported using electricity or gas.

The respondents were found to have a high level of awareness and knowledge on the linkage between diseases and environmental problems. Despite this, the respondents did not think they had a significant role in improving their environment. The linkage between environmental problems and human health was confirmed by the findings. The findings indicate that given a particular set of environmental conditions, certain health outcomes can be predicted. Also observed was that relative poverty of households indicated by the condition of housing one lives in or ability to spend on certain household assets, tended to increase the probability of disease incidence. Households with children aged three years and below were also found to have increased probability of disease incidence, pointing to the vulnerability of young children.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This study sought to document data for analysis of environmental problems at both household and neighbourhood level, and their relationship to incidence of disease in Mukuru Kwa Njenga informal settlement. The study therefore assessed the extent certain diseases are linked to environmental problems and whether residents have information on interactions between urban environment and their quality of life. The respondents' perception as to who is responsible for their resolution was also investigated.

The findings confirm the well known link between urban environmental problems and human health in urban informal settlements. Residents of Mukuru Kwa Njenga informal settlement suffer common communicable and infectious diseases such as: upper respiratory diseases, diarrhoea, malaria and skin diseases which are linked to the environmental problems that beset them. The awareness of the link between environmental problems and health is high among the households and the challenge is how to capture and transform this into viable actions.

However, individual households did not perceive their role in improving the environment as significant. They identified the government, or households in partnership with government as having the major role in improving the living environment. This could be explained by the fact that they do not enjoy security of housing and land tenure and that most of the residents rent their houses. The importance given to government as the actor responsible for improving the environment may also indicate that there is an overall understanding that public authorities should direct the process. The role of NGOs, CBOs, and the private sector was not perceived as being significant. This could be due to the fact that there were indeed no NGOs engaged in environmental improvement in the study area.

The following recommendations to be undertaken by the various actors who have a stake in Nairobi's urban environment, would go a long way in preventing and reducing the health burden households in informal settlements have to contend with:

Government

It is recommended that environmental education be emphasized in primary school as majority of citizens who end up in informal settlements have this level of education.

The government should also explore ways of providing some form of security of land and housing tenure even on communal basis to encourage households to invest in improving their housing structures.

Nairobi City Council

The city council should undertake to supply water to residents of informal settlements, and clamp down on unhygienic illegally connected selling points.

The council should also provide garbage collection service, and in consultation with residents agree on the logistics of undertaking this.

Waterborne sanitation units incorporating showers with appropriate water borne lavatories and wash hand basins should be constructed in strategic places which should be well lit to encourage use even at night.

Where waterborne sanitation is not possible, pit latrines with hand washing facilities could be constructed in a manner that allows easy emptying to minimize overflowing when they become full thereby leading to human excreta contamination. This would also minimize the need for digging new ones and therefore reduce demand for more land.

The main access roads should be paved and provided with proper drainage so as to prevent flooding and ensure the area accessible at all times.

Provide a health center; the fact that as many 40 percent of the residents do not seek medical attention when they get sick is an indication that existing medical facilities may be too expensive.

NGOs and CBOs

They should make a bigger presence in informal settlements, and move from not just providing curative health care but also integrate this with environmental education and improvement.

They should capture the high level of environmental awareness by designing intervention projects that stimulate people to participate, and seek to motivate joint responsibility between households and public authorities in the environmental improvement of the area.

Residents

The community should identify strategic open and accessible areas where all households deposit their garbage to facilitate collection or burning. Households should organize to deposit their refuse in closed containers to avoid littering

The residents should initiate community based enterprises that combine environmental management with income generating activities such as waste recycling and composting as this will not only improve the environment but also their incomes.

The residents should communally construct and operate water kiosks so that they pay for water directly to Nairobi City Council in order to lower the cost of water.

The residents should take advantage of the fact that improvement of environmental infrastructure such as roads, pathways, and sanitation would not only lead to lessening the disease burden but also to higher incomes due to proliferation of commercial enterprises such food stalls, beauty salon, furniture shops and general stores as higher income groups would attracted to shop in the area.

Recommendations for Further Research

Ability to cope with the effects of environmental problems is often limited by education and economic circumstances. Research should be undertaken to find out the extent to which socio-economic factors affect the perceptions people have in informal settlements on the link between environment and quality of life and actions people take to protect themselves.

Most residents of informal settlements work in industries or are engaged in informal employment; which expose them to environmental hazards. Research should therefore be undertaken to establish the contribution of the work environment to their health.

Since people are not affected equally by the same environmental problem as substantial variations in sensitivity to an exposure may occur within a population, research should also be undertaken to find out whether there is a significant difference of the effects of urban environment on health as relates to gender, age., place they had migrated from, and the period of stay in the area.

The research assessed the environmental problem-disease relationship within the study area, however further research should be undertaken to quantify the contribution of specific environmental problems to the disease burden.

REFERENCES

African Medical and Research Foundation (AMREF) 1990 *Child Survival Baseline Survey, Nairobi, Mukuru Viwanda Slums.* AMREF, Nairobi, Kenya

African Medical and Research Foundation (AMREF) 1991 *Rapid Appraisal on the Environmental Health Situation in the Mukuru and Soweto Slum Villages of Nairobi.* AMREF, Nairobi, Kenya

African Population and Health Centre (APHRC) 2002 *Population and Health Dynamics in Nairobi's Informal Settlements:* APHRC, Nairobi, Kenya.

Briggs, D., Corvalan. C., and Nurminen, M. 1996 *Linkage Methods for Environment and Health Analysis.* WHO, Geneva.

Central Bureau of Statistics (CBS) Kenya, Human Resources and Social Services Department (Kenya), and Kenya 2000 *Second Report on Poverty in Kenya; Volume II – poverty and Social Indicators.* CBS, Nairobi Kenya.

Central Bureau of Statistics (CBS) Kenya 2001 *Population and Housing Census. Volume I.* CBS, Nairobi, Kenya.

Central Bureau of Statistics (CBS) Kenya, Ministry of Health (MOH) Kenya, and ORC Macro 2004 *Kenya Demographic and Health Survey 2003.* Calverton, Maryland: CBS, MOH, and ORC Macro.

Eckholm, Erick P. 1997 *The Picture of Health: Environmental Causes of Diseases.* George Mc Leod Limited, Toronto, Canada.

Ferguson, B. and Navarrete, J. 2003 "A Financial Framework for Reducing Slums: Lessons from Experience in Latin America," *Environment and Urbanization* Vol. 15 No. 2 pp. 201-215

Nachimias, Frankfort Chava and Nachmias, David 1996 *Research Methods in the Social Science.* St. Martins Press Inc – New York

Government of Kenya 2004 *Kenya Demographic and Health Survey.* Central Bureau of Statistics, Nairobi, Kenya.

Hinkle, L. E. and Loring, W. C. (Eds.) 1977 *The Effect of the Man-made Environment on Health and Behaviour.* US Department of Health, Education and Welfare, Atlanta, Georgia, USA.

Israel, Glenn D. 1992 *Sampling the Evidence of Extension Program Impact.* Program Evaluation and Organizational Development, IFAS, University of Florida

Jacobi, Pedro R. (1994) "Households and Environment in the City of Sao Paulo; Problems, Perceptions and Solutions," *Environment & Urbanization* Vol. 6 No. 2 pp.87-110

Kish, Leslie 1965 *Survey Sampling.* John Wiley and Sons. Inc., New York

Kotcheeva, Lada and Singh, Ashbindu 1998 *An assessment of Risks and Threats to Human Health Associated with Degradation of Ecosystem.* United Nations Environment Programmes, Washington DC, USA.

Lamba, D.1994 "The forgotten half: Environmental Health in Nairobi's Poverty Areas," *Environment and Urbanization*, Vol. 6 No.1 pp. 164-173.

Macoloo, G. C. 1988 'Housing the Urban Poor: A Case Study of Kisumu Town, Kenya', *Third World Planning Review* Vol. 10 No. 2 pp. 159 – 174.

Macoloo, G. C. 1994a 'Tenure Insecurity and Housing Development in Kenya', *Appropriate Technology,* Vol. 21 No. 2.

Macoloo, G. C. 1994b 'Housing Policy and Urban Poverty in Kenya', *Paper Presented at the International Seminar on 'Urban Poverty' (October 7 – 9)* Bergen, Norway: CROP Secretariat

Macoloo, G. C. 1994c 'The Changing Nature of Financing Low-Income Urban House Development in Kenya', *Housing Studies,* Vol.9, No. 2

Macoloo, G. C. 1998a 'The Relevance of Kenya's Urban Settlement Policies for Independent South Africa' *South African Geographical Journal* Vol. 80 No. 2

Macoloo, G. C. 1998b 'Partnership in the Development Process: Theoretical and Empirical Considerations', Pp. 119 – 129 in Tirfie, P., P. Ngahu, and I. Mwangi (Eds) *Regional development policy in Africa: Problems and prospects towards the 21st Century.* Nairobi: United Nations Centre for Regional Development.

Matrix Development Consultants 1993 Nairobi's *Informal Settlements: An Inventory.* A report prepared for USAID/REDSO/ESA. Nairobi, Kenya, USAID.

Satterthwaite, D. 2003 "The Millennium Development Goals and Urban Poverty Reduction: Great Expectations and Nonsense Statistics" *Environment & Urbanization* vol. 15 No. 2 (October 2003) pp. 181-189

Stephens, C. et al.1997 "Urban Equity and Urban Health using existing Data to understand inequalities in Health and Environment in Accra, Ghana and Sao Paulo, Brazil" *Environment and Urbanization* vol. 9 No. 1 pp.181-202

United Nations (UN) 1993 *Agenda 21: Programme of Action for Sustainable Development.* UN, New York.

United Nations Center for Human Settlements (Habitat) 1989 *Urbanization and Sustainable Development in the Third World: an Unrecognized Global Issue,* Habitat, Nairobi, Kenya.

United Nations Centre for Human Settlements (Habitat) 1990 *The Global Strategy for Shelter to Year 2000.* Habitat, Nairobi, Kenya.

United Nations Centre for Human Settlements (Habitat) 1991 *Human Settlements Development through Community Participants.* Habitat, Nairobi, Kenya.

United Nations Centre for Human Settlements (Habitat) 1992 *Delivery of Basic Infrastructure to Low-Income Settlements.* Habitat, Nairobi, Kenya.

United Nations Centre for Human Settlements (Habitat) 1994a *Population, Urbanization and Quality of Life.* UNCHS (Habitat), Nairobi, Kenya

United Nations Centre for Human Settlements (Habitat) 1994b *Sustainable Human Settlements Development: Implementing Agenda 21* Habitat, Nairobi, Kenya.

United Nations Centre for Human Settlements (Habitat) 1996. *An Urbanizing World: Global Report on Human Settlements, 1996.* Oxford University Press, Great Britain.

United Nations Centre for Human Settlements (Habitat) S1997 *Implementing the Urban Environment Agenda.* Habitat, Nairobi, Kenya

United Nations Development Programme (UNDP) Kenya 2002 *Kenya Human Development Report 2001: Addressing Social and Economic Disparities for Human Developments.* UNDP, Nairobi, Kenya.

World Health Organization (WHO) 1993 *The Urban Health Crisis.* WHO, Geneva, Switzerland.

World Resources Institute(WRI), UNEP, UNDP, and The World Bank 1996 *The Urban Environment.* Oxford University Press, Oxford United Kingdom.

APPENDICES

Appendix 1 Questionnaire

Environmental Problems and Human Health in Urban Informal Settlements: A Case Study of Mukuru Kwa Njenga, Nairobi.

Household Questionnaire

My name is_____ a student from the University of Nairobi. Today we are visiting your household to understand some aspects of environment and health that affect your day to day life. If you do not mind, please spare some few minutes of your time to answer some few questions. Please note that you are under no obligation to answer the questions and you are free to terminate this interview should you deem so. However, the information that you will provide to us will be treated in strict confidence and will be used only for research purposes. Thank you once again for granting us the opportunity to talk to you.

Structure No _____

1. Sex of respondent *1. Male 2. Female*
2. Age of respondent _____ years
3. Did you attend school? 1Yes 2 NO
4. If yes, to what level? *1 Primary*
   2 Secondary
   3 Higher
5. How many people live in your household?

   Children under 3years ----------
   Children over 3 years ----------
   Adults ---------

6. How long have you lived in this area?_____
   1. *In this house _____years _____months*
   2. *Area(Mukuru Kwa Njenga)_____years_____months*
7. Are you renting the house or you own it? *1 renting 2 owner occupying*
8. What is the main source of drinking and cooking water for your household?

   1. Piped into dwelling/ compound
   2. Outdoor tap
   3. Well
   5. Water vendor
   6. Other (specify) _____

9. If you do not have a private connection, how long does it take you get water?
_____minutes

10. How much do you pay for water? _____

11. What most limits the amount of water you use? *1 Cost 2 Time spent fetching water*

12. Do you always boil water for drinking? *1. Yes 2. No*

13. How do you store water for drinking?
    1. *Closed container*
    2. *Open container*
    3. *Other(specify)*_____

14. What kind of toilet facility does your household use?
    1. *Own flush toilet*
    2. *Shared flush toilet*
    3. *Traditional pit latrine*
    4. *Ventilated pit (VIP) latrine*
    5. *No facility*

15. How many persons/households share this toilet facility? _____

16. What is the main source of cooking fuel used by your household?
    1. *Kerosene*
    2. *Charcoal*
    3. *Firewood*
    4. *OTHER (Specify)*_____

17. What is the main source of lighting fuel used by your household?
    1. *Kerosene lamp*
    2. *Gas lamp*
    3. *Electricity*
    4. *OTHER (Specify)*_____

18. Do you have a kitchen*? 1. Yes 2. No*

19. If no where do you do your cooking?

20. Does your household have?

a) A car	*1. Yes 2. No*
b) A motor cycle	*1. Yes 2. No*
c) A bicycle	*1. Yes 2. No*
d) Electricity	*1. Yes 2. No*
e) A refrigerator	*1. Yes 2. No*
f) A radio	*1. Yes 2. No*
g) Television	*1. Yes 2. No*
h) Telephone	*1. Yes 2. No*

i) An electric/gas stove *1. Yes 2. No*
j) Sofa set *1. Yes 2. No*
h) Kerosene stove *1. Yes 2. No*

21. Main material of the floor (Observe)
    1. *Mud/earth*
    2. *Wood Planks*
    3. *Cement*
    4. *Other(specify)*_____
22. Main material for the roof (Observe)
    1. *Grass/Thatch*
    2. *Corrugated Iron (Mabati)*
    3. *Tins*
    4. *Other(specify)*_____
23. Main material for the wall (Observe)
    1. *Mud/`Dung/ Sand*
    2. *Wood Planks*
    3. *Cement*
    4. *Corrugated Iron (mabati)*
    5. *Tins*
    6. *Other(specify)*_____
24. How does your household dispose off its garbage?
    1. *Regular collection by local authority*
    2. *Infrequent collection by local authority*
    3. *Pays for private collection*
    4. *Dumps in street, empty plot*
    5. *Other (specify)*
25. Have you or any member of your household complained of the following in the last two weeks?

    a) *Malaria* *1. Yes 2. No*
    b) *Diarrhea* *1. Yes 2. No*
    c) *Coughing* *1. Yes 2. No*
    d) *Skin infection* *1. Yes 2. No*

26. Did you seek medical treatment for the complaint? *1. Yes 2. No*

27. Where did you seek medical attention?

    1. *Self treatment (kiosk/shop)*
    2. *Pharmacy/ Chemist shop*
    3. *Private clinic*
    4. *Government health facility*
    5. *Mission health facility*
    6. *Other(specify)*_____

28. Do you think that the state of your house and neighbourhood environment leads to ill health?

		If Yes which disease
Water quality	*1 Yes 2 No*	_____
Water quantity	*1 Yes 2 No*	_____
Solid waste disposal	*1 Yes 2 No*	_____
Housing condition	*1 Yes 2 No*	_____
Sanitation facilities	*1 Yes 2 No*	_____
Cooking fuel pollution	*1 Yes 2 No*	_____

29. What is your opinion on the environmental status of your neighbourhood?
    1. *Good*
    2. *Fair*
    3. *Poor*

30. If fair/poor, who do you think is responsible for this status?

1. Individual households 2.Government (Local, Central) 3.Private sector 4.Civil society (NGOs, CBOs)

Drinking Water	
Solid waste disposal	
Housing condition	
Sanitation facilities	
Cooking fuel provision	

31. Who do you think is responsible for the improvement and management of the neighbourhood environment?

1. Individual households 3.Neighbourhood community 2.Government (Local, Central)
4. Civil society (NGOs, CBOs)

Drinking Water	
Solid waste disposal	
Housing condition	
Sanitation facilities	
Cooking fuel provision	

32. What do you think should be done to improve the neighbourhood environment?

_____

_____

_____

Appendix 2 Study variables

Variable Name	Observations	Mean	Std. Dev.	Min	Max
Sex of respondent	200				
Age of respondent	199	31.3	8.8	16	70
Respondent attended school	200				
Level of schooling	199				
Children less than 3yrs in household	200	0.7	0.8	0	4
Children more than 3yrs in household	200	1.6	1.7	0	9
Adults in household	200	2.1	0.9	1	9
Length of stay in dwelling in months	198	58.1	75.7	0.1	540
Length of stay in Mukuru in months	199	96.8	84.3	1	540
If dwelling is rented	200				
Source of drinking water	200				
Time spent to get water in minutes	200	14.0	14.0	0	120
Amount paid for water (per 20 litres)	199	3.3	1.5	0	20
Limitation to water amount	197				
If household always boils water before drinking	200				
Where drinking water is stored	200				
Type of toilet facility	199				
Number of people sharing toilet facility	183	14.6	9.6	0	60
Source of cooking fuel	200				
Source of lighting fuel	199				
If household has kitchen	200				
Where household uses as kitchen	200				
Household has car	201				
Household has motor cycle	201				
Household has bicycle	201				
Household has electricity	201				
Household has refrigerator	201				
Household has radio	201				
Household has television	201				
Household has telephone	201				
Household has electric/gas stove	201				
Household has sofa set	201				
Household has kerosene stove	200				
Main floor material	201				
Main roofing material	201				
Main wall material	201				
Household's garbage disposal	201				
Malaria incidence	201				
Diarrhea incidence	201				
Cough incidence	201				
Skin infection incidence	200				
If household sought medical attention	201				
Where household sought medical attention	200				

If water quality lead to disease	201				
Water quality disease	0				
If water quantity lead to disease	201				
Water quantity disease	0				
If solid waste lead to disease	201				
Solid waste disease	0				
If housing condition leads to disease	201				
Housing condition disease	0				
If sanitation leads to disease	201				
Sanitation disease	0				
If source of cooking fuel leads to disease	201				
Source of cooking fuel disease	0				
If poor drainage lead to disease	200				
Poor drainage disease	0				
Opinion on environmental status	0				
Responsibility for drinking water status	201				
Responsibility for solid waste management status	201				
Responsibility for housing condition status	201				
Responsibility for sanitation facilities status	200				
Responsibility for source of cooking fuel status	199				
Responsibility for drinking water	201				
Responsibility for solid waste management	201				
Responsibility for housing condition	201				
Responsibility for sanitation facilities	201				
Responsibility for source of cooking fuel	201				
What needs to be done to improve environment status					